APPLICATION OF NONLINEAR PHONOLOGICAL THEORY TO INTERVENTION WITH SIX PHONOLOGICALLY DISORDERED CHILDREN

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ABSTRACT

APPLICATION OF NONLINEAR PHONOLOGICAL THEORY TO INTERVENTION WITH SIX PHONOLOGICALLY DISORDERED CHILDREN

The purpose of this investigation was to examine the utility of nonlinear phonological frameworks for designing and executing an intervention program with phonologically disordered children. Six such children between the ages of 3 and 6 years participated in the study three times a week over three consecutive six-week blocks.

The following general questions were addressed:

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real?

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of intervention methods that contrast the onset and rime versus those that utilize the mora a constituent?

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

An alternating block, mulitiple baseline design (counterbalanced over six single subjects) provided an opportunity to investigate the above questions. Within each six-week block, three week periods were devoted in turn to prosodic (syllable structure) training and segmental training. Prosodic subblocks were divided into two four-session subblocks to contrast developmental change for targets presented as moraic constituents versus onset-rime constituents. Segmental

periods were divided into two four-session subblocks to contrast developmental change for features from higher and lower levels in the feature hierarchy.

Analyses during and after the study demonstrated the following with respect to the four research questions:

1. The nonlinear frameworks provided a logical model for deriving attainable intervention goals. All of the children became intelligible by the end of the project as a result of attaining the goals determined by nonlinear phonological theory.

2. Rate of attainment of syllabic and segmental goals differed, with a faster rate of change for syllabic goals overall, suggesting independence of segmental and prosodic tiers, and possible dominance of the prosodic tier. Interactions between tiers were also observed, suggesting that they are interdependent as well as autonomous.

3. Moraic and onset-rime condition quantitative results were virtually equivalent, but some qualitative differences appeared which had relevance for the each of the theories with respect to status of the onset, word-final consonants, and epenthesis.

4. Higher level features in the feature hierarchy tended to be acquired before lower level features.

The nonlinear phonological frameworks stimulated a successful intervention study. Evidence gained through this study in turn contributes to the understanding of the nonlinear constructs.

TABLE OF CONTENTS

ABSTRACT ..... ii.

LIST OF TABLES ..... xiv.

LIST OF FIGURES ..... xvii.

ACKNOWLEDGEMENTS ..... xxi.

DEDICATION ..... xxii.

Chapter

1. INTRODUCTION 1

Nonlinear Phonology 2

Nonlinear Phonology in the Tradition of Generative Grammar 2

Assumptions Particular to Nonlinear Phonology 3

Phonological Process Approach to Intervention with Phonologically Disordered Children 13

Theoretical Deficiences of the Phonological Process Approach 14

Clinical Deficiencies of the Phonological Process Approach 15

Nonlinear Frameworks and Developmental/Clinical Phonology 16

2. METHOD 19

Subjects 19

Subject Recruitment and Participation 20

Subject Characteristics and Matching 20

Design 21

Assessment and Analysis Procedures During the Intervention Period . 24

Initial Assessment 24

Analysis during the Study 27

Intervention 27
Segmental Condition Target Selection 27
Syllabic Condition Target Selection 29
General Outline for Training Sessions 29
Treatment Methodology Specific to the Syllabic Condition 30
Analysis Following the Intervention Period 34
Feature Hierarchy Analysis 35
Syllabic Data 36
Results Reporting 37
3. SUBJECT 1: SUMMARY 38
Case History Information 38
Subject Characteristics 38
Prior Treatment 38
Phonological System at Initial Assessment 40
Phonotactics: Syllables and Words 41
Segmental Development and Feature Hierarchy 45
Intervention Plan: Block 1 49
Segmental Intervention Plan 49
Syllabic Intervention Plan 50
Results of Block 1 Intervention 51
Segmental Goals 51
Syllabic Goals 53
Intervention Plan: Block 2 54
Segmental Intervention Plan 54
Syllabic Intervention Plan 55
Results of Block 2 Intervention 56
Segmental Goals 58
Syllabic Goals 61
Block 3 and Beyond 63

Discussion 64

Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 64

Conversational Intelligibility Gains 64

Language Test Results 65

Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 67

Onset-Rime versus Moraic Constituency and Intervention? 67

Nonmatches and Syllable Theories at Assessment 68

Intervention Data and Syllable Theory 68

Higher versus Lower Level Features in Development? 72

Block 1 72

Block 2 72

Summary 73

4. SUBJECT 2: SUMMARY 75

Case History Information 75

Subject Characteristics 75

Prior Treatment 75

Phonological System at Initial Assessment 75

Phonotactics: Syllables and Words 75

Segmental Development 78

Intervention Plan: Block 1 82

Segmental Intervention Plan 83

Syllabic Intervention Plan 84

Results of Block 1 Intervention 85

General Results 85

Segmental Goals 86

Syllabic Goals 89

Intervention Plan: Block 2 93

Segmental Intervention Plan 93
Syllabic Intervention Plan 94
Results of Block 2 Intervention 95
Segmental Goals 95
Syllabic Goals 100
Block 3 and Beyond 104
Discussion 104
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 104
Conversational Intelligibility Gains 104
Language Test Results 108
Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 108
Interaction of the Syllabic and Skeletal Tiers 109
Onset-Rime versus Moraic Constituency and Intervention? 109
Higher versus Lower Level Features in Development? 111
Summary 111
5. SUBJECT 3: SUMMARY 113
Case History Information 113
Subject Characteristics 113
Prior Treatment 113
Phonological System at Initial Assessment 113
Phonotactics: Syllables and Words 113
Segmental Development 121
Intervention Plan: Block 1 128
Syllabic Intervention Plan 128
Segmental Intervention Plan 130
Results of Block 1 Intervention 133
General Results 133
Syllabic Goals 133

Segmental Goals 142
Intervention Plan: Block 2 144
Syllabic Intervention Plan 144
Segmental Intervention Plan 146
Results of Block 2 Intervention 147
General Results 147
Syllabic Goals 148
Segmental Goals 153
Block 3 and Beyond 153
Discussion 154
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 154
Conversational Intelligibility Gains 154
Language Test Results 157
Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 158
Differences between Sylalbic and Segmental Conditions 158
Interaction of the Syllabic and Segmental Tiers 159
Onset-Rime versus moraic constituency and intervention? 159
Quantitative Comparisons of Moraic and Onset-Rime Conditions . 160
Qualitative Comparisons of Moraic and Onset-Rime Conditions .. 160
Higher versus Lower Level Features in Development? 162
Trained Targets: Block 1 162
Trained Targets: Block 2 163
Generalizations and Relevance of Features 163
Summary 164
6. SUBJECT 4: SUMMARY 166
Case History Information 166
Subject Characteristics 166
Prior Treatment 166

Phonological System at Initial Assessment 168
Phonotactics: Syllables and Words 168
Segmental Development 172
Intervention Plan: Block 1 180
Syllabic Intervention Plan 180
Segmental Intervention Plan 183
Results of Block 1 Intervention 184
Syllabic Goals 185
Segmental Goals 191
Intervention Plan: Block 2 194
Syllabic Intervention Plan 194
Segmental Intervention Plan 197
Results of Block 2 Intervention 197
Syllabic Goals 197
Segmental Goals 201
Block 3 and Beyond 203
Discussion 204
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 204
Conversational Intelligibility Gains 205
Language Test Results 207
Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 209
Onset-Rime versus Moraic Constituency and Intervention? 210
Higher versus Lower Levels Feature in Development? 212
Summary 213
7. SUBJECT 5: SUMMARY 215
Case History Information 215
Subject Characteristics 215
Phonological System at Initial Assessment 218

Phonotactics: Syllables and Words 218
Segmental Development 227
Intervention Plan: Block 1 231
Syllabic Intervention Plan 231
Segmental Intervention Plan 232
Results of Block 1 Intervention 233
Syllabic Goals 234
Segmental Goals 238
Intervention Plan: Block 2 241
Syllabic Intervention Plan 241
Segmental Intervention Plan 242
Results of Block 2 Intervention 242
Syllabic Goals 242
Segmental Goals 247
Block 3 and Beyond 249
Discussion 250
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 250
Conversational Intelligibility Gains 250
Language Test Results 251
Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 253
Onset-Rime versus Moraic Constituency and Intervention? 254
Higher versus Lower Level Features in Development? 255
Summary 255
8. SUBJECT 6: SUMMARY
Case History Information 257
Phonological System at Initial Assessment 257
Phonotactics: Syllables and Words 257
Segmental Development 266

Intervention Plan: Block 1 270
Segmental Intervention Plan 270
Syllabic Intervention Plan 271
Results of Block 1 Intervention 272
Syllabic Results 273
Segmental Goals 281
Intervention Plan: Block 2 284
Segmental Intervention Plan 284
Syllabic Intervention Plan 285
Results of Block 2 Intervention 286
Segmental Goals 286
Syllabic Goals 292
Block 3 and Beyond 294
Discussion 294
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children? 294
Conversational Intelligibility Gains 294
Language Test Results 298
Are the Separate Prosodic and Segmental Levels of Representation of Nonlinear Phonology Psychologically Real? 299
Onset-Rime versus Moraic Constituency and Intervention? 300
Higher versus Lower Level Features in Development? 301
Summary 302
9. DISCUSSION 305
Between-Subject Comparisons 305
Will Nonlinear Phonological Frameworks Help to Predict Logical and Attainable Goals for Phonologically Disordered Children?
Are the Separate Prosodic and Segmental Levels of Representations of Nonlinear Phonology Psychologically Real? 305
Onset-Rime versus Moraic Constituency and Intervention? 314
Higher versus Lower Levels Feature in Development? 323

Limitations of the Study 333
Sample Size 333
Design 333
Extraneous Variables 334
Syllabic/Segmental Condition Contrast 334
Subblock Conditions 334
Future Research 335
Summary 336
Implications for Intervention 337
Intervention and Phonological Theory 338
NOTES .....
REFERENCES 341
APPENDIX 1: BASIC WORD LIST FOR ELICITATION 345
APPENDIX 2: FEATURE SPECIFICATIONS FOR ADULT ENGLISH 347
APPENDIX 3: INTERTRANSCRIBER RELIABILITY DATA FOR S1, S4, AND S5..... 354
APPENDIX 4: MATCH AND NONMATCH DATA FOR ALL SUBJECTS 359
Table 1.1.--S1: Assessment and Block 1 Proportional Match Data ... 360
Table 1.2.--S1: Block 2 Proportional Match Data 361
Table 2.1.--S2: Proportional Match Data: Assessment and Block 1 .. 362
Table 2.2.--S2: Block 1 Session Data for Syllabic Condition 364
Table 2.3.--S2: Block 2 Session Data for Syllabic Condition 366
Table 3.1.--S3: Proportional Match Data: Assessment and Block 1 .. 370
Table 3.2.--S3: Proportional Matches in Block 1 and Block 2 372
Table 4.1.--S4: Proportional Matches: Assessment and Block 1 374
Table 4.2.--S4: Proportional Match Data: Block 2 376
Table 4.3.--S4: Diphthongs: Blocks 1 and 2 377
Table 5.1.--S5: Proportional Match Data: Assessment/Block 1 379
Table 5.2.--S5: Proportional Match Data: Block 2 381

Table 6.1.--S6: Proportional Match Data: Assessment and Block 1 .. 383

Table 6.2.--S6: Proportional Match Data: Block 2 385

APPENDIX 5: PHONETIC TRANSCRIPTIONS FOR ALL SUBJECTS 387

Subject 1 389

Subject 2 399

Subject 3 409

Subject 4 424

Subject 5 440

Subject 6 457

LIST OF TABLES

Table — Page

2.1. Main characteristics of subjects during study 21

2.2. Order of treatment conditions for each subject within Blocks 1 and 2 23

2.3. Sample feature chart showing match and nonmatch data and feature differences 36

3.1. Subject information for S1 39

3.2. S1: Syllable-initial clusters at Initial Assessment and at the end of Block 1 .. 42

3.3. S1: Summary of singleton segmental acquisition at Initial Assessment characterized by sound class, matches and nonmatches according to word position, and feature differences 47

3.4. S1: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test 70

4.1. Subject information for S2 76

4.2. S2: Summary of singleton segmental acquisition at Initial Assessment 79

4.3. S2: Language test scores at Initial Assessment and end of Block 3 108

4.4. S2: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test 110

5.1. Subject information for S3 114

5.2. S3: Proportion of spontaneous, echoic and prompted utterances per adult word shape 115

5.3. S3: Diphthong realization in various syllable/word types at Initial Assessment 118

5.4. S3: Summary of singleton consonant acquisition at Initial Assessment 123

5.5. S3: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test 160

6.1. Subject information for S4 166

6.2. S4: Summary of singleton segmental acquisition at Initial Assessment 174

6.3. S4: Proportional matches for onset-rime and moraic targets across the

study cast for Kolmogorov-Smirnov test 211

7.1. Subject information for S5 216

7.2. S5: Language test results at Initial Assessment and end of Block 3 217

7.3. S5: WI consonant slot matches by cluster category and match type at Initial Assessment and at the ends of Blocks 1 and 2 220

7.4. S5: WI /s/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2 221

7.5. S5: SI /l/-, /w/- and /j/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2 225

7.6. S5: SI /r/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2 226

7.7. S5: Summary of singleton segmental acquisition at Initial Assessment 228

7.8. S5: Proportional matches across the study for onset-rime and moraic trained skeletal slots cast for Kolmogorov-Smirnov test 255

8.1. Subject information for S6 258

8.2. S6: Number of substitutions over total nonmatches (and percentage) for singleton consonants, by substitution type, in WI, SIWW and WF positions at Initial Assessment 259

8.3. S6: WI singleton matches and substitutions at Initial Assessment 261

8.4. S6: Proportion of glottal and [h]([C]) onsets in vowel-initial child forms at Initial Assessment 262

8.5. S6: WI cluster realizations at Initial Assessment 263

8.6. S6: Substitutions for SIWW singleton consonants at Initial Assessment 264

8.7. S6: Substitutions for WF singletons at Initial Assessment 265

8.8. S6: Summary of singleton segmental acquisition at Initial Assessment 267

8.9. S6: Substitutions for SIWW singletons at end of Block 1 276

8.10. S6: Proportion of substitution types over total nonmatches for singletons within and across word positions at the end of Block 1 276

8.11. S6: Differences between Initial Assessment and Block 1 for singleton substitution types expressed as a proportion of total nonmatches 277

8.12. S6: Substitutions for WF singletons at the end of Block 1 279

8.13. S6: WI singleton matches and substitutions at end of Block 1 282

8.14. S6: Substitution types for /s/ and /z/ singletons in WI, SIWW and WF

positions at the end of Block 2 287

8.15. S6: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test 301

9.1. Difference in average proportional gains between syllabic and segmental conditions in Blocks 1 and 2, by subject 307

9.2. Feature specifications for /h/ and /l/ and S3's realizations of these in Blocks 1 and 2 325

9.3. Summary of intervention targets for subjects across blocks 327

9.4. Summary of intervention contrasts in terms of place and sound class and identification of faster rate of acquisition within those categories 329

LIST OF FIGURES

Figure		Page
1.1.	Alternate Representations of Word/Syllable Constituents in Onset-Rime and Moraic Theories	4
1.2.	Feature Geometry for English	8
1.3.	Regressive consonant assimilation in the absence of CV interaction	10
2.1.	Schematization of Research Design	22
2.2.	Stimuli Constituents for Onset-Rime and Moraic Subblock Condition Training	33
3.1.	S1: Proportional Matches for Primary Training and Observation Targets at Initial Assessment	40
3.2.	S1: Feature Geometry at Initial Assessment	48
3.3.	S1: Proportional Gain in Matches for Syllabic and Segmental Targets between Initial Assessment and Block 1 Major Probes	52
3.4.	S1: Proportional Matches for Syllabic Targets in Block 1 Minor Probe	54
3.5.	S1: Proportional Matches for Syllabic and Segmental Targets in Block 2 Minor Probe	56
3.6.	S1: Proportional Gain in Matches for Syllabic and Segmental Targets between Block 1 and Block 2 Major Probes	57
3.7.	S1: Proportional Matches for Trained and Untrained Segmental Targets in Block 2 Major Probe	58
3.8.	S1: Proportional Matches for Syllabic Target /st/ in Block 2 Sessions	60
3.9.	S1: Developmental Progression in Proportional Matches for Trained Phonological Targets across the Intervention Period	65
3.10.	S1: Feature Geometry at End of Block 2	66
3.11.	S1: Proportional Differences between Moraic and Onset-Rime Match Scores for Minor Probes, Introductory Parts of Production Sessions, and Overall Session Data (Spontaneous and Echoic Responses)	69
4.1.	S2: Feature Geometry at Initial Assessment	80

4.2. S2: Average Proportional Gain in Matches for Trained and Untrained Targets between Initial Assessment and Block 1 86

4.3. S2: Proportional Gain in Matches for Trained and Untrained Targets between Initial Assessment and Block 1 Major Probes 90

4.4. S2: Proportional Matches for Syllabic Targets in Block 1 Sessions 92

4.5. S2: Proportional Gain in Matches for Trained Targets between Block 1 and Block 2 Major Probes 96

4.6. S2: Proportional Gain in Matches between Block 1 and Block 2 Major Probes for Untrained Targets 97

4.7. S2: Proportional Matches in Block 2 Major Probe for Targets with Match Proportions Differing from Those Shown in Figures 4.5 and 4.6 98

4.8. S2: Average Proportional Gain in Matches for Trained and Untrained Targets between Block 1 and Block 2 Major Probes 99

4.9. S2: Proportional Matches for Syllabic Targets in Block 2 sessions 102

4.10. S2: Developmental Progression in Proportional Matches for Trained Segmental Targets across the Intervention Period..... 105

4.11. S2: Developmental Progression in Proportional Matches for Trained Syllabic Targets across the Intervention Period 106

4.12. S2: Feature Geometry at End of Block 2 107

5.1. S3: Proportional Matches for CVC and CVCV Word Shapes at Initial Assessment 116

5.2. S3: Feature Geometry at Initial Assessment 124

5.3. S3: Proportional Gain in Matches for Syllabic and Segmental Targets between Initial Assessment and Block 1 Major Probe 134

5.4. S3: Proportional Matches for WF (CVC) Targets in Block 1 Major Probe .. 135

5.5. S3: Proportional Matches for SIWW (CVCV) Targets in Block 1 Major Probe 137

5.6. S3: Proportional Matches for Syllabic Targets in Block 1 Sessions 140

5.7. S3: Proportional Matches for Trained and Untrained Segmental Targets in Block 1 Major Probe 143

5.8. S3: Proportional Matches for Syllabic and Segmental Targets (WI unless Otherwise Indicated) in Block 2 Major Probe 148

5.9. S3: Proportional Gain in Matches for Syllabic and Segmental Targets between Block 1 and Block 2 149

5.10. S3: Proportional Matches for Syllabic Targets in Block 2 Sessions 152

5.11. S3: Developmental Progression in Proportional Matches for Trained

Phonological Targets across the Intervention Period 155

5.12. S3: Feature Geometry at End of Block 2 156

6.1. S4: Feature Geometry at Initial Assessment 175

6.2. S4: Proportional WI Matches at Initial Assessment 176

6.3. S4: Proportional SIWW Matches at Initial Assessment 176

6.4. S4: Proportional WF Matches at Initial Assessment 177

6.5. S4: Proportional Gain in Matches for Syllabic and Segmental Targets between Initial Assessment and Block 1 Major Probes..... 184

6.6. S4:Proportional WF Matches in Block 1 Major Probe 186

6.7. S4: Proportional SIWW Matches in Block 1 Major Probe 187

6.8. S4: Proportional Matches for WI Training and Observation Targets in Block 1 major probe 191

6.9. S4: Proportional Gain in Matches for Syllabic and Segmental Targets between Block 1 and Block 2 major probes 198

6.10. S4: Proportional Matches for Syllabic Targets in Block 2 Major Probe 200

6.11. S4: Feature Geometry at End of Block 2 206

6.12. S4: Developmental Progression in Proportional Matches for Trained Phonological Targets across the Intervention Period 207

7.1. S5: Proportional Matches for Two-Element (CC) Clusters with and without Short Epenthesis, Overall and by Cluster Type, at Initial Assessment 222

7.2. S5: Proportional Matches for Two-Element (CC) Clusters with and without Short Epenthesis, Overall and by Cluster Type, in Block 1 Major Probe. 222

7.3. S5: Proportional Matches for Two-Element (CC) Clusters with and without Short Epenthesis, Overall and by Cluster Type, in Block 2 Major Probe. 222

7.4. S5: Feature Geometry at Initial Assessment 229

7.5. S5: Average Proportional Gain in Matches for Syllabic and Segmental Targets between Initial Assessment and Block 1 Major Probes 234

7.6. S5: Proportional Gain in Matches for Trained and Untrained Segmental Targets between Initial Assessment and Block 1 Major Probes 240

7.7. S5: Average Proportional Gain in Matches for Trained and Untrained Syllabic and Segmental Targets between Block 1 and Block 2 Major Probes 243

7.8. S5: Developmental Progression in Proportional Matches for Trained Phonological Targets across the Intervention Period 251

7.9. S5: Feature Geometry at End of Block 2 252

8.1. S6: Feature Geometry at Initial Assessment 268

8.2. S6: Proportional Gain in Matches for Syllabic and Segmental Training Targets between Initial Assessment and Block 1 Major Probes 273

8.3. S6: Proportional Gain in Matches for Trained and Untrained SIWW Syllabic Targets between Initial Assessment and Block 1 Major Probes 275

8.4. S6: Proportional Gain in Matches for Trained and Untrained WF Syllabic Targets (excluding Liquids) between Initial Assessment and Block 1 Major Probes 278

8.5. S6: Proportional Gain in Matches for Trained and Untrained WI Segmental Targets between Initial Assessment and Block 1 Major Probes 283

8.6. S6: Proportional Gain in Matches for Syllabic and Segmental Training Targets between Block 1 and Block 2 Major Probes 288

8.7. S6: Proportional Gain in Matches for Trained and Untrained Segmental Targets between Block 1 and Block 2 Major Probes 289

8.8. S6: Average Proportional Gain in Matches for Segmental Targets between Block 1 and Block 2 Major Probes 290

8.9. S6: Developmental Progression in Proportional Matches for Trained Syllabic Targets (except Block 2 Targets /k/ and /g/) across the Intervention Period 295

8.10. S6: Developmental Progression in Proportional Matches for Trained Segmental Targets and Block 2 Syllabic targets /k/ and /g/ across the Intervention Period 296

8.11. S6: Feature Geometry at End of Block 2 297

9.1. Representation of Clusters -- Adult Targets, Children's Reduced Forms, and Clusters Articulated with Unstressed Epenthetic Vowels 317

9.2. Comparative Derivations of S1's [fw] Substitution for Obstruent-Approximant Clusters Based on Kaye et al. (1987) and a Proposed Alternative 318

9.3. Alternate Representations of S2's Block 1 Cluster Realizations in Onset-Rime and Moraic Theories 320

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To Florence May Parker

(1899-1989)

For your love of children

CHAPTER 1

INTRODUCTION

Because human communication involves the interaction of many factors which are both physical and mental, the clinical field of speech-language pathology relies on developments in related disciplines, from anatomy and physiology to those concerned with the mind and its constructs. For the last twenty years, clinicians have looked to linguistic theories for models of language and methods of data collection and analysis on which to base assessment and treatment methodologies for speech and language disorders. Grunwell states that "linguistic analysis is now a well-established technique in the range of assessment procedures employed by speech and language pathologists" (1985, 1).

When linguists make major changes in the description and explanation of language, speech-language pathologists have an opportunity to search for more effective assessment and intervention methodologies by deriving implications from the theoretical changes. Clinicians maximize their opportunities for successful application when they select the most robust of theories. A linguistic theory attains a robust status primarily through its capacity to describe the synchronic facts of a language more parsimoniously than previous theories. If a theory can also *explain* the facts of a language, it will be preferred among a group of descriptively adequate ones.[1] Once 'internal evidence' (synchronic data from one adult language) has demonstrated a theory's adequacy, its robustness becomes enhanced through 'external evidence', most significantly from other unrelated languages, but also from historical change, language acquisition, and language breakdown (Kenstowicz and Kisseberth 1979, 139-140). The best opportunity for successful clinical application occurs when such external evidence has begun to enhance a theory's status. As a result of the application, a clinician may be able to provide the linguist with more evidence relevant to the

theory, both factual and utilitarian. This evidence will not prove or disprove the theory, but may elucidate aspects of it that are less accessible through internal analysis.

The research reported in this dissertation examines the utility of current nonlinear phonological frameworks for planning and executing an intervention program with six phonologically disordered children. In this chapter I will first outline the basic characteristics of nonlinear phonology and then relate principal concerns regarding phonological process analysis, the most prevalent phonological approach to intervention.

Nonlinear Phonology

Nonlinear Phonology in the Tradition of Generative Grammar

Nonlinear phonology[2] developed in the late 1970's, with the major impetus provided by Goldsmith's dissertation on tone (1976). Based in generative phonology, nonlinear frameworks adhere to many of the tenets of the generative grammar tradition. The following assumptions from generative grammar underlie the work for this thesis.

1. In linguistic description it is desirable to decrease the number of language-specific rules and processes to a minimum, putting the "burden" for explaining language development on structures and principles of the innate system (Chomsky 1981).

2. For all grammatical 'parameters' within a linguistic component (such as syntax or phonology), there is an 'unmarked' versus 'marked' option. Theories of markedness vary in their assumptions and definitions. However, most assume that the unmarked value for a parameter is the one available from innately endowed 'Universal Grammar' (UG). Marked values are assumed to represent the more unusual of the options and as such need 'positive evidence' from the input language. Pharyngealized consonants and complex segments such as /g^{b}/ are exotic examples of marked options. Until a child hears them used in his language community, his speech will reflect the innate endowment -- nonpharyngealized articulations of single segments. Defining which options are marked and which unmarked across languages becomes more difficult for less exotic phenomena, however, and continues to engage the attention of linguists.

3. Although there may be interaction among linguistic components for language processing, each is sufficiently autonomous to study as an independent system (Clements 1989b).

Assumptions Particular to Nonlinear Phonology

Nonlinear phonology differs (at a minimum) from original conceptualizations of generative phonology by (1) the concept of hierarchical representation of both prosodic and segmental information rather than strictly linear (sequential) representation, and (2) the concept of tier association as a cause of and constraint on phonological "rules."

Elaboration of these concepts follows below.

Hierarchical Representation

Within the phonological component, there are a number of hierarchical levels ('tiers'). Separate tiers have been posited for larger prosodic units, such as the word, the foot, and the syllable, as well as for smaller melodic units, such as the segment and its composite features. The phonological tiers are hypothesized to be logically and empirically autonomous, while associated with each other in principled ways.

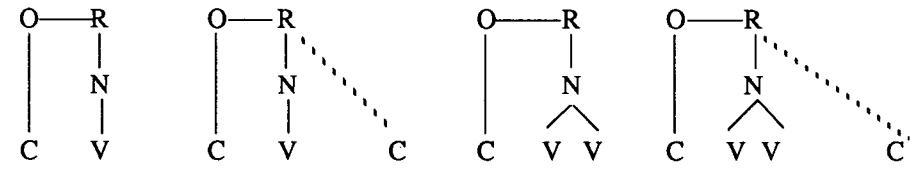
Different phonologists have put forward a number of subtheories regarding those hypothetically autonomous aspects of phonological organization and behavior. Subtheories pertinent to the dissertation are discussed briefly.

A. Prosodic level

With respect to the 'top' of the hierarchy, phonologists disagree on (1) the status of the syllable as a constituent, and (2) the components of the syllable or its equivalent.

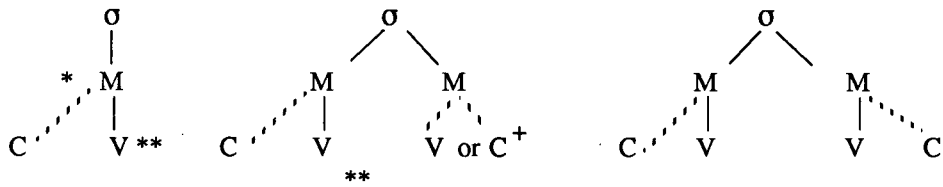
Kaye et al. (1987) consider onset-rime strings, rather than the syllable, to be the primes at the level of prosodic structure between feet and segments (see figure 1.1). The onset (O) is a projection of the prevocalic consonant(s), and the rime (R) a projection of the nucleus (N) -- itself a projection of the vowel or other most sonorant segment. Postvocalic consonants are adjoined to the rime node. According to this view, the onset and the rime are independent constituents with their own set of phonological functions, both within themselves and in relation to each other.

Onset-rime representations: According to Kaye, Lowenstamm and Vergnaud (1987)



CV unit CVC unit CVV unit CVVC unit

Moraic representations: According to Hayes (1987)



CV unit CVV or CVC unit CVVC unit

Key: O: Onset N: Nucleus VV = diphthong
R: Rime σ : Syllable (/oʊ/, /ɛɪ/, /aʊ/, /aɪ/, /oɪ/)
M: Mora V = lax vowels and tense vowels (/i/, /u/)

* In Hayes (1989), the prevocalic consonant is adjoined directly to the syllable node, but the research undertaken here utilized Hayes (1987), in which the prevocalic consonant is adjoined to the mora. The different level of adjunction does not crucially bear on the empirical consequences of the present study.

** V = lax vowel or tense vowel (i.e., only /i/, /u/. See appendix 2.)
VV = diphthong and diphthongized nonhigh tense vowels. This is a notable departure from Hayes in which long vowels are equivalent to diphthongs (i.e., V: = VV). In intervention sessions which focused on final consonants, vowels were all lenghtened in the oral presentation of stimuli, making a length distinction between tense and lax vowels indiscriminate.

+ According to stress rules, English is a 'weight by position' language, which means that the first postvocalic consonant may project a mora. In this study closed monosyllables with single vowels were considered bimoraic.

Figure 1.1. Alternate representations of word/syllable constituents in onset-rime and moraic theories

Government ("a binary asymmetric relation holding... between two skeletal positions" [Kaye et al. 1987, chapter 2, 1]) proceeds from left to right within each of the constituents (onset and rime) and from right to left between constituents (from the rime to the onset). In other words, government defines domains within which segments may associate to each other. Association may result in the appearance of changes to the governed segment, depending on the feature composition of the two segments.

Other phonologists (Hayes 1987; Hyman 1985; McCarthy and Prince 1986) posit: (1) that the syllable is a constituent and prime of the prosodic tier, and (2) that prosodic 'weight units' or 'morae' (M) are the critical constituents of syllables for stress assignment and other phonological rules. Weight units are realized through vowels (or other resonants). Morae may also be realized through postvocalic consonants in 'weight-sensitive' languages, where stress assignment is sensitive to certain postvocalic consonants as well as to the vowel constituents. (For this dissertation we have assumed that English is a 'weight-sensitive' language and that closed monosyllabic words are bimoraic. For further discussion see the section on treatment methodology particular to the syllabic condition in chapter 2.) Morae are grouped together to form syllables with a postulated maximum of two morae per syllable. Syllables are then grouped into 'feet' and 'prosodic words'. Drawing on McCarthy and Prince's (1986) notion of 'minimal word', a bimoraic word is taken to be the basic unit available from UG at this prosodic level . McCarthy and Prince (1986) postulate the 'core syllable' CV as a basic unit at the syllabic level. Prevocalic and postvocalic consonants that do not contribute to the marking of syllable weight are simply adjoined to the mora or syllable (the level of adjunction being currently controversial). They do not form a particular constituent in and for themselves and, as such, have no particular independent phonological functions as prosodic constituents.

A demonstration of some of the differences between the onset-rime and moraic theories is shown in their alternate representations of two possible congruent phonological phenomena in a child's phonology -- missing final consonants and lack of diphthongs (see figure 1.1). The onset-rime theorist would claim that both of these structures require branching under the rime constituent.

A single onset constituent is a direct projection of the initial consonant; a single rime constituent is a direct projection of the nucleus, itself a projection of the vowel. Representation of one postvocalic consonant requires a first level branching under the rime node. Diphthongs require branching under the nucleus, a lower level branching than that for the first postvocalic consonant. For representation of a CVVC word with both a diphthong and a final consonant, branching is required at both the rime and nucleus levels. A child who uses neither final consonants nor diphthongs is continuing to operate with the minimal structure required for the universally available O-R unit.

The moraic theorist would claim, alternatively, that the child who uses neither final consonants nor diphthongs in one syllable is operating with a *minimal* prosodic weight unit for a syllable -- viz. one mora, or perhaps, a core syllable. Setting a parametric value licensing two morae per syllable, for a weight-sensitive language such as English, would then license both final consonants *and* diphthongs, since both the consonant and the second part of the vowel have phonological 'weight' as prosodic units. In order for diphthongs and postvocalic consonants (or single vowels and two postvocalic consonants) to appear in one syllable, the last consonant must be adjoined at the moraic or syllabic level. (The locus of consonant adjunction is currently under debate; in this dissertation I followed Hayes [1987] in which the locus of adjunction is the mora.)

The foregoing differences might result in different predictions for development. Following moraic theory, one might expect a child to acquire diphthongs and single final consonants (or diphthongs and consonants within one syllable at the same time as single vowels and two consonants in a syllable) in the same time period when learning a weight-sensitive language, because the child would learn the constitution of bimoraic syllables in the language. Following onset-rime theory, one might expect a notable time lag between acquisition of final consonants and diphthongs because of the need to 'set parameters' for multiple levels of branching, i.e., a representational complexity. If branching of the basic O-R string happens first, as a primary type of branching (the rime subdividing into nucleus and adjoined consonant), the child might acquire

final consonants first. Since the rime depends upon the nucleus, however, nuclear branching might take precedence over rime branching, which would result in prior acquisition of diphthongs.

B. Segmental Level

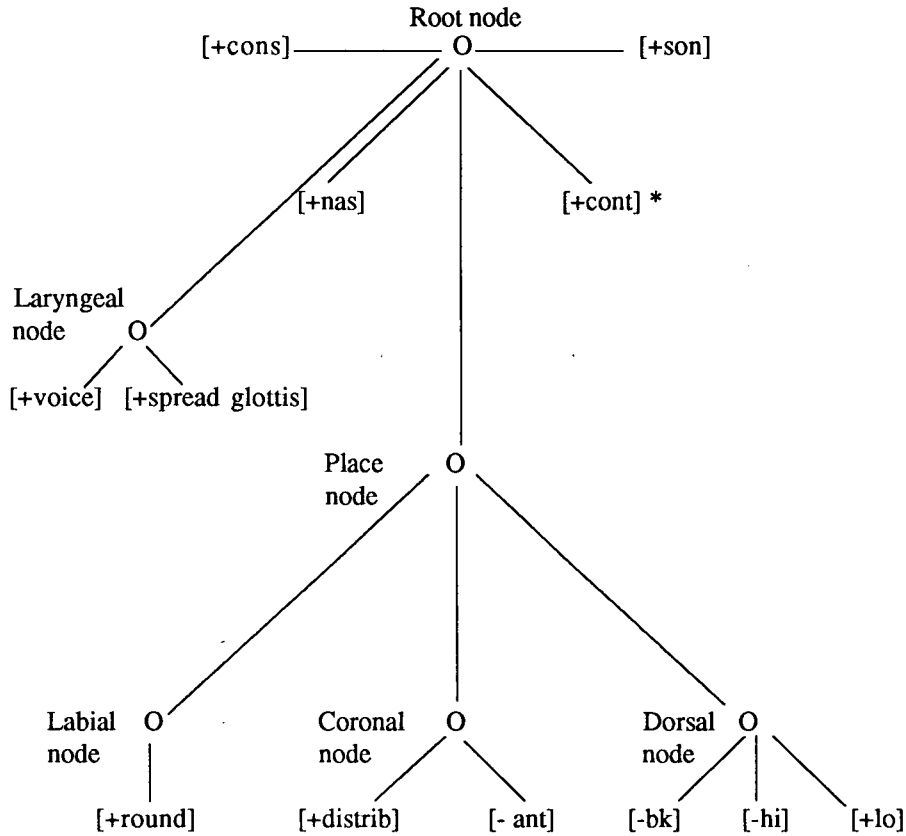
Proponents of nonlinear feature representations currently agree on a basic tree structure, such as the one used as the basis for this study (see figure 1.2), modified from Sagey (1986)[3]. Because languages have different segmental inventories, specified representations of the individual feature systems will differ for languages, but the general framework and set of marked and unmarked features is assumed to be universal. The determination of the set of universal and language-specific features and their relative markedness is an ongoing enterprise in phonology.

As figure 1.2 shows, the feature hierarchy hypothesis includes the concept that features group together into loci (nodes) with relationships of dominance or sequence. The groupings reflect the observation that "certain sets of features commonly act as single functional units with respect to phonological rules" (Clements 1989b, 1). In this dissertation, the intermediate nodes, i.e., Labial, Coronal, and Dorsal Place, were considered monovalent features dominating binary or privative terminal features relevant to that place. The nonterminal nodes are:

1. The Root node: This node links the segment to the prosodic tiers "above." Major class features [sonorant] and [consonantal] define the Root node (and thus the segment) as a vowel, consonant, liquid, or glide (McCarthy 1988). The Root node dominates the terminal features [continuant] and [nasal].

2. The Laryngeal node: The Laryngeal node defines the glottal characteristics of the segment. It is linked to the Root node. Terminal features of this lower level node include those for [voice] and [spread glottis].

3. The Place node: The Place node defines the oral cavity characteristics of the segment. It is a dependent of the Root node above but dominates the individual Place nodes -- Labial, Coronal and Dorsal.



Note: Marked features are indicated on terminal nodes with plus or minus specification. Labial, Coronal, and Dorsal nodes are considered monovalent. The Root node designates the segment. It links into the prosodic tiers above. (See appendix 2 for more detail.)

*Affricates are designated as 'complex segments'. 'Complex' is a mnemonic describing the branching structure of affricates with respect to [continuant]. (The term is from Lombardy [1989] but does not imply her analysis.)

Figure 1.2. Feature geometry for English

Clements (1989a,b) differentiates between Consonant-Place nodes and Vowel-Place nodes. (For this study the primary concern was development of consonants. Hence Place node is undifferentiated for consonants as opposed to vowels unless otherwise specified.)

4. The Labial Place node: The Labial Place node refers to lip articulations. It is linked to the higher level Place node and dominates its terminal feature [round].

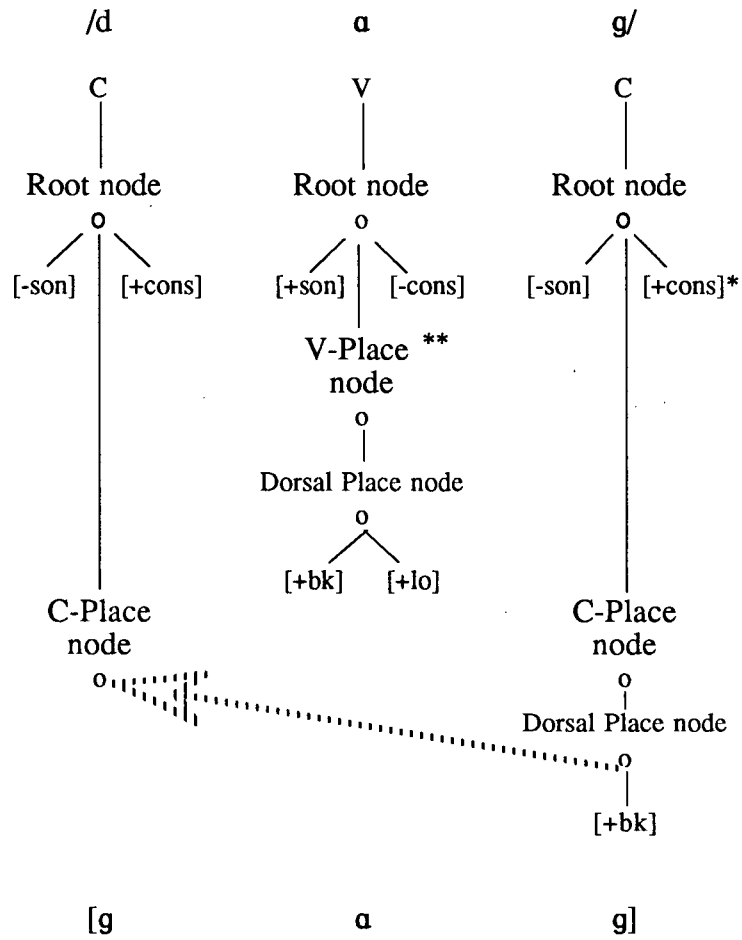
5. The Coronal Place node: The Coronal Place node refers to articulations of the tongue blade and tip. It is linked to the Place node above and dominates its terminal features [anterior] and [distributed]. Coronal Place is considered the universally unmarked or 'default' Place (Paradis and Prunet, forthcoming). When it does not dominate any terminal features, its specification is therefore assumed at the level of the general Place node.

6. The Dorsal Place node: The Dorsal Place node refers to articulations of the tongue dorsum. It is linked to the Place node above and dominates its terminal features [high], [low] and [back].

Tier Association

As stated previously, tiers are assumed to be autonomous. However, they may associate to each other (with 'association lines'). There are basic principles for association of tiers. For example, (1) more than one consitutent may be linked to a constituent on another tier, (2) association lines linking constituents must not cross, and (3) direction of association is parameterized. Association principles constrain and explain phonological operations (processes or rules).

Two of the fundamental hypotheses regarding basic phonological operations are: (1) that they may only spread, delink, insert, or delete constituents, and (2) that these operations may apply only to *adjacent* constituents. For assimilation to take place, for example, the affected constituent must be adjacent to the 'spreading' constituent at the relevant level of hierarchical structure. Then it can receive the specification of the designated constituent's feature(s) by spreading. Hierarchical representations reveal adjacencies not apparent in surface representations. This is illustrated in figure 1.3, an example of a nonlinear description of regressive consonant assimilation.



* Only salient features for each example are shown.

** According to spreading conventions, if two adjacent segments have identical specification, spreading of those features from one of them to a third is blocked by the second. (Association lines must not cross.) Following Clements (1989a, b) consonant and vowel Place nodes are independent and therefore spreading of Dorsal Consonant-Place node to an adjacent C-Place node is possible because the Vowel-Place node is on an independent (and therefore nonadjacent) tier. Other representations are possible, but this is used to illustrate consonant adjacency, spreading, and linking.

Figure 1.3. Regressive consonant assimilation in the absence of CV interaction

When /dɑg / (dog) is realized as [gɑg], but /dɑl/ (doll) is realized as [dɑl], assimilation results from consonant-consonant interaction, rather than consonant-vowel interaction. The consonants, although separated by a vowel in the surface form, have to be adjacent at some deeper level of representation in order for assimilation, i.e., spreading of features, to take place. If they were adjacent at the level of Consonant-Place (C-Place) node (Clements 1989a, b), the Dorsal Place node of /g/ could spread to the C-Place node for /d/ (an 'empty node' for reasons of 'underspecification').

If, on the other hand, vowels were tier-adjacent to consonants at all levels of representation, specified Dorsal Place node features of the vowels would block Dorsal Place consonant feature spreading (according to standard nonlinear interpretations of spreading, such as Archangeli [1988]).

Dominance, Government and Underspecificaton

A. Domains for government

As a consequence of hierarchichal organization, some parts of the structure dominate others, circumscribing domains for phonological 'government'. In the example of [gɑg] for /dɑg/, the assimilation may reflect, at one level, a general principle of consonant government by word position -- the postvocalic consonant dominates the prevocalic consonant (similar to Kaye, Lowenstamm, and Vergnaud's [1987] 'interconstituent government' from rime to onset). The dominance relationship may only appear phonetically as assimilation when segmental simplification is "required" for performance reasons (such as a young or disordered child's inability to produce two contiguous stops with different lingual places of consonant articulation within one syllable). Feature specification relationships between segments may interact with positional government to produce results such as assimilation as (see section C below).

B. Underspecification

A current hypothesis about feature specification is underspecification. Those who argue for underspecification claim that underlying representations of segments (or other phonological

constituents) are minimal, containing information only about the idiosyncratic (distinctive) properties of the constituent. For example, a segment which is [+sonorant] may be considered underspecified for [voice]. The [+voice] feature is predictable, given the [+sonorant] feature.

With respect to which features must be encoded in representations, there is convergence of opinion on some issues, but disagreement on others. Proponents of 'radical underspecification' (Kiparsky 1982; Pulleyblank 1986; Archangeli 1988) claim that the underlying representations include "only unpredictable values for features, ...[whereas] predictable values are inserted by rule during the course of the derivation" (Archangeli 1988, 192). Proponents of 'contrastive underspecification' (Clements 1987; Steriade 1987) claim that underlying representations include values for features "only where that feature is being used to distinguish segments in the respective contexts; noncontrastive values are left blank" (Archangeli 1988, 191). In this dissertation I have adopted a radical underspecification perspective. Appendix 2 lists the phonemes of English and the specified feature values assumed for each of them, and includes a more detailed discussion of markedness. (The reader will find reference to this appendix useful for comprehension of the data chapters.) According to the feature specifications hypothesized, the least specified consonant is /t/ and the least specified vowel is the epenthetic or reduced vowel /ə/.

The only specified value for /t/ is postulated to be [+consonantal], since /t/ is unmarked in terms of all other consonantal features. Marked consonantal features for English, which do need to be specified, are assumed to be: [+consonantal], [+continuant], [+nasal], [+voice], [-anterior], [+distributed], and Labial or Dorsal Place.

The only specified value for /ə/ is hypothesized to be [+sonorant], since /ə/ is a neutral vowel unmarked in terms of all other vowel features. Marked vowel features are assumed to be: [-voice], [-back], [+low] and [+round]. (See appendix 2 discussion on markedness.)

In terms of development, input will both confirm default features and values as part of a language's phonology as well as present evidence for the specified values thereof. As the input evidence becomes sufficient and the child's phonological production capacity matures, one expects a child to add specified values gradually to the set of universally unspecified features.

C. Underspecification and government

The regressive assimilation example in figure 1.3 demonstrates a possible interaction of positional government and underspecification. In the case of /dɑg/, the Coronal Place node under which place features for /d/ are represented is considered the least marked or underspecified of the Place nodes for English (see appendix 2). The /g/, as a segment with a specified Place node (Dorsal), is 'more specified' than the 'empty' Place node of the /d/, and as such is 'dominant' in specification terms. If positional government gives the postvocalic consonant dominance over the prevocalic consonant, *and* there is a dominance relationship in terms of feature specification, the features of the former may spread to the prevocalic position. In a developing phonological system, when representational and/or articulatory constraints block two places of consonant production within one syllable (or O-R unit), those segments which have specification can dominate the underspecified Coronal Place node, with specified features spreading to that empty node. Eventually, pressure to conform to the adult language and increasing representational/articulatory abilities result in accommodation of both specified and unspecified consonants within a syllable.

Phonological Process Approach to Intervention with Phonologically Disordered Children

For intervention with phonologically disordered children, the Natural Phonology theory with its phonological process analysis (Stampe 1969) is the most widely used application of phonological theory (e.g., Edwards and Bernhardt 1973; Ingram 1981; Hodson and Paden 1983; Grunwell 1985). Its use has resulted in improvements in assessment and intervention over structuralist theory/substitution analysis, because it focuses on generalizations about different aspects of a child's overall system. These generalizations lead to the formulation of therapeutic goals which affect more than one phoneme within the system.

Effective programming notwithstanding, several aspects of the theory and its application seem insufficient, both with respect to description and explanation.

Theoretical Deficiencies of the Phonological Process Approach

The theoretical deficiencies of the phonological process approach lie in:

1. The assumption of adultlike underlying representations (UR's) derived from an intact adultlike perceptual system (Stampe, 1969). The possibility exists that children may have idiosyncratic underlying representations (Maxwell, 1984). Nettelbladt (1983) suggests, for example, that when a child's word is missing segments in the adult target, that child form may result from word shapes created by extraction of components of the adult target rather than from deletion processes within the child's own system. Not all of the adult word may be perceived and stored. That part of the adult form (phrase, word, syllable or segment) may be perceived and stored which conforms to the child's restricted syllable/word 'templates'. (The term 'template' is borrowed from nonlinear accounts of morphemic representation and word formation processes, and was introduced into accounts of child phonology by Menn [1978, 1983]). In early phases of development, one might assume that templates (and outputs) reflect the unmarked defaults provided by UG.

2. The assumed psychological reality of the processes themselves. Stampe (1969) suggested that 'natural processes' operate on the adultlike underlying representation to allow simplification for output. It may be a correct generalization about the observed *data* that the child's form [sɪp] for the input form /ʃɪp/ demonstrates 'depalatalization', but there is no evidence that a 'process' has 'operated' on a 'representation'.

3. The lack of principled explanation of the occurrence of any of the processes. Whereas it is more than likely true that certain phonological phenomena are natural for humans, because of physical, physiological and (possibly) cognitive constraints, neither Stampe (1969) nor subsequent applications of his theory have offered any explanations why some sound changes are more natural than others. (Recently, Stevens and Keyser's [1987] enhancement theory may be bringing auditory and phonetic data to bear on the question of naturalness, however.)

4. The implications of development as a negative "progression" of process suppressions, limiting and ordering. In order to progress from realizing the UR /ʃɪp/ as [sɪp] to [ʃip], a child's

depalatalized output has to "dedepalatalize." In order to progress from [tʰɛɪt] to [kʰɛɪk] for cake, a child has to "back" the "fronted" /k/. In order to realize final consonants, a child has to "undelete" a deleted consonant. This type of implied negative progression is reminiscent of "the child as Little Linguist," a syntactic developmental theory which arose from early applications of generative grammar, but which has been discounted in recent years by Pinker (1984) and others. For example, the child is not seen as first having deletion rules which remove adult syntactic markers and categories, and then "undeleting" rules which put them back. Development is seen more as a positive process. The innately available unmarked system acts as a passive constraint, allowing mappings of representations and outputs which conform to its default "specifications." At those points in time when maturation permits and evidence for alternate specifications is sufficiently overwhelming, representations are specified in concordance with markings of the input language and the range of outputs increases (see also Sadanandan 1987).

Clinical Application Deficiencies of the Phonological Process Approach

The lack of a constrained and coherent theory leads to extensive variability in clinical application.

1. Each observer of child phonology can generate a unique list of processes, making it as exhaustive or simple as desired.

2. An exhaustive list (such as Hodson and Paden, 1983) often has the one or more processes over the domain of a single segment, which results in a list equivalent to a substitution analysis.

3. Very often the list is conceived without notion of rank or hierarchy, making goal prediction ad hoc. (Some authors have grouped processes. For example, Nettelbladt [1983] creates a severity ranking by comparing the prevalence of syllable structure processes with less severe feature-changing processes. Hodson and Paden [1983] rank their 48 processes from Level 0 to 3 (profound to less severe), placing some syllable structure processes in their severe levels.)

Nonlinear Frameworks and Developmental/Clinical Phonology

The introduction of groupings and rankings of processes in the disorder literature demonstrates a pretheoretical awareness of hierarchy and levels. In order to develop further our understanding of constraints and groupings or levels of organization within children's systems, nonlinear frameworks which by *representation* outline levels, hierarchies, and dependencies would seem beneficial.

A few developmental phonologists have applied some of the concepts of nonlinear phonology to analyses of children's phonology. Menn introduced the discussion to child phonology (1978, 1983) in terms of templates. More recently, Spencer (1986), Sadanandan (1987), Ingram (1988), Stemberger (1988), and Stemberger and Stoel-Gammon (in press) have presented arguments about phonological development in terms of underspecification, feature hierachy, and tier structure. Application in the clinical field is more limited. It includes Spencer's (1984) analysis of one child's disordered system in terms of McCarthy's (1981) templatic morphology, Chiat's (1989) analysis of the interaction of one child's syllable structure and fricative stopping utilizing Selkirk's (1980) syllable theory, and Dinnsen's (1989) accounting for order of segmental acquisition from predictions of universal feature hierarchies.

Before the research for this dissertation, there was no reported application of nonlinear phonological theory to intervention. The basic concepts presented above -- autonomous and hierarchical levels, association principles, and syllable/word theories -- lead, however, to the following general questions pertinent to phonological intervention.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real?

If the prosodic and segmental levels of representation are psychologically real, then it should be possible to plan phonological intervention which focuses separately on the two levels.

Furthermore, if the dominance of the prosodic tier over the segmental is developmentally relevant, one might expect to find a faster rate of change for prosodic intervention than for segmental intervention. No previous studies have directly compared phonological intervention at the prosodic versus segmental levels.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of interventions that contrast the onset and rime versus those that utilize the mora as a constituent?

Intervention which reflects the most psychologically real representation might be more facilitative, resulting in a faster rate of acquisition of syllable/word types.

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

Allowing for the fact that phonologists do not agree on all details of the hierarchy, such as the total range of features, the locus of individual features, and their markedness status, one might predict that higher and, therefore, dominant features/nodes should have developmental precedence over subordinate features/nodes. Complication of this question arises from the concept of markedness, in that early inventories should reflect unmarked default features and their values according to predictions of UG (see appendix 2):

1. Root node: [-consonantal] for vowels, [-sonorant] for consonants (Since [consonantal] and [sonorant] define the segment, early specification of [+consonantal] and [+sonorant] are necessary, or there would be no segments.)
2. Laryngeal node: [-voice], [-spread glottis] for consonants; [+voice] for vowels
3. C-Place node: Coronal -- [+anterior], [-distributed]
4. V-Place node: Labial [-round]; Dorsal [+back], [-low].

Individual variation in development may result in somewhat different segmental inventories at any given point of comparison between children, further complicating the issue. Different inventories may result from feature hierarchies with different sets of specified features at the point of comparison. However, the question remains, given markedness relationships and individual variation, whether a general developmental sequence is predictable from feature level, the higher (dominating) features being specified first.

CHAPTER 2

METHOD

To address the research questions posed at the end of chapter 1, a longitudinal intervention study was carried out with six children between the ages of 3 and 6 years. All of the children had moderately severe or severe phonological disorders. Each child participated in individual speech therapy sessions three times per week for five months. The five-month period was divided into three six-week blocks, each containing sixteen treatment sessions and three probe sessions. The first two blocks were the experimental blocks with strict condition orders. In the third block, the needs of the child at that time determined selection and order of conditions.

Subjects

Criteria for subject selection were:

1. Age: Between 3 and 7 years
2. Severity: A moderately severe to severe phonological disorder, characterized by limited phonemic and syllable/word shape inventories. (In practical terms, family members had difficulty understanding the child's speech much of the time.)
3. Language environment: English as the only input language
4. Absence of any other major impairment except a language production disorder, a mild impairment of language comprehension, cognition, or motor development, or controlled otitis media
5. Parent participation: Attendance at all treatment sessions and carrying out of home activities for the duration of the project

Subject Recruitment and Participation

E recruited subjects by letter through health units, agencies, preschools and school boards. Agency speech-language pathologists performed an initial screening after obtaining parental consent, and E did the final screening, selection and assessment. Because of limited subject availability, the selection process took four months. This resulted in different starting dates for the subjects. Two new subjects joined the project in each of three subsequent months, E assigning subject numbers by selection order. E observed S6's phonological development for four months prior to enrolling her as a subject, because she was age 2;6 at referral (outside the 3;0 minimum age suggested). When it became apparent that her developmental rate was notably protracted, she was selected to participate in the study. No subjects withdrew, attendance was regular, and parents participated enthusiastically in the program throughout the project period.

Subject Characteristics and Matching

Main characteristics of the subjects are reported in table 2.1.[4] All but S6 were male. As table 2.1 shows, it was possible to match two pairs of subjects for both age and gender -- S4 and S3 at about 3 1/2 years -- and S1 and S5 at 6 years. Serendipitously, the phonological systems of the children within each of these two pairs were also similar. Although S2 and S6 differed in age and gender, they were matches because of similarity in types of substitutions at the segmental level. (S6's phonological system matched that of S3 and S4 in terms of limitations at the syllabic level.) The matching facilitated counterbalancing of conditions across subjects (see below).

One of the children, S5, had a developmental delay in all areas, with the most severe impairments in language production and fine motor skills. Three of the children had general language production disorders, one had controlled otitis media, and one a notable tongue thrust during speech and swallowing.

Table 2.1.-- Main characteristics of subjects during study

Subject	Age	Severity of disorder	Associated factors
1	5;10 - 6;2	Moderate-severe	Tongue thrust; finger-sucking habit Sibling with mild phonological disorder Diverse dialectal influences
2	4;2 - 4;6	Moderate-severe	Chronic otitis media, myringotomy Mild morphophonological delay
3	3;4 - 3;8	Severe	Severe language production disorder
4	3;5 - 3;10	Severe	Severe language production disorder
5	6;2 - 6;6	Moderate-severe	Severe language disorder Mild cognitive delay Mild motor impairment
6	2;11 - 3;3	Severe	No apparent associated factors

Design

Both a multiple baseline and an alternating treatment design were employed. Through the application of multiple baseline and alternating treatment design methods, some inference can be made that environmentally manipulated variables have impacted on development (Hegde 1985, 30).

The multiple baseline design allowed E to compare treated and untreated parts of each child's linguistic system in order to evaluate possible effects of intervention. This provided a means for addressing the first of the research questions on general efficacy of the nonlinear frameworks for intervention. Untreated phonological targets served as baselines, as did other aspects of the children's language development. Based on generalization studies (Elbert and Gierut 1986), E predicted:

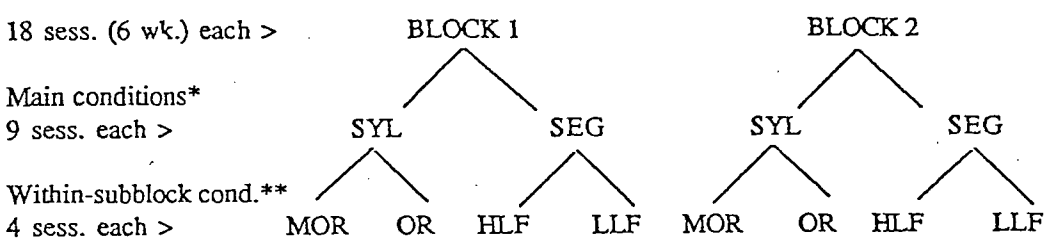
1. That those phonological elements most similar in feature components (with reference to segmental intervention) or prosodic ('skeletal') slots (with reference to prosodic intervention) to

actual therapy targets would show more improvement through generalization than those phonological targets with fewer commonalities.

2. That vocabulary and morphology measures might increase at an accelerated rate. Since phonological intervention often involves the presentation of words and inflectional morphemes not in the child's production system, one might anticipate accelerated acquisition rates for these measures (assuming that input frequency and intensity affect their rate of development).

3. That the area with least potential for rapid development was syntax. Although some of the therapy involved phrase and sentence practice, syntactic goals were only treated as subsidiary goals for S3, S4 and S5, the three children with language disorders.

The alternating treatment design allowed E to contrast condition types relating to the last three research questions set out at the end of chapter 1: (1) intervention targeted at the segmental versus prosodic (designated frequently throughout the text as syllabic[5]) tier (main conditions), (2) prosodic stimuli presentation and production manipulations as moraic versus onset-rime constituents (syllabic subblock conditions), and, (3) training of higher level versus lower level features in the feature hierarchy (segmental subblock conditions). In this study, alternations took place as follows: (1) every nine sessions (i.e., approximately every three weeks) for the syllabic and segmental training subblocks, and (2) every four sessions (i.e., approximately every ten days) for the within-subblock conditions (syllabic theory contrast and feature hierarchy contrast). This design is schematized in figure 2.1.



*SYL = syllabic condition; SEG = segmental condition; 1 session = minor probe
**MOR = moraic; OR = onset-rime; HLF = higher level feature; LLF = lower level feature

Figure 2.1. Schematization of research design

These time periods were considered long enough to provide an opportunity for consolidation of each condition's targets, while short enough to provide alternation within subblocks. The design allowed for a minimum of two alternations across the time blocks, a minimum recommended for such designs (Barlow, Hayes and Nelson 1984, 229).

To control for order and sequence effects, conditions were counterbalanced across subjects (within matching pairs), rather than within subjects (see table 2.2).

Table 2.2.--Order of treatment conditions for each subject within Blocks 1 and 2

Block #	No. of Sess.	S1	S2	S3	S4	S5	S6
1	8	SeL:SeH[a]	SeL:SeH	SyM:SyO	SyO:SyM	SyO:SyM	SeH:SeL
	8	SyM:SyO[b]	SyO:SyM	SeH:SeL	SeL:SeH	SeH:SeL	SyM:SyO
2	8	Same as	Same as	Same as	Same as	Same as	Same as
	8	Block 1	Block 1	Block 1	Block 1	Block 1	Block 1

[a]SeL = segmental condition -- lower level feature in feature hierarchy (4 sessions)
SeH = segmental condition -- higher level feature in feature hierarchy (4 sessions)

[b]SyM = syllabic condition -- moraic theory (4 sessions)
SyO = syllabic condition -- onset-rime theory (4 sessions)

As table 2.2 shows, a basic counterbalancing of treatment orders was achieved across the first four subjects. Main condition order assignment for the first two subjects was segmental/syllabic with opposing subblock orders -- higher level feature/lower level feature versus lower level feature/higher level feature, and moraic/onset-rime versus onset-rime/moraic respectively. Main condition order assignment for S3 and S4, who commenced training in the month after S1 and S2, was syllabic/segmental, with opposing subblock orders -- moraic/onset-rime versus onset-rime/moraic, and higher level feature/lower level feature versus lower level feature/higher level feature respectively. S5 and S6 were assigned to opposing main treatment (syllabic/segmental) conditions and within-subblock conditions (onset-rime/moraic versus moraic/onset-rime; lower level feature/higher level feature versus the opposite). The above

condition assignments ensured three subjects per condition order set (i.e., three with the order syllabic/segmental, three with the order moraic/onset-rime, three with the order higher level feature/lower level feature, and vice versa).

E set out the first four condition orders ahead of time (see S1 to S4 above), and then assigned subjects to condition according to the point in time at which they were accepted for the project. Main and subblock condition orders for the fifth subject were selected to contrast with those of S1, because the screening showed that S5 matched S1 in terms of age, gender, and phonological system. This allowed *complete* counterbalancing of treatments across similar phonologies for two of the six subjects. *Subblock* condition counterbalancing for subjects with similar phonological systems was achieved for: (1) S3 versus S4 (matches by age, gender, and phonological systems), and (2) S2 versus S6 (matches by substitution type at the segmental level). *Main condition* counterbalancing across phonologies similar in terms of syllabic structure was achieved for S3 and S4 versus S6.

Assessment and Analysis Procedures During the Intervention Period

Initial Assessment

An initial assessment consisted of an audiorecorded phonological/language sample and a battery of standardized tests of language comprehension and production. (These same tests were administered at the end of Block 3.) Stimulability of phone production in isolation and nonsense syllables was probed briefly during the assessment. For the older subjects -- S2, S5, and S1 -- phonemic perception was tested with the Auditory Discrimination Subtest of the Test of Language Development (Primary, 1982), and, for S1, also with the Goldman-Fristoe-Woodcock Auditory Discrimination Subtest (1974). A hearing screening, an oral mechanism examination including items from Robbins and Klee (1987), and a case history filled out by the parent completed the assessment procedures.

Phonological Sampling

A standard set of objects and pictures provided the stimuli for a (predominantly) spontaneous single-word elicitation, which was recorded using a Nagra IV reel-to-reel tape

recorder and Ampex 631 tapes with an AGK D202 microphone. (See appendix 1 for the list of 164 basic words.) General conversation during the recording session provided other words (200-400 per sample) for analysis, many in connected speech contexts.

All English consonants in word-initial position (WI), word-final position (WF), syllable-initial-within-word position (SIWW) and, where possible, syllable-final-within-word position (SFWW) were probed.[6] In order to check for morphophonemic effects on WF consonants (becoming SIWW after derivation), derived forms were also elicited, through adjunction of [i] to nouns and [ɪŋ] to verbs, e.g., sun, sunny; rub, rubbing. (Although E attempted to elicit the derived forms after elicitation of the root word, this was not always possible in the assessment context.) In order to control for possible assimilatory effects, consonants were elicited in a variety of word shapes which included CV, VC, and C_iVC_i words (when such words existed) as well as more complex word shapes. Vowels and diphthongs were not specifically probed, but were in fact available for analysis from the word list as well as from the conversational sample.

Phonetic Transcription

E transcribed the assessment and major probe tapes using a Revox taperecorder and Videoconcepts F700 dynamic earphones. The IPA (1979) symbols and diacritics supplemented by a few extra codings served for the narrow transcriptions performed. (See appendix 5 for details about transcription.) Codings relating to imitated versus spontaneous speech and single words versus connected speech were also included.

E randomly selected taped, transcribed samples from half of the subject group (S1, S5, and S4) as bases for determination of intertranscriber reliability. A second individual, who was very experienced in phonetic transcription of children's speech, transcribed the taped samples independently. When transcriptions did not match, the two listened jointly to the tape in order to resolve disputed forms.

Each phonetic slot with its onset or offset characteristics counted as one item. For example, E may have transcribed a child's production of /tɔɪ/ as [$t^hɔɪ$]. The second transcriber may have transcribed that same item as [tɔ^ə]. In this case, the consonant difference counted as one mismatch and the diphthong difference a second, yielding no matches for the word (0/2).

The S1 sample contained 70 words from the Block 1 and Block 2 major probe tapes (35 each), yielding 138 consonants for comparison. (See appendix 3 for data.) For S1, the two transcribers were in agreement about 75% of the consonants prior to discussion, and 97% after discussion. Disagreements for S1's data primarily concerned degree of dentalization of the coronal obstruents and degree of voicing -- i.e., detail not relevant to the intervention goals for S1. Because discussion led to a similar agreement level for the samples from the two tapes (96% and 97%), transcribers concluded that one tape/child was sufficient for subsequent reliability checks.

For S4, transcriptions of 35 words from the Block 1 tape were compared, yielding 64 consonants and three diphthongs for comparison. When presence or absence of (nonphonemic) glottal stops was considered, transcription agreement was 69% before discussion, and 93% after discussion. Eliminating concern for glottals, there was 88% agreement before discussion, and 99% agreement following discussion. The other main initial disagreement concerned degree of voicing. Since S4's frustration level during testing resulted in frequent use of exaggerated glottal fry (aperiodic voicing) in early probe tapes, the disagreement on laryngeal features is understandable. Neither of these laryngeal characteristics was relevant for S4's intervention plans.

For S5, transcriptions of 35 words from the Block 1 tape were compared, yielding 80 consonants for comparison. There was 86% agreement before discussion, and 96% after discussion for consonant transcription. The main initial disagreements concerned transitional phenomena, which were not relevant for S5's intervention plan.

In areas of disagreement, the transcribers found that they basically perceived the same phenomena, but used different descriptors before arriving at a solution through discussion. None of the critical elements relating to the intervention for each child were in disagreement, since those concerned broader phonemic categories rather than details of narrow transcription. Because the results -- using stringent reliability criteria -- were comparable across the first three data sets, and because mismatches were not critical to the intervention programs, no further phonetic transcription reliability checks were made.

Analysis during the Study

Three evaluative probes were administered per block, at sessions 9, 18, and 19. The 'minor' probes at sessions 9 and 18 tested untrained words containing targets of the previous three-week condition in an elicitation task, a conversational speech sample, and a story retell (from Clinical Probes of Articulation Consistency [1981] or E-generated). They were recorded on Fuji FR-II cassettes using a Marantz PMD220 tape recorder and AKG D310 microphone. A week's vacation was scheduled between the 18th and 19th sessions to inhibit carryover from the condition probe to the major block probe. The major block probe consisted of the standard single-word elicitation task from the assessment plus any conversational speech elicited, recorded on the Nagra reel-to-reel equipment.

During the intervention period, E recorded transcribed utterances on a subset of forms from Grunwell (1985), namely the phoneme and cluster realization charts and the phonotactics forms. These served as a basis from which to draw feature diagrams and deduce syllable/word constructs .

Intervention

The analyses performed led to formulation of detailed intervention plans which conformed to the experimental framework for each subject.

Segmental Condition Target Selection

Unestablished or very marginally established segments (less than 10% matches) were possible training targets. Segments related and unrelated to the training targets in terms of features remained as observation targets. Reduced stimulability did not necessarily eliminate segments as targets, especially if the experimental design or the child's system limited available choices.

Using the feature hierarchy in figure 1.2 as a basis, E drew feature hierarchy figures for each child. (See individual chapters for details of target selection for each subject.) E then selected unestablished features at higher and lower positions in the hierarchy as intervention targets. E assumed the following with respect to classification of feature height:

1. Terminal features are lower than intermediate nodes or other nonterminal nodes, i.e., the terminal feature [round] is lower than its class node -- Labial Place, [continuant] is lower than Root node.

2. Terminal features of a node are equivalent in height, i.e., Coronal Place feature [+distributed] is at the same level as Coronal Place feature [-anterior].

3. Root node features are at the highest level, with [consonantal] and [sonorant] higher than [nasal] and [continuant]. (As stated in chapter 1, I have followed McCarthy [1988] in assuming that [consonantal] and [sonorant] define Root node, as opposed to being terminal features.)

3. Laryngeal node features are lower than Root node features but higher than Place node features. Although the theory does not assume that Place node is lower than Laryngeal node, E assumed that glottal functions take precedence over shaping of the oral cavity. Production of phonemes such as /h/ and /ʔ/ is independent of any oral cavity shaping, whereas production of any phoneme with oral cavity shaping also requires laryngeal function (marked or unmarked).

4. Place node is higher than Labial Place and Dorsal Place nodes, which are at equivalent levels.

5. As the default Place node, Coronal Place node is higher than Labial Place and Dorsal Place nodes, since it is assumed at the level of Place node.

In order to select segments as training targets and observation targets, E then consulted feature specifications for English, relating features to the segments for which those features are distinctive (appendix 2 in this thesis). Since establishment of features was the goal, often more than one segment became a training target during a feature subblock. For example, in the case of S1, the feature [-anterior] was a lower level terminal feature target. The segments /ʃ/ and /ʤ/ were both selected for establishment, with /ʒ/ and /ʧ/ remaining the baseline observation targets. This provided a maximal contrast of a 'complex' versus simple (nonbranching) segment, as well as a voiced versus unvoiced [-anterior] segment. The training of a voiceless fricative and a voiced affricate in the same time frame provided a means of evaluating the effects of training on development of voicing and 'complex' structure, although the focus in therapy sessions was on

[-anterior] tongue placement, and not on the complex/noncomplex distinction or the voicing distinction.

The syllabic data dictated choice of word position for target training. Only well-established word positions served as slots into which to insert the new segments, in order to maintain as much independence as possible between the segmental and syllabic conditions.

Syllabic Condition Target Selection

Syllabic targets included two types: (1) unestablished or marginally established syllable/word shapes, e.g., CVC, CCVC, CVCVC, and (2) extension of segment or sound class word position realization. In the latter case, E assumed that dominance of the prosodic tier over the segmental tier implies that syllable/word position determines licensing of segments, rather than the reverse. Marginally established syllable/word positions remain underspecified in comparison to other syllable/word positions for the features of a language. For example, at one point in development, coronal fricatives may be licensed for realization in WF position, but not in WI position or clusters. (Autonomy of syllabic constituents is evident in the fact that some may be specified for a given set of features whereas others are not.) Development did not entail learning the feature composition of coronal fricatives, but the strengthening of the system's syllable positions by the realization of more segments within those positions.

The segmental data dictated choice of segments to insert into the new syllable slots. Only segments well-established in some word position became targets, in order to maintain as much independence as possible between the segmental and syllabic conditions. As was the case for the segmental condition, reduced stimulability did not necessarily eliminate possible targets, and some syllable/word shapes and segments remained as untrained observation targets.

General Outline for Training Sessions

Training sessions were audiotaped on the Marantz PMD220 using the AKG D310 microphone and Fuji FR-II tapes. All training words differed from probe words and the former did not contain any unestablished segments or word shapes except the target for that subblock condition. Sessions in all conditions followed this general outline:

1. Awareness training for the training target: mildly amplified stories, songs, poems, etc., which focused on the target (no vocal response required)

2. Auditory perceptual contrast training of the target and its error pattern with minimal or near minimal pairs or trios (only at the beginning of a subblock)

3. Imitation training with auditory, visual and physical cueing from the target in isolation, through permissible syllable/word shapes to sentence patterns, then spontaneous sentences and finally conversation

Minimal pair contrasts were used frequently throughout production training, although, for syllabic targets, E ensured that only those constituents particular to the onset-rime or moraic condition were made salient in contrast training (see section below on intervention specific to the syllabic condition).

4. Practice in monitoring of others and self at the sentence level and above

5. Tangible and/or social reinforcement for correct productions at all levels, with special prizes being earned for use of set numbers of targets in conversation

6. Parent participation within the sessions, followed by a brief counselling session concerning required home practice.

Parents were asked to note any changes in spontaneous speech outside the therapy situation, and any information pertinent to subject history during the intervention period which could threaten internal validity of the project (Ventry and Schiavetti 1980, 104).

Treatment Methodology Specific to the Syllabic Condition

Counting Conventions for Moraic Constituency

A. Monosyllabic words

E assumed that, in English, a mora may be realized by either a vowel or the first tautosyllabic consonant following the vowel. Following this assumption, the following were considered bimoraic:

1. CVC monosyllabic words

In English monosyllabic words, lax vowels are followed obligatorily by consonants, suggesting that the consonant has prosodic relevance, i.e., syllabic weight. It is not

obligatory, however, that a consonant follow a tense vowel (/i/ and /u/ only in this study). This suggests that consonants may not have syllabic weight after tense vowels, as the vowels are bimoraic.

While the difference between tense and lax vowels is acknowledged in priniciple, it was not considered an independent factor in a certain type of intervention session focusing on CVC development. In that type of session, the method of presentation involved addition of C_2 to a C[V:::] unit (S3 and S6), in which both lax and tense vowel stimuli were presented with exaggerated length, i.e., with an indeterminate number of morae. The targeted final consonant was treated as an adjoined unit in those intervention sessions. With increasingly rapid articulation, syllable timing was reduced to that of the adult model -- at which point the moraic status would presumably be the same as that of the adult model (bimoraic with both lax and tense vowels, the WF consonant being adjoined in cases of syllables with tense vowels).

2. Syllables with diphthongs, i.e., two identifiable (usually lax) vowel units (in this study /aʊ/, /aɪ/, /ɔɪ/, /oʊ/, /ɛɪ/)

3. CVCC or CVVC monosyllabic words (VV=diphthong).

B. Disyllabic words

1. In general the possibly bimoraic status of the unstressed /i/ suffix in English was ignored when relating moraic status of CVCV and CVC words for S3, S4, and S6 (see Block 1 syllabic intervention plans for each subject), because (1) the focus for moraic status was on the first (stressed) syllable, and because (2) the children had no difficulty pronouncing [i(:)] in open syllables.

2. For disyllabic words, other complexities arose. For example, according to the counting methodology, the first syllable of the underlying form of a derived diminutive word such as doggie /dɑg+i/ would appear to have two morae (/dɑg/ -- V=1, C_2=1), as would the first syllable of the underlying form of tractor (/træk/ -- V=1, C_3=1). The bimoraic status of the /dɑg-/ portion of doggie changes, however, when it occurs in the derived diminutive ([dɑ'gi^{I}] -- V_1=1), whereas it does not change for tractor ([træk'tɚ] -- V_1=1, C_3=1). Onset creation (premoraic consonant adjunction) for the second syllable of doggie (/-.i/ becomes [-.gi]), leaves only one

constituent in the first syllable -- the vowel -- as a candidate for moraic assignment. The first syllable of tractor, on the other hand, remains closed at the surface level ([træk'tɚ]) and, thus, the first syllable has bimoraic status.

Stimuli Presentation

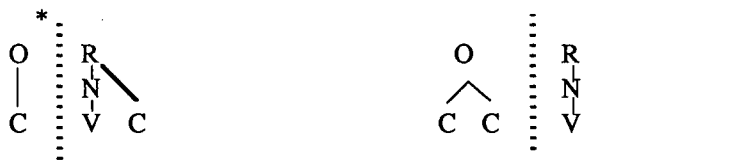
At the outset of imitation training during syllabic subblocks, E presented segments, syllables and/or words through speech (that is, auditory cues) with simultaneous visual and physical manipulation cues. These cues were provided in such a way as to emphasize phonological constituents according to the theory in question (see figure 2.2).

In the onset-rime condition, the maximal onset and maximal rime were presented as discrete stimuli. For example, a CVC word was presented as C and VC ([t^h]-PAUSE-[ɑp]); a CCV word was presented as CC and V ([st]-PAUSE-[ɛɪ])

In the moraic condition, the immediately prevocalic consonant was considered "attached" to the following vowel making the basic constituent (core syllable) CV. Consonants were added to this (inseparable) CV unit. For example, to establish the CVC word shape when final consonants were missing in the child's system, separate CV and C stimuli were presented. (See note above on monosyllabic words for one type of methodology. See the Block 1 intervention section for S4 for another.) To establish WI clusters, a CCV word was presented as a C and a CV, i.e., [s]-PAUSE-[tɛɪ].

While it could be argued that either presentation method could be construed as the other method -- the O-R '(C)C - V' presentation could be construed as moraic as well because the moraic unit was presented separately from the prevocalic adjoined consonant(s) -- it was assumed that constituent status was the important variable. Thus, 'CC', if presented separately, was then a unit, or constituent (a domain with internal structure and its own set of operations for phonological rules). Because onset clusters are not constituents in moraic theory, E did not present them as such in the moraic condition. One could construe the CV moraic constituent as the basic O-R unit. However, presentation of a CV unit does not focus on the onset and rime as separate and independent constituents, which was desirable in the onset-rime condition.

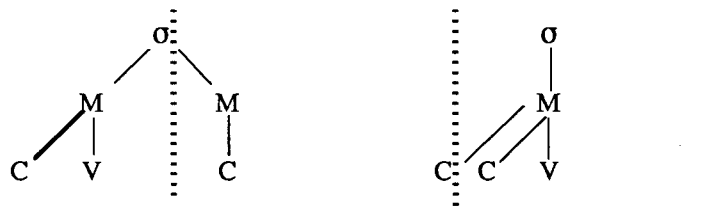
Onset-rime stimuli



C + VC stimuli
for CVC word shape training

CC + V stimuli
for WI cluster training

Moraic stimuli



CV + C stimuli
for CVC word shape training

C + CV stimuli
for WI cluster training

Key: O: Onset N: Nucleus
R: Rime σ : Syllable
M: Mora

*Dotted lines delineate divisions for stimuli presentation. Constituents on one side of the dotted line were presented separately from constituents on the other side of it.

Figure 2.2. Stimuli constituents for onset-rime and moraic subblock condition training

It could be argued that phonetic considerations favored the moraic condition from the outset, since the phonetically motivated glottal onset of the VC must be suppressed in the onset-rime condition; that is, C + [ʔ]VC impedes pronunciation of CVC. When E preceived this to be a problem for a child, a rapidly alternating series of ([ʔ])VC, C, VC, C, VC was presented for elicitation. Rapid speech elicitation facilitated suppression of the [ʔ] onset. A possible advantage for onset-rime condition training, on the other hand, may have been contrast training for onsets in auditory stimulation and production training, e.g. [st] versus [t] versus [s] (heightening awareness of the difference between the child's production and the adult target) as well as rhyming activities heightening awareness of the rime.

Other than these biases, there was an additional problem for /s/ clusters. In both theories, the /s/ may be considered extrametrical when preceding a stop word initially (Kiparsky 1979). This puts the /s/ outside of the "true" onset for /sp, st, sk /. It had to be treated as an onset constituent in this study to maintain consistency with the basic decision to contrast rime and onset.

An uncontrollable biasing factor could have been the choice of lexical items and probe items for each condition. The "magic" of changing damp into stamp (and thus remembering that type of word) may be greater for a particular child than changing ick into stick, or vice versa. This kind of experimental bias could neither be predicted nor controlled, but it was assumed to be equivalent for conditions.

Once a child demonstrated phonetic control of the syllable/word structure target, procedures for establishing phrases and sentences were the same as for segmental targets.

Analysis Following the Intervention Period

In order to analyze the results of the various probes more precisely, E performed computer assisted analyses following the study, using spreadsheets Excel and WINGZ on the Macintosh Plus computer. The majority of the analyses reported in the results chapters are based on the initial assessment and the major probes at the ends of Blocks 1 and 2, the two experimental blocks. For some of the children, analyses based on the minor probes and session data complement the major probe results.

Feature Hierarchy Analysis

E recorded matches and discrepancies between the child form and the adult model for each phoneme per word position (consonants for all children, and consonants and diphthongs for S4's Block 1 and 2 probes). For each child, proportional matches and gains were calculated for each phoneme in the major probe, with descriptions made of feature differences and changes based on the feature hierarchy.

This approach is relational, in that features or syllable shapes are noted as marked or unmarked with respect to the adult model presented in appendix 2. 'Omissions' of cluster and diphthong elements were entered as missing Root nodes in the feature hierarchy data, as were 'omissions' of singletons. The example in table 2.3 demonstrates the feature descriptions for the word face > [hæt]. (Because there are a large number of spreadsheets for data analysis they are not included in the dissertation.)

An anomaly arises in the description of phonological development when a child's system appears to have a specified value for the wrong segments. For example, [+distributed] is labelled a 'specified' feature in English for /r/ and interdentals in this report, but for many children, it appears to be a feature of coronal obstruents when produced with an interdental tongue position ("frontal lisp"). In this case the '*distributed*' aspect of the coronals as produced incorrectly has the quality of an underspecified '*default*', taking the place of the [(+)anterior] coronal default for English. An articulatory basis for the "incorrect" default can be observed and serve as an explanation for the phonological anomaly -- a consistent interdental tongue position. Sometimes the unexpected default appears to have no observable articulatory or perceptual basis. In such cases, the anomaly can only be described as such.

Table 2.3.--Sample feature chart showing match and nonmatch data and feature differences

Adult Target	% Match	Match Tokens	Non-match Tokens	Phonetic Realization or Omission	Feature Differences: Types	Feature Differences: Tokens
f	0%	0	1	h	Place node unspecified[a]	1
ɛɪ	0%	0	1	æ	SYL[b]: VV > V SEG[b]: Dors: [-hi, -lo] unspecified	1
s	0%	0	1	t	Root node: [+cont] unspecified	1

[a]The Root node features [+consonantal] and [+continuant] were assumed to be specified. However, no articulator node was specified, hence the 'Place node unspecified' designation. The [h] was a default [+*continuant*] consonant. Although /h/ has no underlying [continuant] specification (McCarthy 1988, 92), the Laryngeal node [+spread glottis] specification of /h/ was assumed to be equivalent in function to the [continuant] specification of the Root node. (See section on features in chapter 9, however.)

[b]Both syllabic and segmental differences between /ɛɪ/ and [æ] are addressed within the feature chart.

Syllabic Data

General Syllabic Data

For each child, E calculated proportional matches and gains for general syllable/word shapes for each major probe, and for individual targets relating to that syllable/word target. The latter were available in the feature charts (see above). The former were derived from confusion matrices which distinguished between adult target syllable/word shapes and child forms. For S3 and S4, these were similar to Grunwell's (1985) Phonotactic Possibilities: Contrastive Analysis. Adult target syllable/word shapes were listed on the vertical axis and child syllable/word shapes on the horizontal axis. Whereas Grunwell used individual matrices for mono-, di- and polysyllables, E included all in the same matrix in the current analysis. This was done because very often an adult polysyllabic target (CVCVC) was realized as a monosyllable by the child (CV), and, less often, an adult target monosyllable (CV) as a child reduplicated or diminutized disyllable, e.g., doggie for dog (CVCV). For S1 and S5, only the WI clusters were under observation, and

hence the confusion matrices only included words with initial clusters. For S2 and S6, E was able to derive syllabic data directly from the feature charts.

Moraic versus Onset-Rime Condition Results

Testing for differences between the moraic and onset-rime conditions depended on whether the same or different segments were involved in the opposing conditions. For example, in the case of S1, /kw/ was a target in the moraic condition, and /tw/ a target in the onset-rime condition. Major probe data was one source for comparison, but because of the limited number of tokens in the major probe, E also used minor probe data. When the comparison between onset-rime and moraic conditions involved the same cluster or segments, as in Block 2 for S1 (i.e., /st/), E analyzed therapy session data.

Interobserver reliability was checked for one session of S1's sessions. Using an audiotape tape of the session, E and a second observer independently scored S1's spontaneous and echoic responses as correct or incorrect. Prior to discussion, agreement between E and the second observer was 87% for scoring of correct and incorrect imitative responses and 88% for scoring of spontaneous responses. After discussion, there was 100% agreement for imitative responses, and 99% agreement for spontaneous responses. Initial disagreements were due primarily to differential assignment of responses to echoic versus spontaneous categories. Because agreement was high, no further reliability checks were made of session data.

Results Reporting

The next six chapters contain individual case studies for the six children. Each chapter includes:

1. A summary of pertinent biographical data related to the disorder
2. A summary of language test results
3. A detailed analysis of the child's phonological system at Initial Assessment
4. The intervention plans for Block 1 and Block 2, with rationales for target selection
5. The results of Block 1 and Block 2 intervention

CHAPTER 3

SUBJECT 1: SUMMARY

[kən ɑɪ ʔav mɑɪ vwɛɪ::k nɛʊ]

Case History Information

Subject Characteristics

During the reported period of the study, this boy was 5;10 - 6;4. The phonological disorder was associated with the following (see table 3.1):

1. A tongue thrust during speech and swallowing
2. Finger-sucking
3. Mild difficulty with phonemic discrimination
4. Dialectal variation in input by changing residency -- Vancouver (3 years), Australia (2 years), Vancouver (1 year) -- and parent's dialect -- Mother English, father Australian
5. Middle child of three boys, with the younger sibling having a mild articulation disorder

Prior Treatment

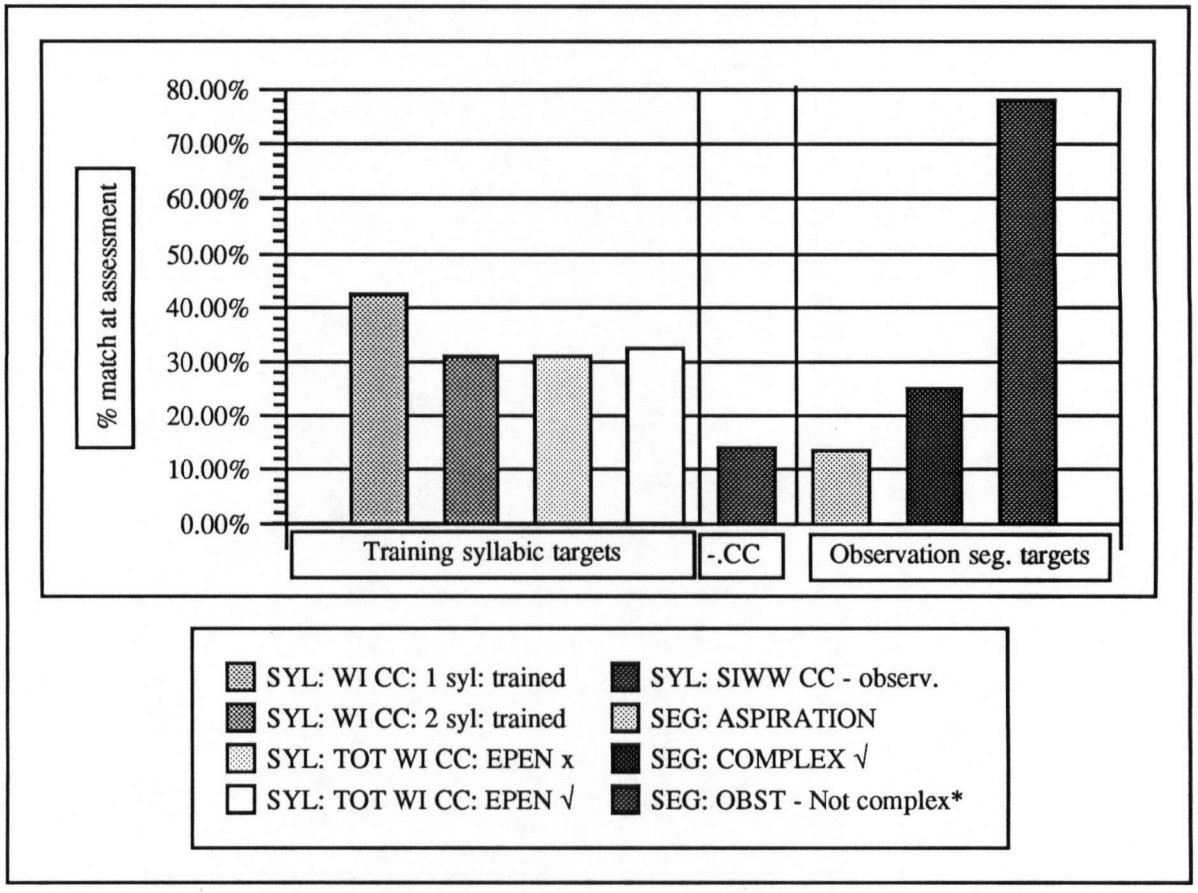
S1 was initially assessed at the age of 2;9 for unintelligible speech. At that time his phonetic inventory consisted of voiced and glottal stops, glides /j/ and /w/, and fricatives /f/ (as a substitution for final voiceless sibilants) and /θ/ (as a substitution for final /f/). Syllable/word shapes were reduced, with many missing final and medial consonants. He received intermittent speech therapy in Vancouver and Australia with focus on several final consonants, as well as /f/ and /t/ in all positions. At the age of 5;2 (the most recent assessment prior to the project), the following were missing: liquids, alveopalatals, affricates, /h/, WI voiceless stops and some strident fricatives. Although there were no word reductions, cluster reduction was frequent. From 5;6 to 5;9 he received infrequent articulation therapy focusing on high frequency words, /ð/, and an introduction to /l/ in WI position.

Table 3.1.--Subject information for S1

AGE	5;10 - 6;2 for reported period
GENDER	Male
BIRTH ORDER	Second of 3 boys; third has mild phonological disorder
DIALECT	Mother -- English; Father -- Australian; Residence -- Vancouver, Canada (previously Vancouver and Australia)
HEARING	Screened within normal limits at beginning of project
PHONEMIC DISCRIMINATION	Test of Language Development (Primary) (1982) Auditory Discrimination Subtest -- borderline average (*S.S.* of 7) Goldman-Fristoe-Woodcock Audit. Discrim.Test (1974): -1.5 *S.D.*
ORAL MECHANISM	Tongue thrust and Class 1 malocclusion Finger-sucking habit Some lack of independence for jaw and tongue movements, such that elevation of the tip and body of the tongue could not be performed with an open jaw before training
LANGUAGE SKILLS	Age-appropriate
PREVIOUS THERAPY	Between 2;9 and 5;0, intermittent therapy in Vancouver and Australia for final consonants, /f/ and /t/ with other speech-language pathologists A few sessions in the 6 months prior to the project with a different speech-language pathologist who introduced /ð/ and /l/ No changes noted in the year prior to the study

Phonological System at Initial Assessment

In figure 3.1 baseline data for syllabic and segmental targets are displayed. Absence of training target data for the segmental condition indicates a lack of matches for those training targets at time of asssessment.



Note: There were no matches for syllabic training target WI #CC in 4-syllable words and segmental training targets /l/ and alveopalatals. There were no matches for syllabic observation targets #CCC and segmental observation targets /h/, /r/, and the interdental fricatives. Clusters were judged with and without EPEN, i.e., short epenthesis (reduced vowel).

*OBST - Not complex = coronal obstruents (stops and fricatives) with appropriate lack of branching (complex) structure

Figure 3.1. S1: Proportional matches for primary training and observation targets at Initial Assessment

Phonotactics: Syllables and Words

Word structure and 'skeletal slot' realizations matches with adult targets (i.e. not necessarily segmental matches) were found for:

1. Number of syllables in a word
2. Number of final consonants in a word
3. Diphthongs (some nonsignificant dialectal differences)

On the other hand, syllable-initial consonant clusters were reduced or simplified in comparison with the adult target (see table 3.2). As the length of the word increased, the frequency of reduction increased. In WI position, the following was observed in terms of cluster matches for 'skeletal slots' (not necessarily segments):

1. Monosyllabic words: 11/26 (42.31%) matches for diconsonantal clusters, with nonmatches being singletons. Neither diphthongs nor postvocalic consonants appeared to influence realization of initial cluster elements, indicating that limitations of output were not a limitation based on allowable skeletal slots per se.

2. Disyllabic words: 8/26 (30.77%) matches for diconsonantal clusters, with nonmatches being singletons.

3. 4-syllable words: No matches (two attempts) for diconsonantal clusters (singleton realizations).

4. Triconsonantal clusters: No matches (four attempts). For the three mono- and disyllabic items, two slots were filled and for the trisyllabic item one slot was filled.

Syllable-initial diconsonantal clusters within words matched only once out of seven times: eyebrows - [ʔaɪ.vwauð]. Not all compounds had clusters -- the clusters in airplane and icecubes were realized as singletons.

The segmental data further demonstrates the delay in cluster development. With the exception of /gj/ in one of two items (argue), no consonant clusters matched adult targets for *both* segments. The first segment of the cluster matched the adult target 37.31% of the time and the second element 24.14% of the time.

There were further differences in realization of the two consonantal-type elements depending on their segmental composition.

Table 3.2.--S1: Syllable-initial clusters at Initial Assessment and at the end of Block 1

Cluster	Initial Assessment	End of Block 1[a]
(/sn/)[b]	SYL[c]: (CC) (1/3) SEG: /s/ > [+*distributed*][d]	SYL: /sn/ > CC^+ SEG: /s/ > [+*distributed*]
/sp, sm, sk, (sn)/	SYL: C SEG: /s/ RN > Ø	SYL: CC^+ SEG: /s/ > [+*distributed*]
/st/	SYL: C SEG: /s/ > [+*distributed*]; /t/ RN> Ø	NO CHANGE
/Cl/:	SYL: C SEG: /l/ RN > Ø[e]	SYL: CC^+; epen. (1/2) SEG: /s/ RN > Ø (1/2); /l/ > [j] or[lj]
/Cj/	SYL: C SEG: /j/ RN > Ø (except SIWW [gj])	SYL: CC* except /mju./; SEG: Match except /mju./ > /my/
/C/[w]	SYL: CC or (C)[f] SEG: C_1 matches: When Lab or after epen. vowel : Usually C_1 Lab[+cont], i.e., [f]	SYL: CC*,+ SEG: C_1: Matches except for most coronals : C_2 remains [w]
/sCC/	SYL: C or CC SEG: Lab [f] or [fw]	SYL: $C(C)^+$ (Epen.) SEG: Variable

[a]Summary of major and minor probe data -- highlights only. Changes show stars(*) for trained targets and + for untrained targets.

[b]Marginal acquisitions in brackets

[c]SYL = syllabic information; SEG = segmental information

[d]*Italics* = inappropriate marking according to appendix 2 Feature Specifications

[e]One [j] for /l/

[f]19/32 with CC, otherwise C

/s/-clusters

Variability in skeletal slot realization was noted for /s/-clusters depending on the second element of the cluster. This fact at the outset indicates a bidirectional influence between the segmental and syllabic tiers. Syllabic constraints resulted in missing segments but segmental constraints also appeared to influence *which* clusters were realized with two elements.

1. Cluster with both elements realized: /sn/ in one item, i.e., snake > [θ n : ɛɪk]. In appendix 2, /s/ is designated as the maximally underspecified [+continuant] consonant and /n/ as the maximally underspecified [+nasal] consonant. Both share the default Place node for English -- Coronal (Paradis and Prunet, in press). This sharing of default coronality perhaps facilitated realization of the two elements for reasons of phonological and phonetic simplicity. However, sharing of coronality was not the sole factor enabling [sn] production, since S1 did not produce /st/ with both elements. According to Kiparsky (1979), the /s/ of /sn/ is not extrametrical. Thus both elements could be incorporated into the syllable structure without the need for specification of an extrametrical constituent. (If extrametrical segments are not licensed prosodically -- licensing of them being the marked case -- they cannot be realized.) A further factor enabling [sn] production was possibly word-specific and pragmatic: because snakes hiss, the [s] is a "natural" onset to the word.

2. Clusters with missing Root nodes: /sp/, /sm/, /sk/, /st/, and two of three possible /sn/ tokens. The second elements in all of these clusters are noncontinuant consonants.

At the prosodic level, the universal minimal word has only one prevocalic consonant, and it is therefore predictable that a child will produce clusters with one element in early phases of phonological development. Given a choice of two segments, the more likely one to appear is (1) the better-established segment, and (2) the one which is not extrametrical.

The omission of 'extrametrical' /s/ (Kiparsky 1979) can account for the realizations of /sp/ as [p] and /sk/ as [k]. However, /st/ did not pattern with the other /s/-stop clusters but was produced as the child's default [+*distributed*] coronal continuant [θ]. This seems to be the result of simultaneous interaction of segmental and syllabic constraints. At the outset of encoding, only one skeletal slot apparently was licensed for realization from the prosodic tier. However, at the level of segmental encoding, two minimally specified consonantal coronals appeared to be

'competing' for realization. As a singleton, WI /t/ was realized 6/16 times with continuancy (once as [θ] and the rest of the time as [^{t}θ]). Thus there was not a clear contrast between the two coronals. The segment with more specified features -- /s/ by virtue of its consistent [+continuant] Root node specification -- was realized.

The realization of of /sm/ and /sn/ (two out of three tokens) was similar to that of /sp/ and /sk/ clusters, in that the /s/ was missing. The extrametricality hypothesis would not predict this outcome, because the /s/, as the less sonorous of the two syllabifiable elements, would then be realized. However, nasals were better-established as a sound class. Segmental factors probably played a facilitating role in this case.

3. /s/-clusters with [w] as a second element (from /w/ or /l/) were realized with two elements as [fw]. In this way, they were equivalent to stop clusters with [w] (see the section on stop-initial clusters below). This divergent /s/-cluster fact once again reaffirms that syllable structure realization depends partially on segmental composition. It also supports the extrametricality hypothesis that /s/, when followed by a (sonorous) approximant, can have a surface realization, because specification of an extrametrical constituent is not required

4. Triconsonantal clusters with /s/ (/skw/, /str/, /spr/, /skr/): The [fw] realization of elements in monosyllables is ambiguous for such clusters. The [f] may have been a realization of /s/, the stop being omitted. However, it is more likely that the (extrametrical) /s/ has not been licensed for realization. In the second major probe the stops do in fact surface but the /s/ does not, suggesting that the latter interpretation is more justifiable. The singleton [f] substitution in screwdriver > [fuv^{w}ɑɪvɔ^{ə}] may be a syllable-level assimilation from other labiodentals in the word.

Stop-Initial Clusters

Stop-glide clusters (phonemic or phonetic glides) behaved similarly depending on the glide involved.

1. Clusters with [w] as the second element: These were realized most of the time with both consonant slots filled. When both elements were present, the first matched the target some of the time if the target was labial (e.g., bread > [bwʌd^{ə}], a connected speech utterance). However, in

single word utterances, the use of vowel epenthesis also facilitated the appearance of the first element as itself (e.g., grey > [gəwɛɪj^{ə}]). When there was no epenthesis (and *always* in connected speech), spreading of specified (Labial Place) and unspecified ([+continuant]) features of [w] resulted in [fw] substitutions for clusters with nonlabial and even one labial initial consonant (e.g., truck > [fwʌk]; brush > [vwʌθ]).

In a few cases, only the first element was produced (as a segmental match), e.g., for WI /br/, /θr/ and /kw/ in disyllabic words and one of two monosyllabic words starting with /fr/ (i.e., front). This was perhaps a developmentally earlier type of cluster realization and is consistent with predictions of the sonority hierarchy hypothesis that the least sonorous element will be realized. However, in the case of the disyllablic items twenty and quiet, when [fw] did not surface, only the [w] appeared. This appears to violate the extrametricality hypothesis, but is consistent with /s/-nasal cluster realization. In these cases, the /w/ is phonemic, and may have been a better-established *segment* than the stops (see note on /t/ above under the section on /st/-clusters), and thus a more likely candidate for realization. (This also shows that the [f] must have arisen late in the derivation, following the encoding of [w].)

2. By contrast with the [w] clusters, neither /j/[7] nor [j] from /l/ appeared for /Cj/-clusters, except once in SIWW position after /g/ (argue >[ɑugju]). One anomaly was noted for /sl/, which patterned with the [w] clusters, since /l/ > [w] in this context (e.g., sleep > [fwip]). As there were two tokens of [w] for /l/ in the singleton data, the [fw] is within the general sound patterns of the system.

Segmental Development and Feature Hierarchy

Matches with adults targets were observed for the majority of vowels and diphthongs, /ʊ/ and vocalic /ɚ/ being exceptions[8]. A few minor differences from the Vancouver area dialect appeared, probably related to the parents' regional dialects. (See table 3.3, figure 3.2, and appendix 5, table 1.1.)

For all consonants and cluster segments, 39.96%[9] of the child forms matched adult targets.

Match data revealed the following:

1. Nasals, glides, final stops, and labial fricatives were established.

2. Syllable-final (SF) position was advanced over syllable-initial (SI) position for segmental realizations (42.36%), a tendency also noted above for clusters.

3. WI position had the fewest matches (30.33%).

Nonmatches included both missing sound classes and within class feature differences as follows:

1. Missing sound classes were liquids and nondistributed coronal fricatives/affricates.

2. The lack of aspiration for initial voiceless stops plus missing /h/ denoted lack of specification for the feature [+spread glottis]

3. Some other voicing mismatches were noted but represented only 1.36% of total feature differences.

Summary of Feature Differences

The following represented the most salient of the feature differences in descending order (refer to figure 3.2):

A. Unspecified child forms where adult targets are specified

1. Root node: [+consonantal] was unspecified for liquids (11.62% of total differences [percentage expressed in terms of total feature differences throughout this section]), although it was specified once for /l/ (1/35 times [2.86%]).

2. Root node: There was no specification (i.e., missing element) for some consonants -- 7.52% of total differences.

3. Laryngeal node: [+spread glottis] was unspecified phonemically (6.15% of total differences), resulting in [ʔ] for /h/, and was also not available as a redundant feature for many unaspirated voiceless WI stops (5/37 matches [13.51%]).[10]

4. 'Complex' structure of SI affricates was not in place (1.83% of syllable-initial total differences, but in six out of eight cases in absolute terms).

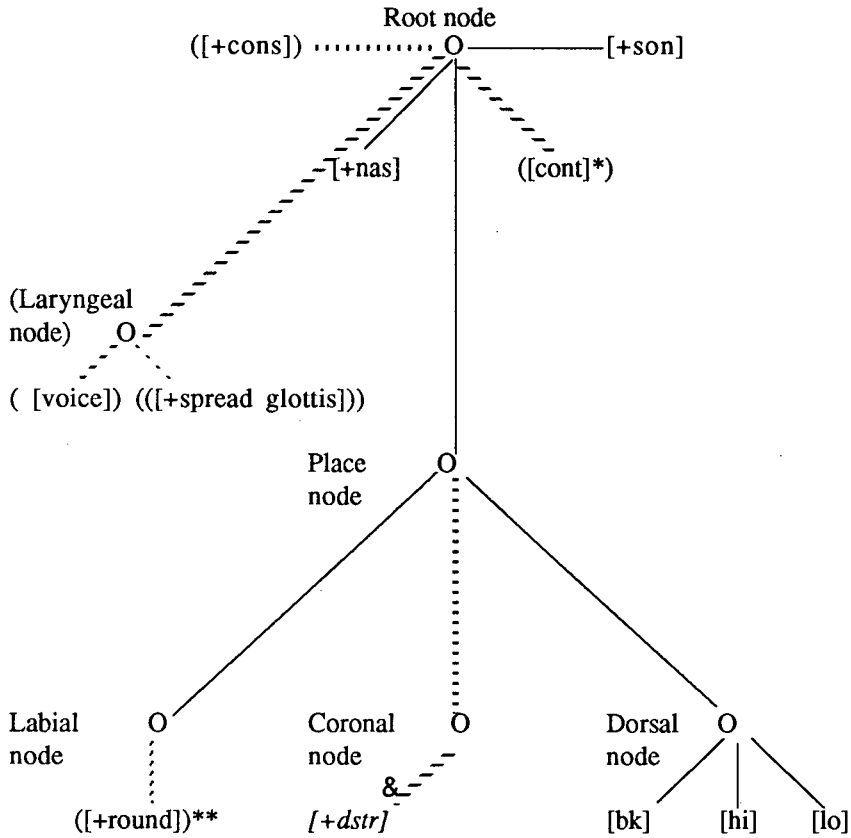
Table 3.3.--S1: Summary of singleton segmental acquisition at Initial Assessment characterized by sound class, matches and nonmatches according to word position, and feature differences

Sound class	Word position matches	Word position nonmatches	Main feature differences
Vowels	Most	/ʊ/, /ɚ/	[+rd] u or *s[1] Rhotacization u
Glides --/w, j/	All		
Nasals	All		
Stops [-voice]	WF, SFWW, (SIWW)[2]	WI, SIWW (/p/, /t/)	WI: [+spread glottis] u Cor: [+*dstr*] *s : '*complex*' *s
Stops [+voice]	SFWW, (WI), (SIWW), (WF)	WI (all); SIWW, WF (/d/)	Minor infrequent errors Cor: [+*dstr*]*s
Fricatives -- Labial	WI, (SIWW), (WF)	SIWW, WF (/v/ only)	Minor infrequent errors
Fric/Affricates -- Coronal	None	All	[+*dstr*] *s or u (/θ/, /ð/) 'complex' *s or u
Liquids	None	All	Both: [+cons] u /ɹ/: *Lab* Place for Cor*
/h/	None	All	LN: [+sp gl] u

Note: Similar tables appear for all Ss.

[1]u= unspecified; *italics*, *s = '*specified*' inappropriately with reference to appendix 2 Feature Specifications for English

[2]Parentheses around word position initials indicate partial establishment: 40 - 80% matches under the Matches column, 10 - 40% matches under the Nonmatches column. These are arbitrary cutoffs used as guidelines for selecting targets.



Note: Parentheses indicate marginal features in system development. Double parentheses indicate very marginal features. Italics indicate inappropriate feature. Dotted lines represent marginally established nodes or features.

*'Complex' branching structure inconsistently applied

** [ʊ] not [+rd]

&[+dstr] = default interdental tongue place

Figure 3.2. S1: Feature geometry at Initial Assessment

B. '*Specified*'[11] child forms where adult targets are unspecified or otherwise specified

1. Place node -- Coronal Place: The[+*distributed*] interdental or dental place was a feature of sibilants and some coronal stops (19.83%). This describes the interdental tongue position. The'default' coronal segment for S1 was not [+anterior] but [+*distributed*]. Coronal place node was underspecified in the extreme, as the lack of clearly distinguishable stops, fricatives, and affricates demonstrates.

2. Place node: *Labial* for Coronal Place node appeared for realizations of /r/ (see section on Block 1 segmental intervention plan in chapter 5 for further discussion of glide substitutions for liquids), a few tokens of /θ/ (13.16%), and stops in clusters with stops and [w].

3. Root node: [+*continuant*] appeared as a feature of the first element of clusters with [w]. This feature difference and the one above were often concurrent and facilitated the appearance of two-element clusters.

4. Coronal fricatives and stops had '*complex*' branching structure in WI position 9/41 times (2.45% of total syllable-initial [SI] differences).

Intervention Plan: Block 1

As shown in table 2.2, S1's major treatment conditions proceeded in the order segmental/ syllabic. Subcondition orders were lower level feature/higher level feature, and moraic/onset-rime.

Segmental Intervention Plan

Lower Level Feature

Targets: /ʃ/ and /ʤ/ -- Coronal node [-anterior] (all word positions)

Higher Level Feature

Target: /l/ -- conjunction of [+consonantal] and [+sonorant] (WI and SIWW positions)

Rationale

1. By establishing alveopalatals, the coronal place node would be specified with one of its marked features -- [-anterior] -- and the child's 'default' category [+*distributed*] would be circumscribed. Furthermore, by using one voiceless fricative and one voiced affricate in training, distinctions between complex and noncomplex segments, and voiced and unvoiced exemplars of

the [-anterior] class, could be made more salient (although the segments were not specifically trained to contrast these features). Generalization could be observed by testing /ʧ/ (and /ʒ/, if it could be elicited).

At the onset of treatment, S1 was stimulable for [ʃ] phonetically some of the time in isolation and syllables, but could not produce a [ʤ] easily. A rounded fricative or affricate, produced with a low flat tongue position, was the usual nonmatching imitative production.

2. Because the the Root node feature [+consonantal] needed to be specified for /l/ (in conjunction with [+sonorant]), /l/ was considered a higher level target than the alveopalatals. (Even if a feature [+lateral] had been invoked for /l/, /l/ would have been higher, because the locus for the [+lateral] feature would have been the Place node, above Coronal.) The syllable-initial positions were targeted, because of a reasonable degree of stimulability and because of the parents' dialect, in which the postvocalic /l/ is barely audible. Imitative errors usually involved palatalization as [lʲ] (merging with usual substitution), or protrusion as [L] ([+*distributed*]).

The /l/ was chosen over /r/ for liquid establishment because /l/ was more phonetically stimulable than /r/. Because S1's mother did not use /h/ consistently in her dialect, /h/ was not considered an appropriate intervention target, although the [+spread glottis] feature was under observation throughout the study both for /h/ and for aspirated stops.

Syllabic Intervention Plan

Moraic Subblock

Targets: Syllable-initial clusters /kw/, /kj/, /pj/

Onset-Rime Subblock

Targets: Syllable-initial clusters /tw/, /fj/, /vj/, /mj/

Rationale

Because all other clusters contained unestablished segments, only /w/- and /j/-clusters were available as intervention targets. One dorsal and one labial cluster were chosen for the /j/-clusters to provide a maximal contrast. No clusters were immediately stimulable in syllables.

The onset-rime condition had more /j/ targets than the moraic condition, because of limitation of lexical items. This may have given an advantage to the onset-rime condition.

However, the inherent difficulty of onset-rime target /tw/ (with the underspecified and somewhat problematic WI /t/) was considered an inequality favoring the moraic condition with its /kw/ target. No clusters were immediately stimulable in syllables.

Results of Block 1 Intervention

Figure 3.3 shows gains in proportional matches for trained and untrained segmental and syllabic targets. The greatest proportional gain was for aspiration on untrained WI stops -- a probable byproduct of training in the moraic condition, during which aspirated stops were individual stimuli for stop-glide clusters. For trained targets, the average proportional gain was greater for the syllabic condition (16.65%, *SD* 5.36%) than for the segmental condition (2.14%, *SD,* 5.36%).

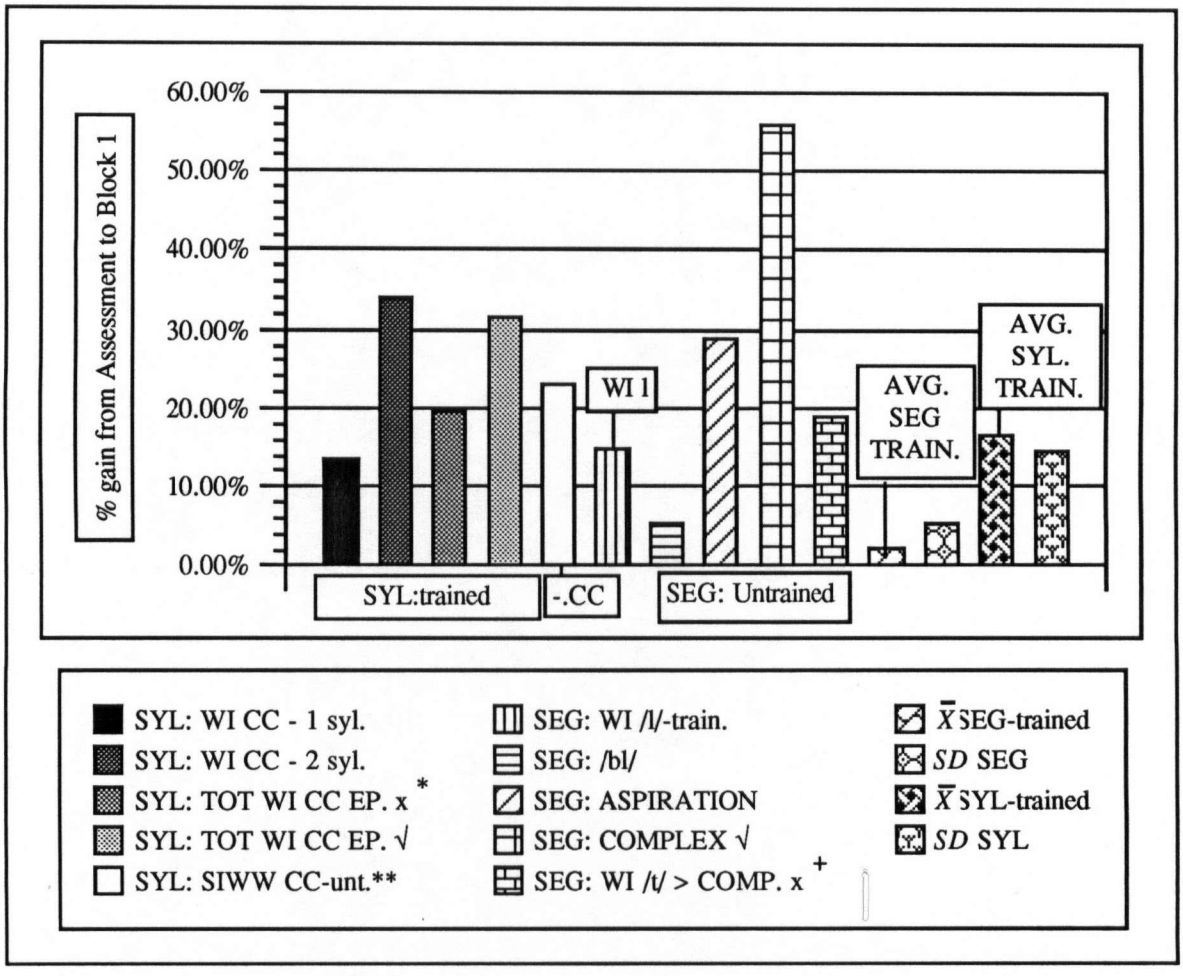
Segmental Goals

Lower Level Feature

S1 used no alveopalatals ([-anterior]). He marked the contrast between complex and noncomplex segments more accurately, completely eliminating the stop onset to initial coronal fricatives. However, cross-category substitutions still remained, as 7/14 /t/ targets were realized as affricates, and 17/19 affricate targets were realized as fricatives in WI position. It appeared that the specified feature [+continuant] was overriding the unspecified feature [-continuant] for the coronal stops/affricates, most of the time for affricates, and some of the time for the stop.

Higher Level Feature

S1 produced 3/20 (15%) SI /l/ tokens ([+consonantal] /[+sonorant]) and one /bl/-cluster. A change other than the trained specification of [+consonantal] was the use of a vocalic onset to /l/ (three nonmatching tokens). Thus the segment with the higher level features seemed to be developing at a faster rate, even though it was not yet mastered.



Note: There were no matches for segmental training target alveopalatals nor for observation targets: #CCC, /h/, /r/ and interdentals.
*EP = short epenthesis (reduced vowel)
**unt. = untrained
+COMP. = complex structure (affricate)

Figure 3.3. S1: Proportional gain in matches for syllabic and segmental targets between Initial Assessment and Block 1 major probes

Other Feature Changes Unrelated to Segmental Targets

Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

A. Unspecifed child forms where adult forms are specified

Laryngeal node: Range of distribution for redundant feature [+spread glottis] was expanded in the stop category (22/52 matches [42.31%]). This feature change possibly resulted from

syllabic condition training, since aspirated isolated phones [k^h] and [t^h] were stimuli in training of the /k/- and /t/-clusters. **

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Root node: [+*continuant]* for the first element of [w]-clusters was reduced in range of application to /t/- and /d/-clusters only. +

2. Place node: *Labial* for Coronal Place was reduced in range of application to /t /- and /d/-clusters, /r/, and /θ/. +

Syllabic Goals

Moraic Subblock

Because of consistent epenthesis use, no exact matches were noted for /kw/ in the major probe, although the /k/ and /w/ elements matched as segments within the clusters in all four instances. All moraic target clusters with /j/ matched. A minor probe in the previous week had slightly different results (see figure 3.4). For both SI positions, /kw/ was completely correct 33.33% of the time. If short epenthesis was considering a minor phonetic timing deviation and thus ignored as a mismatch, 50% of the productions matched the target. Clusters with /j/ were completely correct 76.19% of the time, and 80.95% of the time when short epenthesis was not considered an error.

Onset-Rime Subblock

No matches were noted for /tw/ in the major probe, and /t/ was correct only twice in five attempts. ([f] surfaced for /t/ twice and [d] once.) There was some progression in realization of the /mj/ clusters, in that one production had a rounded front vowel for /ju/ (/mju/ > [my] in musicwriting) but there were no matches. Again, results in the minor probe were slightly different. For /tw/, there were 10% matches without epenthesis and 35% with short epenthesis. Clusters with /j/ matched 80% of the time (no epenthesis).

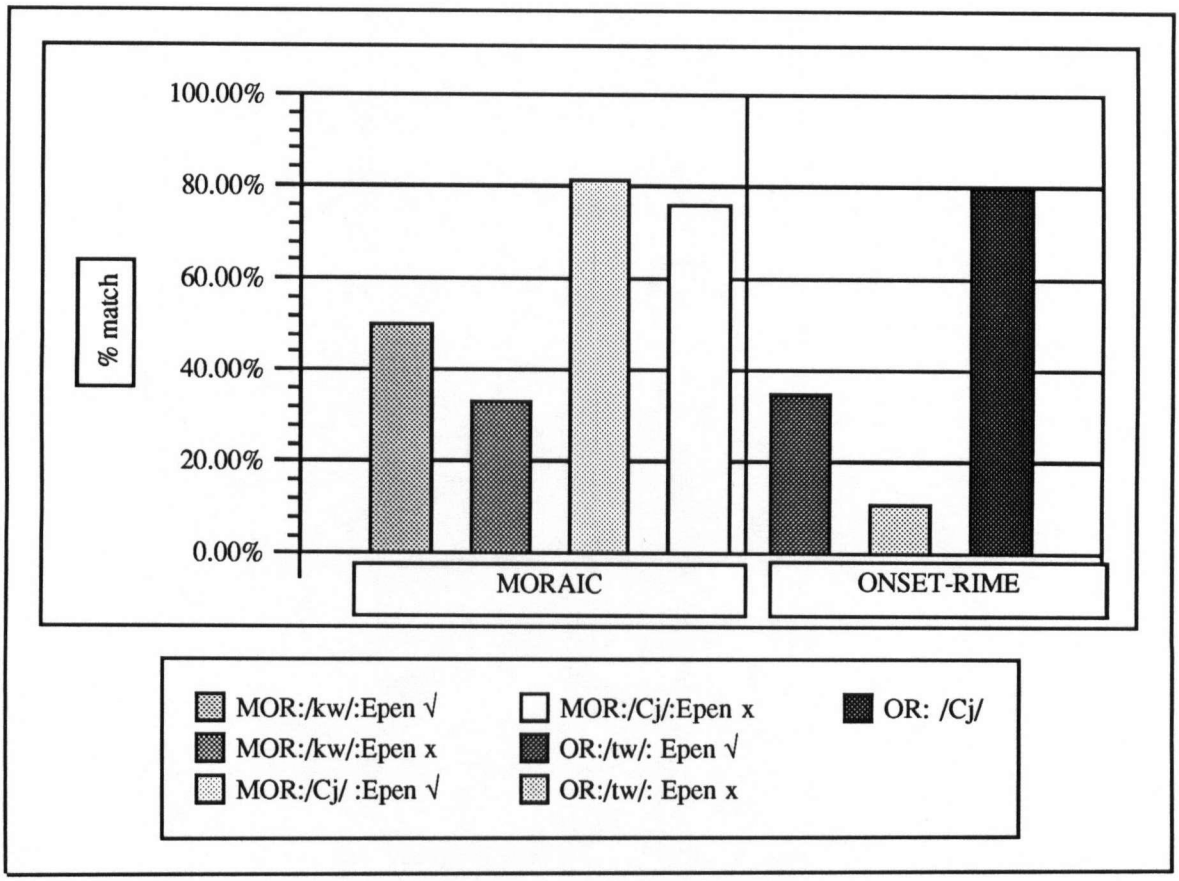


Figure 3.4. S1: Proportional matches for syllabic targets in Block 1 minor probe

Other Syllabic Changes

Overall there was a dramatic change in initial cluster production with elimination of the [f] assimilation for all but coronals, and an increase in the use of epenthesis. If items with short duration epenthesis were counted as matches, 64% of the child forms matched the cluster targets in terms of number of elements. Furthermore, most /s/-clusters were realized with both elements. The percentage gain for WI clusters was 13% for single-syllable words, and 22.19% across all word shapes (counting all items with epenthesis as mismatches). For SIWW clusters, there was an overall improvement of 17.5%.

Intervention Plan: Block 2

Segmental Intervention Plan

Lower Level Feature

Targets: /ʃ/ and /ʤ/ -- [-anterior] (all word positions as in Block 1)

Higher Level Feature

Target: WI and SIWW /l/, WI /l/-clusters -- [+consonantal] /[+sonorant]

Rationale

S1 had not mastered the Block 1 segmental targets, and hence they were repeated. Because WI clusters were developing rapidly in terms of skeletal slot establishment, development of /Cl/-clusters was considered a segmental goal at this point. Expanding the range of targets for /l/ was a logical next step, given the incipient generalization observed for /l/ in the major probe.

Syllabic Intervention Plan

Moraic Subblock

Targets: 1. /kw/ (one half-session for generalization to conversation)

2. /st/ in WI position

Onset-Rime Subblock

Targets: 1. /tw/ (one half-session for generalization to conversation)

2. /st/ in WI position

Rationale

Of all of the WI two-element clusters, the only one without two elements in the probe was /st/. In WF position, /st/ was established at the syllabic level and in one case /ts/ was produced correctly as [+anterior] rather than [+*distributed*]. These facts motivated the choice of /st/ as a syllabic goal. Choosing a syllabic target which would require some phonetic (and therefore) segmental training was a departure from the general design. Because the only other option was triple consonant WI cluster training (which would also involve /s/), and because of the general need to address the WI /s/ and /t/ neutralization, E decided to proceed with /st/ as a syllabic target. To maintain the syllabic focus, the data was then analyzed separately in terms of WI skeletal slots and in terms of features.

Utilizing the same target for both conditions provided an opportunity to evaluate the effects of introducing stimuli as onset-rime versus moraic constituents without the influence of phonemic factors. In order to minimize the intercondition interference, an attempt was made to match lexical item to condition so as to maximize independence and meaningfulness of stimuli, for example,

day/stay for moraic, in which adding an initial [s] to an unaspirated stop provided two words for contrast, versus and/stand for onset-rime, in which the addition of [st] provided two words for contrast.

Results of Block 2 Intervention

Figures 3.5 and 3.6 show results from the minor and major probes in Block 2 respectively.

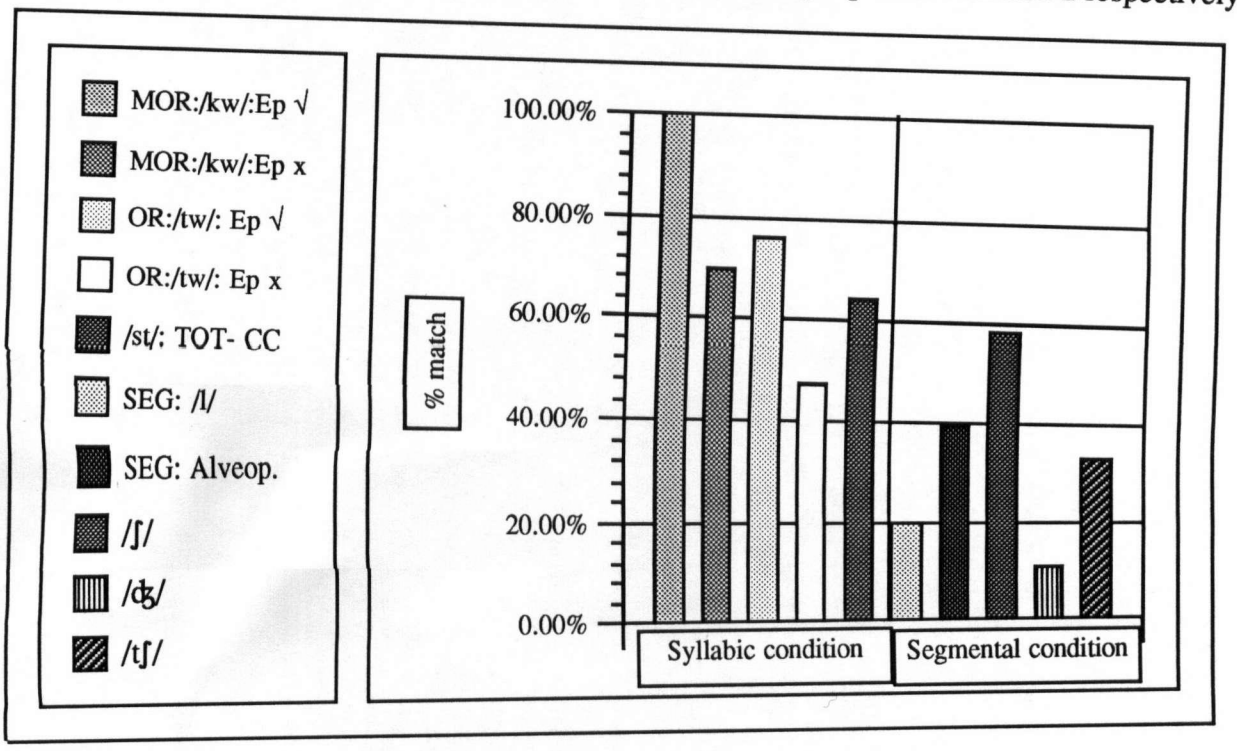


Figure 3.5. S1: Proportional matches for syllabic and segmental targets in Block 2 minor probe

The minor probes results demonstrate a subblock advantage for the syllabic targets, but the major probe results show an advantage for the segmental targets (average proportional gain of 80.85%, *SD*, 17.65% compared with 48.92%, *SD* 7.25% for syllabic targets). This reflects the mastery gained within the week's vacation between the 18th and 19th sessions for Block 2 segmental targets -- a consolidation period.

As can be observed, best results were achieved for syllabic targets /kw/ and /tw/ (when short epenthesis was ignored as an error). The lowest number of matches were observed for segmental targets /ʤ/ and /l/. However, segmental target /ʃ/ had a greater match proportion than

syllabic targets /tw/ (when epenthesis was counted as a mismatch), and had an only slightly lower match proportion than syllabic target /st/.

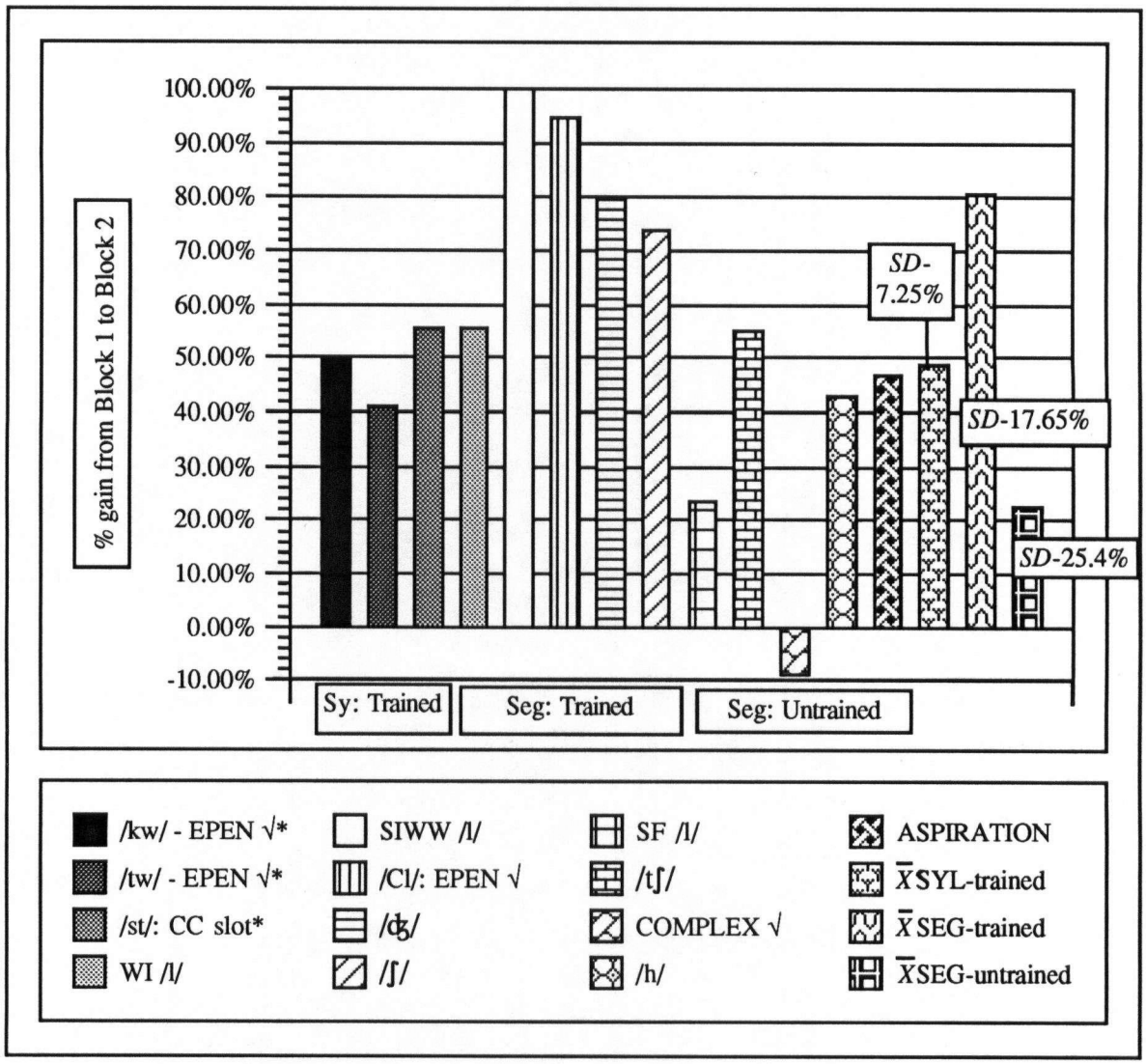
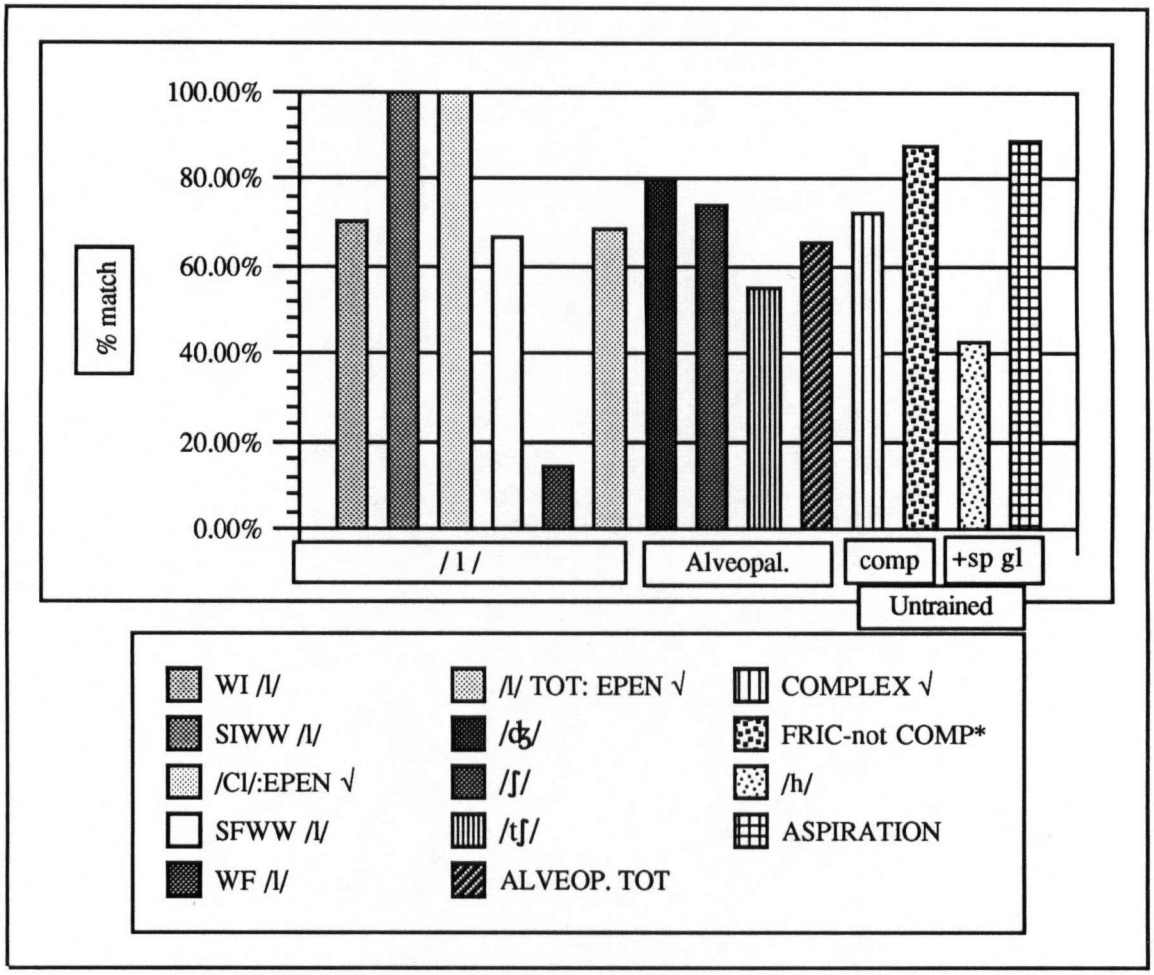


Figure 3.6. S1: Proportional gain in matches for syllabic and segmental targets between Block 1 and Block 2 major probes

As can be seen, best results were achieved for SIWW /l/, /Cl/ (short epenthesis ignored as an error), /ʤ/, and /ʃ/. The apparent regression from the m;inor probe to the major probe for the syllabic target /kw/ reflects particular difficulty with one item -- quarter, produced without a [w].

Segmental Goals

Figure 3.7 shows Block 2 major probe proportional matches for trained and untrained segmental targets.



Note: There were no matches for /ʒ/, /r/, /θ/, or /ð/.

Figure 3.7. S1: Proportional matches for trained and untrained segmental targets in Block 2 major probe

Lower Level Feature

Target: Alveopalatals -- [-anterior]

In the major probe, all alveopalatals except /ʒ/ were used in conversation. Over all phonemes and word positions, 40/61 (65.57%) child forms matched adult targets. Voicing was appropriate across all items.

There were unequal results across word positions and phonemes. The best results were for WF /ʤ/ (100% matches) and /ʃ/ in SIWW and WI position (86% and 83.33% respectively). Over all word positions the rank order of matches was /ʤ/ (80%) > /ʃ/ (73.91%) > /ʧ/ (55%) > /ʒ/ (no matches on three attempts).

In terms of features, there were also unequal results across word positions. In WI position, the 'default' feature [+*distributed*] was completely eliminated and the feature[-anterior] specified; in WF position, however, the feature [+*distributed*] was eliminated for the four /ʤ/ words and for six of the ten /ʃ/ words but not at all for the three /ʧ/ words (65% matches). Furthermore, specification or lack thereof for 'complex' structure was not yet completely established syllable initially (although now only in the alveopalatal class). Affricates were realized as fricatives 7/25 times, and fricatives as affricates 2/16 times.

Higher Level Feature

Target: /l/ -- [+consonantal] /[+sonorant]

In the major probe, generalization of /l/ was apparent across all word positions, even though only SI singletons and clusters had been training targets. Overall, there were 27/45 (60%) matches for /l/ as a singleton.

Results varied across word position. For SI position, there were matches for 82.14% of the words (12/17 [70.59%] for WI position , 11/11 for SIWW position). Among the clusters, only /pl/ (42.86%) and /kl/ (33.33%) had matches, ignoring short epenthesis as an error. In the untrained SF positions, two out of three SFWW items matched and two out of fourteen (14.29%) of the WF items.

Feature changes included establishment of [+consonantal] specification at the Root node across many items, elimination of vocalic onset, lengthening of the initial singleton, and one case of appropriate use of [+*distributed*] (interdental place). One case of inappropriate specification of palatalization ([-anterior]) was noted.

Changes over Time for Trained Segmental Targets

The changes noted for alveopalatals and /l/ occurred during the syllabic block. The single word data from the segmental subblock minor probe did not show this degree of generalization. (This parallels the situation in Block 1, where phonetic stimulability for alveopalatals increased while syllabic targets were being trained.) The token economy, reinforcing spontaneous use of any targets in conversation, possibly promoted this generalization.

At the end of the segmental subblock, the minor probe showed more matches for alveopalatals than for /l/, a reverse of Block 1. Of the 38 alveopalatals, 15 child forms matched the adult targets (39.47%), in comparison with none at the end of Block 1. Only 5/25 (20%) of the /l/ words were matches, compared with 3/22 (13.64%) matches at the end of Block 1. However, the matches occurred for alveopalatals only in WF (9/15 matches [60%]) and SIWW positions (6/15 [40%]), with no matching WI targets. Recalling that for S1, WI position was the weakest in terms of matches in general, the apparent advantage for the alveopalatals over /l/ may be less than it seems. The three WI matches for /l/ demonstrate an advance of /l/ over the alveopalatals for the most troublesome word position.

Other Feature Changes Unrelated to Segmental Targets

Unspecified child form where adult form is specified (resulting in matches)

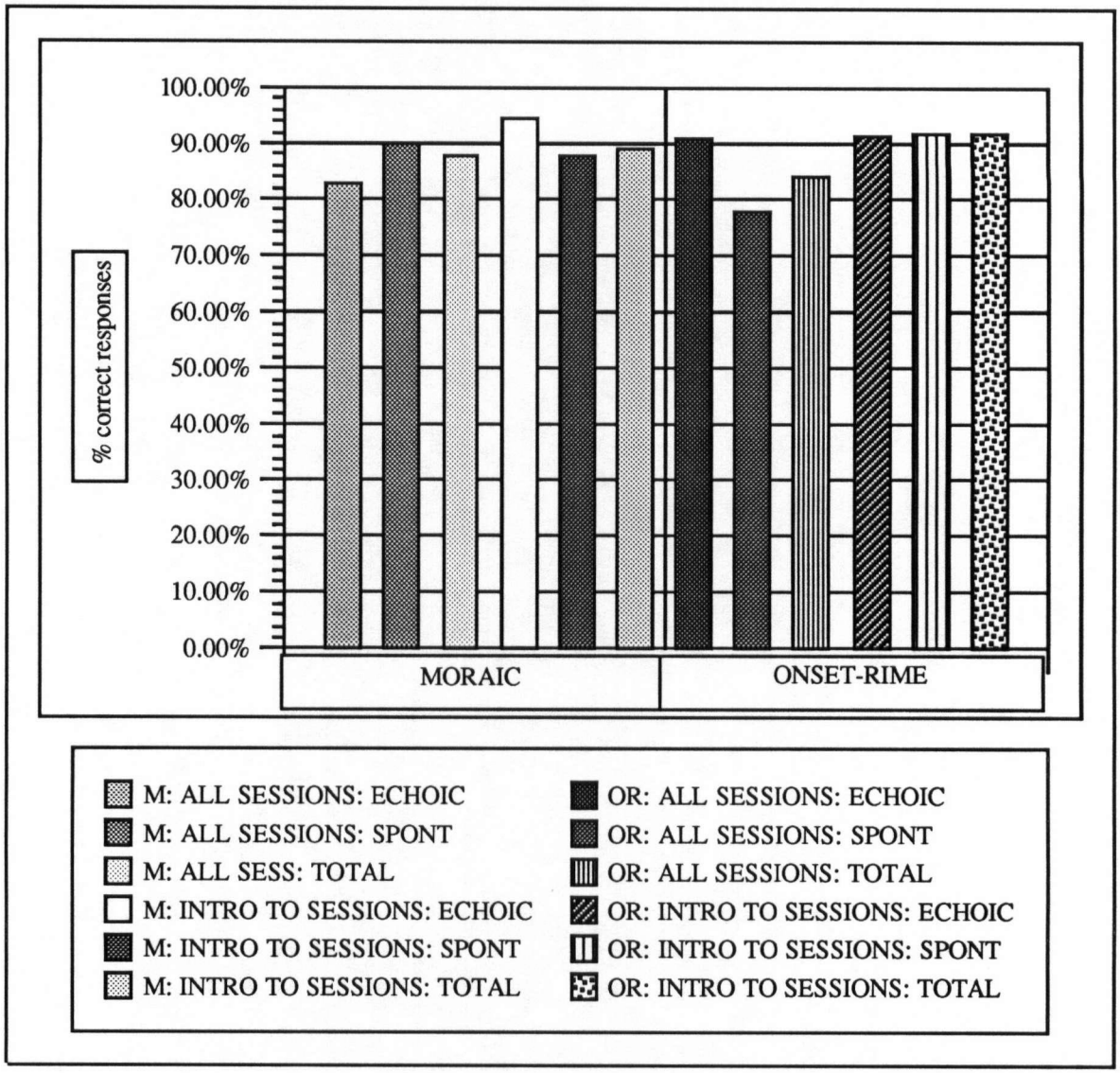
Laryngeal node: Redundant feature [+spread glottis] was now specified more frequently for for /h/ (6/14 matches [42.86%]) and was present for more unvoiced WI stops (41/46 matches [89.13%])

Areas of No Change in Feature Specification

1. Coronal node: [+*distributed*] interdental or dental place use continued for /s/ and /z/ realization.
2. Root node: [+consonantal]/[+distibuted] remained unspecified for /r/.
3. Root node: [+continuant] remained unspecified for /ð/.

Syllabic Goals

Major probe data were insufficient to compare moraic and onset-rime conditions. (Surface realization of two skeletal slots for /st/ was incipient, as 5/9 [55.56%] matching tokens appeared in the major probe, and 11/17 [64.70%] appeared in the minor probe.) The minor probe data and the intervention session data from the syllabic subblock were examined, the latter only for /st/ (see figure 3.8 for session match data).



Note: S1's echoic and spontaneous responses in moraic and onset-rime conditions are shown across all sessions and across introductory parts of the subblocks, when stimuli were presented as discrete moraic or onset-rime constituents.

Figure 3.8. S1: Proportional matches for syllabic target /st/ in Block 2 sessions

Moraic Subblock

A. Minor probe data

If epenthesis was ignored, 23/23 matches were noted for /kw/. If epenthesis was acknowledged as an error, 69.57% of the items matched the targets.

B. Session data for /st/ (skeletal slot results)

Overall, for moraic condition echoic responses, there were 100 /121 (82.64%) diconsonantal imitations. For spontaneous (including self-echoic or self-corrected) responses there were 252/280 (90%) diconsonantal productions, yielding a total of 352/401 (87.78%) skeletal slot matches in therapy sessions.

In the introductory parts of the production training sessions, E made word constituency salient with verbal and visual cues. For these introductory portions, 34/36 (94.44%) moraic condition echoic responses were correct, whereas 106/121 (87.6%) spontaneous responses were correct. It appears that imitation was somewhat better when word constituents were presented separately than when the word was presented as a unit (66/85 - 77.64%). However, once the child could pronounce a word without a verbal model, direct access to constituency (by visual cueing) was perhaps not necessary (correct responses = 146/159 - 91.82%).

Onset-Rime Subblock

A. Minor probe data

If epenthesis was ignored, 16/21 (76.19%) matches were noted for /tw/. If epenthesis was acknowledged as an error, 10/21 (47.62%) of the items matched the targets.

B. Session data for /st/ (skeletal slots)

Overall, for onset-rime condition echoic responses, there were 71/78 (91.13%) matches. For spontaneous responses there were 67/86 (77.91%) responses, yielding a total of 138/164 (84.15%) total matches.

If only the introductory parts of the production sessions are examined, 54/59 (91.52%) onset-rime condition echoic responses were correct, whereas 34/37 (91.89%) spontaneous responses were correct. Word constituency presentation did not apparently influence correct

imitation of words, but there was a notable gap between the introductory parts of sessions and total correct spontaneous productions of words assigned to this condition.

Other Syllabic Notes

From the feature data, it was apparent that the segments of clusters matched the adult target less than 50% of the time. This was because of the substitutions for /s/ ([θ]) and /r/ ([w]). As noted, epenthesis continued to be used in stop and approximant clusters.

Block 3 and Beyond

Since the syllabic goals had been met in terms of number of consonant slots in diconsonantal clusters, a short program introducing triconsonantal clusters followed, complementing a review of /st/. The major foci of Block 3 were necessarily segmental: sorting out [+*distributed]* from [+anterior] (/s/ and /z/ versus /θ/ and /ð/) and establishing [+consonantal] /[+sonorant] with [+distributed] (/r/).

In Block 3, there was some success in sorting out [+*distibuted*] from [+anterior], although many of the alveolar sibilants remained phonetically dental. S1 gained facility in imitation of [r]. Syllabic goals were met.

In a follow-up speech elicitation, four months later, no change was observed for /r/ and alveolar sibilants. A weekly therapy program over a five-month period led to generalization of /r/ in syllable-initial position (including clusters). Because his parents' dialect does not include the postvocalic allophone, this was not a priority for therapy. As secondary dentition has been slow to erupt, and as finger-sucking and tongue thrust continue, the /s/ and /z/ are not yet amenable (at age 8) to consistently correct phonetic placement. Epenthesis in clusters gradually disappeared, particularly following success with /r/-clusters.

Discussion

In terms of the research questions the following interpretations are offered.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

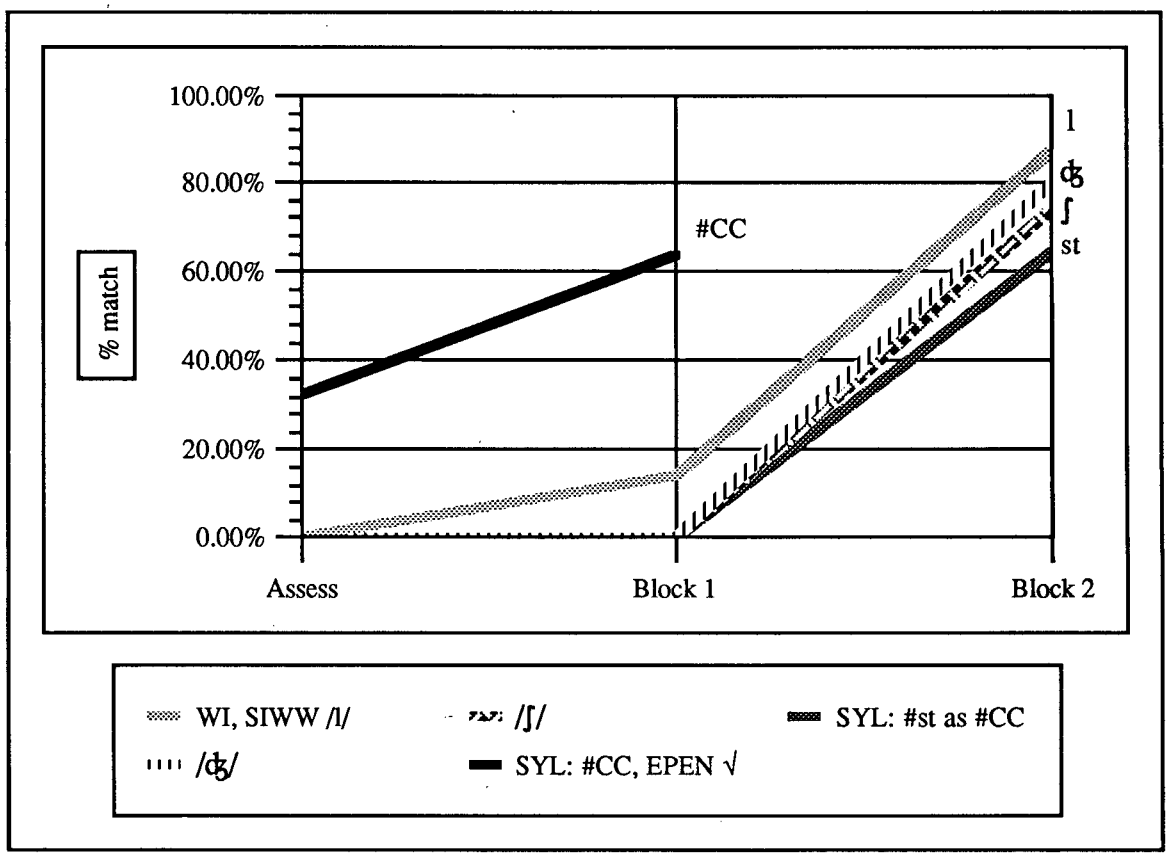
The nonlinear frameworks did lead to reasonable targets for intervention. The intervention project may have been successful for reasons other than the reasonable choosing of targets, such as the intensive stimulation and the mutually enhancing effect of a variety of approaches. However, the generalizations noted below are a *phonological* indication that the chosen targets were relevant for inducing change in the system.

Conversational Intelligibility Gains

There was a remarkable improvement in intelligibility[12] due to the attainment of conversational proficiency for predicted targets /l/, /ʃ/, /ʤ/ and diconsonantal cluster production, epenthesis notwithstanding (see figures 3.9 and 3.10).

Untrained targets which generalized to conversation from the trained ones were, predictably [-anterior] /ʧ/ and (dentalized) /s/, clusters with [w] or [j] as substitutions, and two skeletal slot positions for all /s/-clusters except /st/. Other untrained targets which improved were voiceless initial stops (possibly since [+spread glottis] stops were presented in both moraic and onset-rime conditions as models) and /h/. The latter was never presented in therapy, but may have improved as an extension of [+spread glottis] specification for WI stops. Facility with imitative production of [r] (unstimulable at the onset of intervention) may be attributed to the acquisition of /l/ and the alveopalatals, since /r/ requires the specification of [+consonantal]/[+sonorant] as well as a retracted ([-anterior]) tongue position.

In the year prior to the study and in the four-month break following, minimal changes occurred, lending support to the perception of the project's effectiveness.

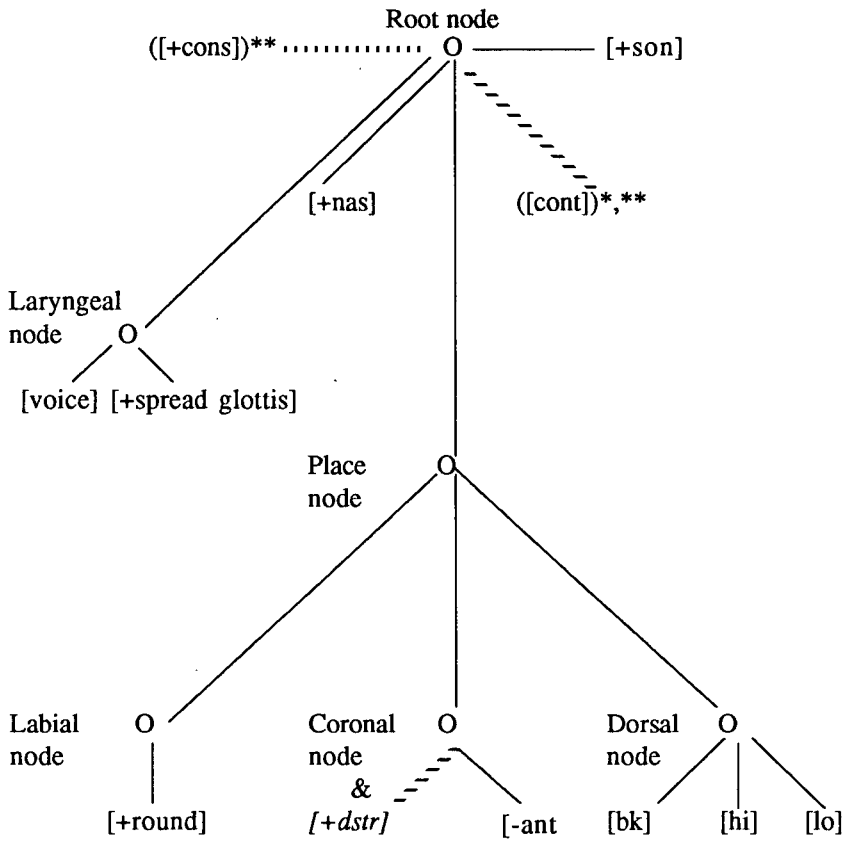


Note: At Block 2, /l/ data includes clusters (100%, short epenthesis ignored as an error). Clusters with epenthesis that were designated as matches had very short epenthetic vowels. When the epenthetic vowel was as long as other unstressed vowels (according to E's transcription), the child form was counted as a mismatch.

Figure 3.9. S1: Developmental progression in proportional matches for trianed phonological targets across the intervention period

Language Test Results

Language test scores (within or above normal limits to begin with) improved in ways which support the conviction that phonological intervention, and not general language development, are responsible for the gains incurred. On the Peabody Picture Vocabulary Test (Form L), S1's score improved from a *SS* of 88 to a *SS* of 121 (average = 100) with nonoverlapping confidence intervals. On the Test of Language Development (Primary), there was improvement for vocabulary, word discrimination, and word articulation subtest scores and equivalence or slight regression of scores for syntactic/morphological subtests. These results were expected, since the enterprise of phonological intervention involves presentation of many (new) words, phonemic discrimination training, and phonetic training, with minimal emphasis (in the general case, and particularly for S1) on syntax.



Note: Parentheses indicate partially established features in system developm
Italics indicate inappropriate feature. Dotted lines represent partially-establi
constituents.
*'Complex' branching structure more consistently applied to affricates;
**[+cont] unspecified for the voiced interdental; [+cons] unspecified for /r/ onl
&Less frequent interdental tongue place

Figure 3.10. S1: Feature geometry at end of Block 2

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real?

At the end of the two blocks, there were quantitative differences between the syllabic and segmental results. At the end of Block 1, there was a clear gain in percentage and types of syllable/word shape matches in comparison with segmental targets, the latter of which had not generalized to conversation. The segmental targets introduced in Block 1 were not mastered until the end of Block 2 (which accounts for the noticeable difference between Block 1 and Block 2 for segmental targets). By contrast, rate of change decreased for syllabic targets in Block 2. Generalization of the specific syllabic target /st/ had not been achieved at the end of Block 2, although widespread changes had occurred across the cluster targets in Block 1. Because /st/ also required segmental learning at the level of the coronal node, it was an expectedly difficult target.

With respect to phonological development and the autonomy of tiers, it appears that there was some independent development that could be exploited in intervention. For this particular subject, syllabic changes were more dramatic at the outset and led to improved intelligibility within six weeks of the onset of therapy. Initial cluster development had begun prior to intervention. Taking advantage of this beginning development led to immediate results. Segmental changes occurred at a slower rate (note /r/ and /s/ particularly), both for phonological and phonetic (articulatory) reasons. Targeting the two tiers independently and alternately was synchronous with this slower-changing aspect of the system.

Complete autonomy of tiers was not supported by this subject's data, however, as the cluster data (particularly the /s/-clusters) showed. Where two tiers interact, especially negatively as for /st/, we might expect a slower rate of change, as was the case for S1.

3. If the 'syllabic/prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable shapes acquired as a result of interventions that contrast the onset and rime versus those that utilize the mora as a constituent?

Nonmatches and Syllable Theories at Initial Assessment

In onset-rime theory, the onset is considered a constituent made up of up to two elements (not including extrametrical /s/). Kaye et al. (1987) suggest that intraconstituent government proceeds from left to right, with deletion and spreading being possible results of this government. In those cases where the first onset consonant was retained and the second was missing, there is support for the hypothesized direction of government (for deletion processes). However, the apparent Labial spreading from [w] to the preceding consonant, resulting in [fw] clusters, would seem to contradict the intraconstituent direction of government hypothesis (for diagram showing spreading for [fw], see figure 9.2). It does, on the other hand, seem to support the concept of onset as a constituent with its own set of operations. (No cases of leftward spreading link labiality from a labial vowel onto the preceding consonant; in other words, the labial spreading is a consonantal onset interaction with no assistance from the rime.)

It is difficult to derive a moraic interpretation of the assessment cluster data, since onsets do not have any moraic status in that theory except where rules involve spreading from onset to coda position for creation or deletion of morae. The adjunction or lack thereof of consonants to a mora may be considered more of a segmental issue than a syllabic one. That only certain segments surfaced, depending on degree of feature-sharing (a segmental tier phenomenon) may support this aspect of the moraic theory.

Intervention Data and Syllable Theory

Quantitative Analysis

Scores were overall slightly higher for moraic condition targets (according to the mean difference shown in figure 3.11) across the study. Greater differences were noted in the minor probes than across session data, however.

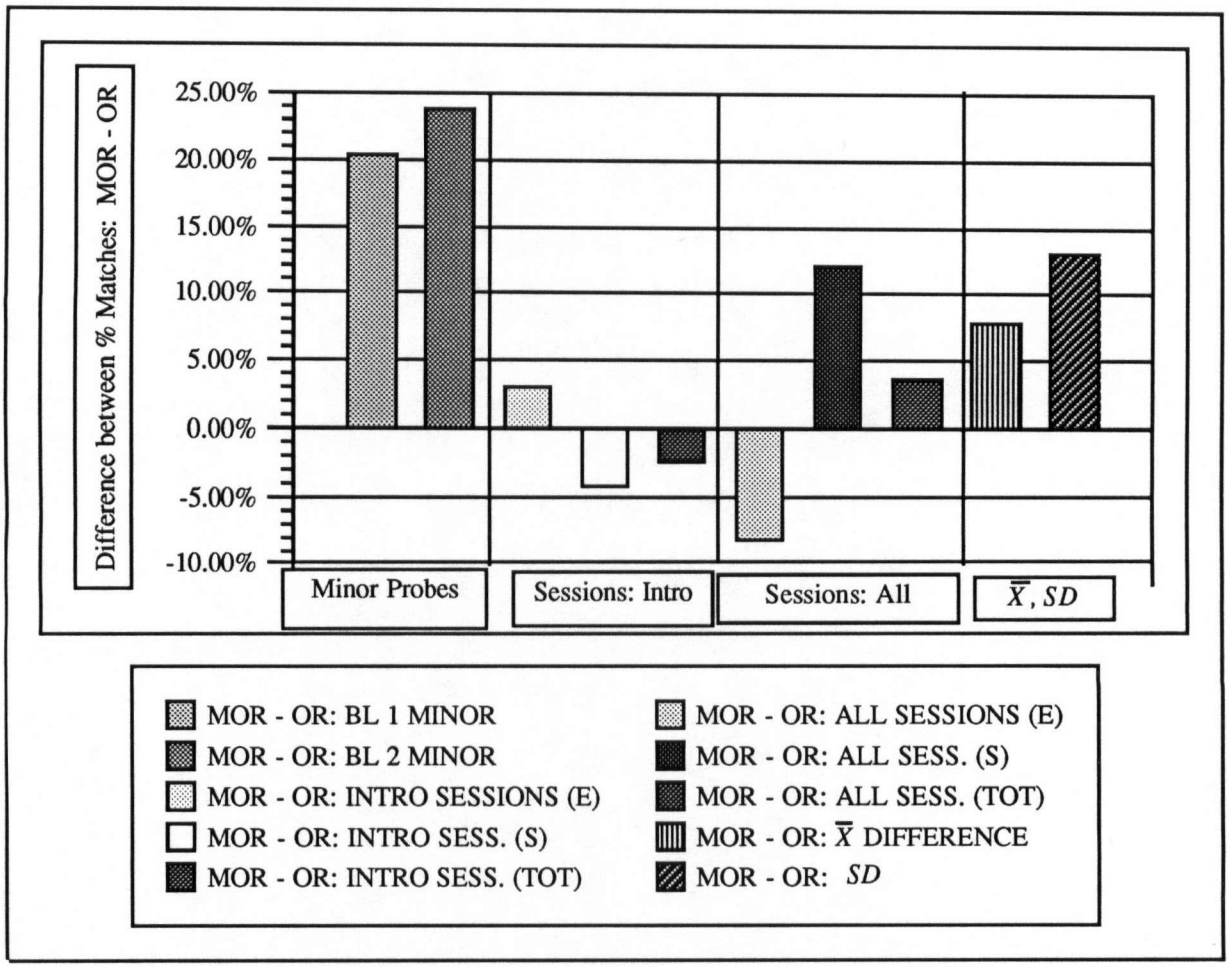


Figure 3.11. S1: Proportional differences between moraic and onset-rime match scores for minor probes, introductory parts of production sessions, and overall session data (spontaneous and echoic responses)

In order to evaluate the aforementioned differences statistically, the Kolmogorov-Smirnov nonparametric measure (comparing cumulative frequency distributions of proportional matches for the two conditions) was chosen. Individually, there were eight different comparison measures available across the study for O-R targets, including four miniprobe comparisons, two major probe comparisons, and two session subblock comparisons. There were seven comparisons for moraic targets (only one major probe measure, due to insufficient data).

The following null (H_0) and alternative hypotheses (H_1) were tested using the Kolmogorov-Smirnov measure (see table 3.4).

H_0: There will be no difference between the proportional match scores for all of the moraic (m) and onset-rime (n) measures across the study.

H_1: Moraic targets had proportionately higher proportional match scores across the study.

Table 3.4.--S1: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test

	<10%	31-35%	36-40%	46-50%	76-80%	81-85%	86-90%	91-95%	100%
s_m (x)	0/7	0/7	0/7	2/7	*2/7*	4/7	5/7	5/7	7/7
s_n (x)	1/8	2/8	3/8	3/8	*6/8*	7/8	7/8	8/8	8/8

$p > 0.1$

The largest discrepancy between number of proportional match data sets falls in the 76-80% column. This yields a test statistic of (8)(7)(.4625)=25.9, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed).

Qualitative Analysis

Although the slight advantage for the moraic conditions was not statistically significant for this child, the actual differences will be discussed below in order to ascertain whether there may be some clinical or linguistic relevance to the observed difference.

Specifically, the moraic condition was more successful for /kw/ and for spontaneous productions of /st/ over all sessions. The difficulty with the onset-rime target /tw/ may, however, have reflected difficulty with WI /t/ at the segmental level. A minimally specified phoneme, such as /t/ in English, may be more inaccessible for change than a more highly specified phoneme, by virtue of having nothing remarkable to identify itself. For S1, WI /t/ was often affected by the interdental default tongue position ([+*distributed*]) for coronals, making change difficult for articulatory reasons. In the onset-rime subblock /t/ itself was not a focus when targeting the /tw/- and /st/-clusters. In the moraic subblock the edge member of the cluster (i.e., /k/) was modelled and imitated separately from the consonant directly preceding the vowel. In other words, the type of stimuli in the onset-rime condition may have contributed to slower rate of change for

spontaneous productions of /tw/ and /st/, because of general negative interactions of the segmental and syllabic tiers for coronals and clusters.

Results were more contradictory for /st/ session data. Over all therapy sessions for /st/, the onset-rime condition had a higher percentage of correct echoic responses, whereas the moraic condition showed a higher percentage of correct spontaneous productions of /st/ syllables and words. However, during the introductory parts of the production sessions (step #3 in training), E presented direct verbal and visual models of word constituency. For these parts of the sessions echoic moraic condition trials had a 3% advantage over the onset-rime trials. Since both conditions had over a 90% rate of correct responses, the result may not be clinically interesting.

Spontaneous productions are the primary responses of interest in an intervention program, but those particular results for /st/ session data are also somewhat ambiguous. During the introductory parts of production sessions, onset-rime words had a greater success rate, but over all sessions, there were a greater number of matches in the moraic condition. This may have reflected an extraneous variable -- the greater number of trials for the moraic condition, giving more practice. A learning effect from the moraic to the onset-rime condition may have resulted in success in the introductory portion of the onset-rime program, but the onset-rime condition itself and/or the lesser number of trials failed to promote the same degree of generalization.

A factor not apparent in the training target data per se may indicate some general learning about clusters based on stimuli in the onset-rime condition. From the assessment to the end of Block 1, the use of epenthesis increased, enabling consistent realization of WI stops in clusters. Onset-rime subblock training methods may have promoted use of epenthesis, since the [w] or [j] of the [tw]-, [mj]- or [fj]-cluster was presented as an [$^{\upsilon}$.w] or [^{i}.j] to make a pronounceable constituent separate from the rime, e.g., twine > [t$^{\upsilon}$-waɪn].

4. If the 'segmental tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

Block 1

At the end of Block 1, /l/ was correct in WI position 3/22 times, whereas there were no matches for the alveopalatals. It appeared that the higher Root node feature [+consonantal] conjoined with [+sonorant] was being more quickly acquired than the lower Coronal node feature [-anterior]. This was a prediction of the feature hierarchy approach.

Block 2

At the end of Block 2, both sets of targets -- /l/ and the alveopalatals -- had generalized to conversation, demonstrating an apparent "catch-up" effect for the [-anterior] feature in comparison with the Block 1 major probe, and a "catch-up" effect for /l/ from the Block 2 minor probe. There was a slight advantage for the alveopalatals over /l/ overall and in WI position at the time of the major probe, although there had been no matching WI alveopalatals a month before, at the time of the minor probe. One of the notable therapy observations at the beginning of Block 2 was the greater *ease of articulation* for alveopalatals than in Block 1, even though intervention had focused solely on /l/ and the syllabic targets in the interim. The rapid increase in generalization of alveopalatals in Block 2 may indicate that phonological learning was being held back primarily by articulatory factors for this set of targets.

The double "catch-up" effects may indicate that the feature hierarchy level did not influence rate of development in Block 2, after the phonemes had begun to emerge. However, the earlier success with /l/ at the end of Block 1, which continued marginally for the trained word positions in Block 2, seems to lend partial support to the relevance of height in the feature hierarchy for development and intervention. Furthermore, by targeting two features simultaneously, it is possible that the higher level feature may positively influence establishment of a lower level feature, particularly if, as in this case, this other feature is a *marked* feature (i.e., [-anterior]) of a default place node for the first (Coronal).

In support of feature relevance are the generalizations observed for related untrained targets. For example, /ʧ/ became evident in the child's speech at the same time as its [-anterior] counterparts -- /ʃ/ and /ʤ/ -- although not at a lower match proportion level, the predicted outcome for an untrained target. The general learning regarding the specification or lack thereof for 'complex' structure among stops, fricatives and affricates appeared to have been facilitated through the training of /ʃ/ and /ʤ/, two segments differing in terms of the branching/nonbranching structure. The facility gained with imitation of /r/ (unstimulable at the outset) may suggest a general development in articulatory skill, but also may suggest the extension of the conjunction of [+consonantal] with [+sonorant] gained from the learning of /l/. From the syllabic condition training, a byproduct appeared to be the consolidation of aspiration on WI voiceless stops (the redundant feature [+spread glottis] possibly learned from practise with [k^h] as a separate constituent). Once the voiceless stops were consistently produced, /h/ appeared in the child's speech -- suggesting generalization of the redundant [+spread glottis] feature to the phonemic level.

Beyond feature hierarchy predictions, word position was shown to be relevant for the process of segmental acquisition (as has been noted often by other observers, e.g., Branigan [1976]; Chiat [1989]). The generally more difficult word position for S1 was WI position, once again observed by the emergence of WF alveopalatals first (in spite of training in all word positions). For /l/ there may have been easier access to WI than to WF position because of the allophonic/dialectal variation between the word positions. However, the fact that it was possible to establish one of the targets -- /l/ -- in the more generally difficult word position may have facilitated the emergence of the other WI targets -- the alveopalatals. Whatever the feature hierarchy model provides in terms of a reference for a child's phonemic system needs, the interaction of the segmental and syllabic variables must also be identified.

Summary

S1 achieved all of his phonological goals for the project, gaining conversational proficiency for trained segmental targets /l/, /ʃ/ and /ʤ/, and trained syllabic cluster targets /Cw/ and /Cj/ and skeletal slot specification for /st/-clusters. Gains were greatest for syllabic targets in

Block 1, and segmental targets in Block 2. Interaction of segmental and syllabic constraints made the syllabic target /st/ more difficult than the syllabic targets for Block 1.

Generalization to untrained targets took place in both conditions in predictable directions -- in the segmental condition from /ʃ/ and /ʤ/ to /ʧ/ (another [-anterior] phoneme), and in the syllabic condition from /Cw/ and /Cj/ to skeletal slot marking and specific phoneme realization for all clusters. Specification of 'complex' structure for affricates as opposed to fricatives and stops was a byproduct of the alveopalatal training, although it was not a direct objective of the training. A probable byproduct of the cluster training was the appearance of aspiration (the redundant feature of [+spread glottis]) for WI stops, a feature which may have transferred to the phonemic level, resulting in emergence of /h/, acquired spontaneously during the intervention period.

Using the Kolmogorov-Smirnov test, there was no statistically significant difference between proportional matches for onset-rime and moraic conditions. Moraic condition training appeared slightly more successful than onset-rime training for spontaneous productions of /st/ and overall for /kw/. However, the imitative parts of the /st/ training showed a slight advantage for the onset-rime constituents. S1's general difficulty with /t/ may have impeded development of /tw/, especially since the /t/ was not presented as a separate stimulus, but as a unit with the glide. The use of epenthesis generally fostered development of cluster element realization. This may have been a result of onset-rime subblock training, in which the [w] or [j] was often lengthened to an [u] or [i], to make a pronounceable constituent.

The marginally faster rate of acquisition for /l/, with its higher level feature conjunction [+consonantal]/[+sonorant], compared with the alveopalatals, with their lower level feature [-anterior], may imply relevance of the feature hierarchy for S1's development .

Lack of change for untrained targets /r/ and the interdentals ([+distributed]) both during and following the project supports the conviction that intervention was responsible for change.

CHAPTER 4

SUBJECT 2: SUMMARY

[babwə bɛnhaʔ, jə nou wʌʔ]

Case History Information

Subject Characteristics

During the reported period of the study, this boy was 4;2 - 4;6. The phonological disorder was associated with:

1. A history of chronic otitis media from age 1 year, with a myringotomy three months prior to study for "glue ear." (Hearing screening at bimonthly intervals throughout the study showed hearing within normal limits.)

2. A mild delay in language production, reflected in inconsistent use of copula and auxiliary BE, pronominal case errors and sibilant morphophonemes

3. A mild attention deficit possibly resulting from the middle ear history (see table 4.1).

Prior Treatment

S2 had participated in a group articulation therapy program for three months prior to the study. Focusing on fricatives had led to production of some sibilants in WF and SIWW positions.

Phonological System at Initial Assessment

Phonotactics: Syllables and Words

S2's phonological system was established at the syllabic level with exceptions in cluster development and positional distribution of coronal obstruents and /l/ (see appendix 4, table 4.1).

Table 4.1.--Subject information for S2

AGE	4;2 - 4;6 for reported period
GENDER	Male
BIRTH ORDER	Second of 2 boys
FAMILY HISTORY	English-speaking (Canadian-raised parents) Father firefighter Mother school staff assistant (not employed during study)
HEARING	Chronic otitis media from age 18 months Myringotomy three months prior to study Hearing screened within normal limits at onset and at periodic intervals throughout study Mild attention deficit probably secondary to hearing loss history
OTHER DEVELOP. HISTORY	No unusual pregnancy, birth or medical history Age-appropriate motor skills No apparent deficits in cognitive and social skills
ORAL MECHANISM	Normal for speech production except for minimal overjet Stimulable for all sounds of English in isolation (some difficulty with suppression of tongue tip for velars)
LANGUAGE	Comprehension* 1. Peabody Picture Vocabulary Test (Form L) -- average range 2. Test for Auditory Comprehension of Language (Revised) -- average range Phonemic discrimination* Auditory Discrimination Subtest of the Test of Language Development (Revised) -- average range Production 1. Structured Photographic Expressive Language Test - Preschool -- borderline low average range. Morphological errors reflecting phonological errors (/s/ and /z/ morphemes), copula /auxiliary omissions and pronominal case errors 2. Language sample consistent with SPELT-P Sentences of 4-6 words, with some longer complex sentences
PREVIOUS THERAPY	Three months group articulation therapy for stimulation of fricatives (some change for sibilants) with another speech-language pathologist

*See table 4.3 for scores.

Syllable-Initial Cluster Development

The more advanced categories were /Cl/ clusters and /Cj/ combinations.

A. /l/-clusters

1. Most SI /l/-clusters were produced with two consonants and full epenthetic vowels: /Cl/ > [Cəl], although /pl/ once had a reduced epenthetic vowel ([Cᵊl]short epenthesis).

2. Both WI /pl/ and /fl/ were realized with one segment only, /pl/ two of four times : /pl/ > [p], /fl/ > [l] (one matching exemplar).

B. Stop-glide clusters

1. The WI /Cj/ combination was realized with /Cj/ two out of three times (once with short epenthesis) and /C/ once, although the SIWW /Cj/ combination was realized only with /C/.

2. The sole token of a /kw/ cluster was realized with the coronal [t] only.

C. /r/ and /s/-clusters

Syllable-initial /r/ and /s/-clusters consisted of one segment: /Cr/, /sC(C)/ > C.

Syllable-Final Clusters

Syllable-final clusters consisted of two elements with the following exceptions:

A. Nasal clusters

The coronal /nt/- and /nd/- clusters were realized with one element some of the time: /nt/ > [t] (five out of nine cases) and /nd/ > [n] (one out of two cases).

B. Stop-sibilant clusters

As with the nasal clusters, clusters with two coronals were more often reduced than other combinations.

1. The /ts/-cluster was realized with [t] only once in three attempts.

2. The solitary /st/-cluster exemplar had both elements missing.

3. The /ks/ cluster was realized with [ʔ] three out of six times. (The WF /k/ was realized as [ʔ] -- also a common realization of WF /t/).

C. Liquid clusters

The /l/-clusters were slightly more advanced than the /r/-clusters in terms of skeletal slot realization, just as the /l/ was better-established as a segment.

1. Although /l/ was specified for [+consonantal] syllable initially, there was a vocalic substitution for /l/ in /lC/ clusters. For /lk/, the /k/ appeared as [ʔ], its usual WF substitution.

2. Clusters with /r/ were realized three out of seven times with two elements, the first a vocalic substitution for /r/, three times with the second consonant only, and in the case of /rf/ not at all.

Positional Syllabic Constraints

Coronal segments had different realizations in different word positions:

1. In the case of WF position, /t/ had no Place feature word finally --WF /t/ > [ʔ] 7/19.

2. As noted above, SF /l/ was realized as a vowel, i.e., without [+consonantal] specification.

3. Coronal sibilants, although usually realized with an interdental tongue position word finally (and occasionally in SIWW position), had no Place feature word initially. All fricatives in fact were realized as [h] in WI position. Only the interdentals deviated from this pattern some of the time. There were three alternate substitutions for /ð/, which matched 4/12 times, but otherwise appeared as [w] (four out of eight times), [h] (three times), or [d] (once). The unvoiced cognate was realized as [h] in thumb but as [ʔ] in thing (both Laryngeal node substitutions).

Segmental Development

In general, the segmental system showed development within all sound classes, with word position (syllabic) constraints evident for stops, fricatives and liquids as noted above. The only completely established classes were vowels and glides (see table 4.2, figure 4.1, and appendix 4, table 2.1).

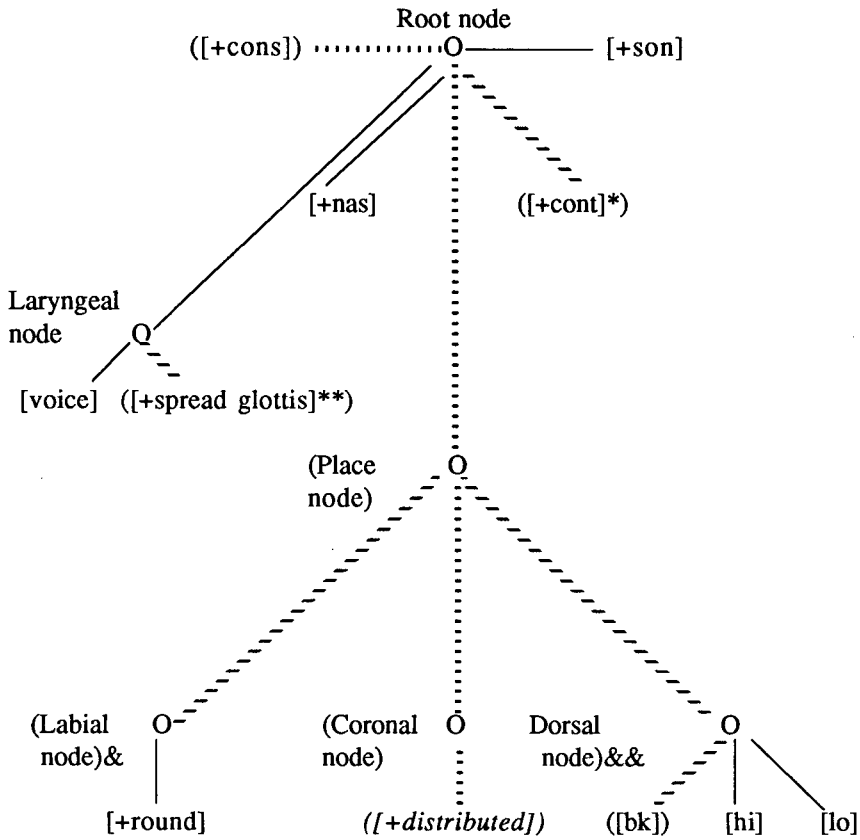
The order of match data across word positions (excluding clusters) showed more advanced development for syllable-initial position over syllable-final position: WI (54.5%) > SIWW (48.7%) > WF (31.78%) > SFWW (18.75%) . Across all consonants and cluster segments, 43.55% of the child forms matched adult targets.

Table 4.2.--S2: Summary of singleton segmental acquisition at Initial Assessment

Sound class	Word position matches	Word position nonmatches	Main feature differences
Vowels	Adequate for intelligibility	Occasional centralization of /ɛ/	[-bk] u[1]
Glides -- /w, j, h/	All		
Nasals	/m/, /n/	/ŋ/	/ŋ/: Dorsal Place u
Stops [-voice]	/p/ : WF, SIWW /t/ - SIWW, (WI)[1], (WF)	/k/ - all (/p/ - WI)	WI: [+spr gl] u 61% /k/: Dorsal Place u WI /t/: [+*dstr*] m*[2] 19% WF /t/: Place node u 37%
Stops [+voice]	/b/ - All /d/ - All	/g/ - None	/g/: Dorsal Place u
Fricatives -- Labial	Neither	Both	WI: Place node u SIWW, WF /v/: RN: [+cont] u, default Place node SIWW /f/: Place u (3) or RN: [+cont] u (2) + default Place node (1) WF /f/: RN: [+cont] u (3), no Place or RN: [+cont] m (2) + default Place (1)
Fric/Affricates -- Coronal	None	(/ð/) All others	WI and (SIWW): [h] = RN:[+cont] m; LN: [+spr gl] m, no Place WF, ((SIWW)): [+dstr] **m* or u (for /ð/) or (R: Ø or [+cont] u) Most 'complex' u
Liquids	/l/ - Syllable-initial	/l/ - Syllable-final /ɹ/ - All	Both: [+cons] u; **Labial* Place for Coronal (Syllable-final: R:Ø)

[1]Single parentheses indicate partial establishment: 40 - 80% under the Matches column, and 10 - 40% under the Nonmatches column. Double parentheses indicate marginal development -- less than 10%.

[2]u= unspecified; **m, italics* = specified inappropriately with reference to appendix 2



Note: Single parentheses and dotted lines indicate partially established nodes or features. Italics indicate nonmatching feature.
*'Complex' branching structure for affricates marginally established or used for nonbranching consonants
**[+spread glottis] established except for aspiration on WI stops
&Established except for fricatives
&&Established for vowels only

Figure 4.1. S2: Feature geometry at Initial Assessment

Match data revealed the following:

1. Overall, vowels and glides matched adult targets sufficiently so as not to interfere with intelligibility.

2. The order of sound class establishment was vowels/glides > nasals > voiced stops > voiceless stops > liquids/fricatives. Nasals were well established except for Dorsal Place /ŋ/. Stops were also established for place except for Dorsal. Overall, the WI voiceless stops that were produced (/p/ and /t/) matched 40.54% of the time, because of lack of [+spread glottis] specification (aspiration) and inconsistent dentalized [+distributed] production of the coronals. Some tokens of SIWW and WF /t/ were not produced, or realized as [ʔ]. This suggested either a complete lack of Root node specification or specification of Root node [+consonantal] and Laryngeal node (the default being [ʔ]).

As noted above, fricative production was incipient. In WF and SIWW positions, there were some /s/, /z/, and /ʃ/ sibilant productions, most of which were inappropriately [+*distributed*]. When the [+*distributed*] sibilant did not appear, a [t], [d] or [h] was the substitution. Occasionally, the voiced fricatives /z/ and /v/ were missing altogether. In the case of the stop substitutions, Place node was specified, but Root node feature [+continuant] was unspecified. In the case of the common WI [h] substitution, one could say that the Root node [+consonant/+continuant] and Laryngeal node [+spread glottis] features were specified, but that Place Node was not specified. The [h] substitution for fricatives paralleled the [ʔ] substitution for stops /t/ and /k/, but for the opposite syllable position.

One liquid -- /l/ -- was established, but only syllable initially (including in clusters with epenthesis as noted above).

In summary, the Place node as an intermediate node was not as well established as Root node and Laryngeal node for consonants, with no specification at all for Dorsal Place. Where established, Place node markings were dependent on sound class and syllable position. For stops, Labial Place was better-established than Coronal across positions. For fricatives, there were some coronals, but no labials. The liquid /r/ as well as SF /l/ were realized as glides in the Labial Place category, rather than as coronals.

Feature Differences for Consonants

Nonmatch feature differences were as follows (in an approximate descending order determined partly by word or consonant frequency and partly by feature difference salience):

A. Unspecified child forms where adult targets are specified

1. Place node: WI fricatives (and some fricatives in other word positions) were unspecified for intermediate or specific Place node, as was WF /t/ (some of the time) and SIWW and WF /k/ (most of the time).

2. Place node: Dorsal Place was not specified for consonants.

3. Root node: There were missing segments (unspecified) in clusters, and in WF position -- WF /t/, /k/, /v/, /z/, and /r/.

4. Root node/Coronal node: [+consonantal] and[+distributed] were unspecified for /r/.

5. Branching structure ('complex') was lacking for affricates except occasionally in WF position.

6. Root node: [+continuant] was unspecified for WI /ð/, WF /θ/, SIWW and WF /v/ and (occasionally) sibilants.

7. Laryngeal node: Voiceless initial stops were unaspirated 38/62 times (61.29%), showing lack of development for redundant feature [+spread glottis]

8. Laryngeal node: [+voice] was unspecified for WF coronal fricatives/affricate substitutions for /z/, /ð/ and /ʤ/ 18/31 times (58.06%).

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Place Node: Coronal [+*distributed*] dental or interdental place was noted some of the time for sibilants and coronal stops.

2. *Labial* for Coronal Place was noted for /r/ and optionally for /ð/ (one word -- that).

Intervention Plan: Block 1

In Blocks 1 and 2, conditions for S2 followed the pattern: segmental/syllabic. The segmental subblock order was lower level feature/higher level feature. The syllabic subblock order was onset-rime/moraic. In this way, S2 contrasted with S6 for subblock orders.

Segmental Intervention Plan

Lower Level Feature Subblock

Target: WI /k/ -- Dorsal Place node

Higher Level Feature Subblock

Target: WF and SIWW /v/ -- Root node [+continuant]; Labial Place node

Rationale

A. Basic rationale

The most salient lacks in the system, irrespective of word position, were Dorsal Place for consonants and Labial Place for fricatives.

B. Dorsal Place

Because /g/ had both Root node and Place node specification across word positions, it could have been a target in any word position. The small English number of words containing /g/ compared with larger numbers containing the other dorsal consonants made /g/ a less desirable target choice. The nasal /ŋ/ was not considered salient enough perceptually to be a target, particularly considering the acoustic similarity of [iŋ] and [iŋ]. This left /k/ as the best choice. Unfortunately, substitutions for /k/ were not consistent across word positions. Furthermore, the only word position where consistent Root and Place node markings resulted in definable *consonantal* substitutions for /k/ was WI position (i.e., not a [ʔ] substitution location). In order to adhere to the general experimental design, which permitted targeting of new segments in well-established word positions only, WI position was the word position choice for establishment of /k/ .

B. Labial fricatives

Interaction of segmental and syllabic tiers was evident from positional differences in substitutions for fricatives. The WI [h] substitution was considered more a syllabic than a segmental concern, both because of its limitation to syllable-initial position and its application across fricative groups. In WF position, the limited evidence of sibilant production demonstrated application of the Root node [+continuant] feature through the unmarked Coronal Place node.

However, this feature was not applied to all fricatives in this word position. Among the similarly low frequency fricatives /v/, /ð/ and /θ/, the /v/ was selected because of (1) its generalization potential to /f/ across word positions and (2) the articulatory tendency for crossover between Coronal Place alveolar and interdental sibilants, rendering the coronals phonetic as well as phonological targets. To establish /v/ in WF and SIWW positions, it was necessary to specify the Root node [+continuant] feature and Labial Place node in order to avoid the default [d] substitution. The establishment of two specifications for /v/ was not considered more complex than the establishment of Dorsal Place node for /k/ because (1) labial stops were well established, and (2) [+continuant] was specified for sibilants in WF position.

Syllabic Intervention Plan

As described above, word and syllable shapes were reasonably well developed for this subject. However, there were strong interactions of word position and segment development. Syllabic goals for S2, then, in part reflected word and syllable shape development and, in part, the increase of range of distribution of segments across word positions. In general, the goals were:

1. To establish two consonant slots for a greater range of WI clusters
2. To establish one WI fricative with Place node marking - an interactive syllabic/segmental goal.

Onset-Rime Subblock

Targets: 1. /sl, st/

2. WI /z/ (a portion of one session)

Moraic Subblock

Targets: 1. /sp, sw/

2. WI /z/ (a portion of one session)

Rationale

1. /s/-clusters: Syllable slot positions for diconsonantal clusters were evident with the /l/-clusters and stop-glide clusters, albeit with epenthesis. However, S2 produced no /r/- or /s/-clusters . Because he produced a few sibilants accurately without [+*distributed*], the /s/ was

considered a better candidate than /r/ for syllabic development within the experimental design. Two /s/-clusters were targeted in each subcondition, one with a sonorant and one with a stop. Place of sonorant and stop was held constant within the condition. The /s/-nasal and /sk/-clusters were generalization targets. The former were expected to generalize by place from the appropriate condition, and the latter from the /st/ condition.

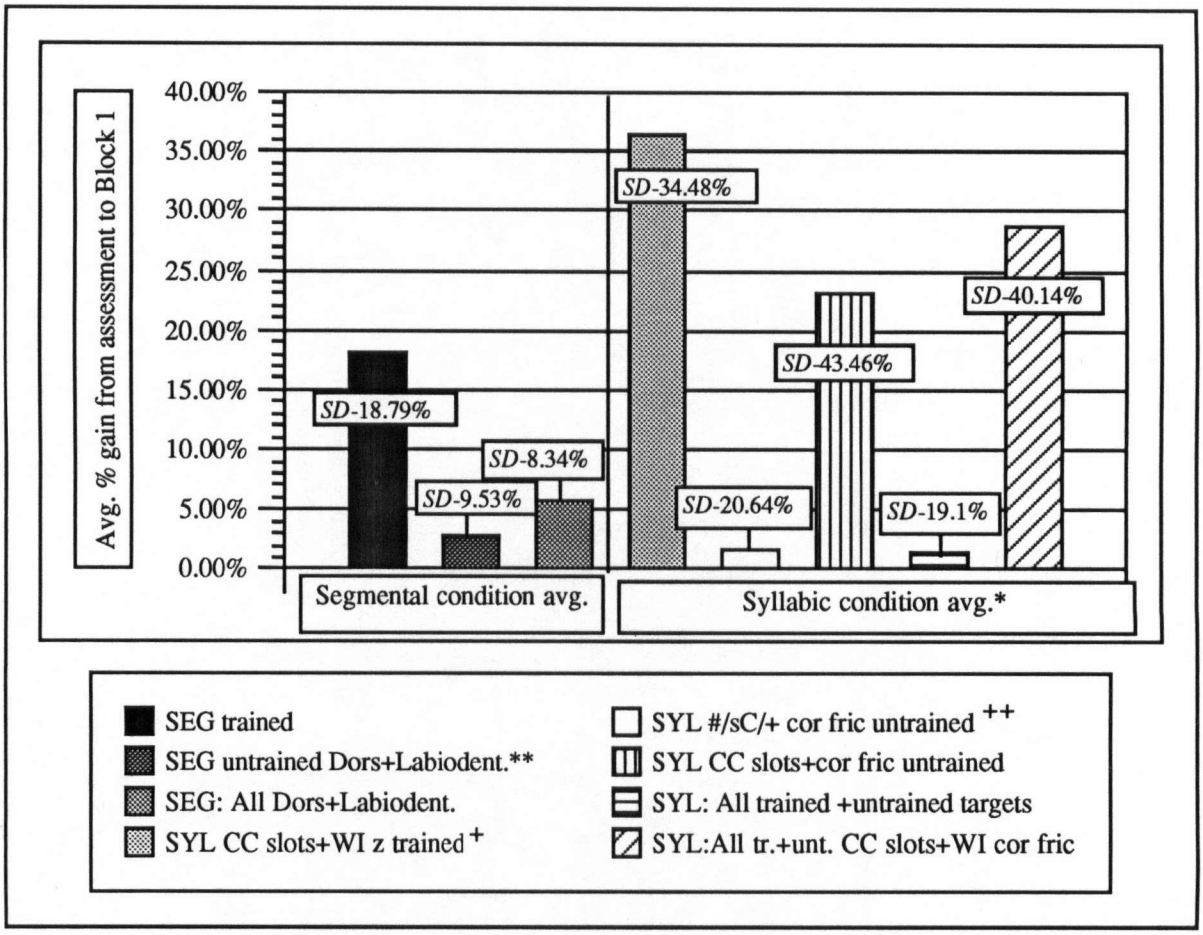
2. WI /z/: The /z/ was chosen rather than the /s/ (1) in order to provide a voiced segment contrast with /v/ (a segmental target), and (2) to compare it with the /s/ of the cluster training. By involving it minimally in both conditions, cross-condition comparisons could be made.

Results of Block 1 Intervention

General Results

Changes occurred within both segmental and syllabic conditions. S2 now used some Labial fricatives, although there was only one match for the other segmental target -- dorsals (an [ŋ], with low transcription confidence). In terms of the syllabic goals, there was an increase in two-element clusters within the /s/- and /r/-cluster categories, as well as one token of a sibilant fricative prevocalically. (See appendix 4, table 2.1, and figures 4.2 - 4.4).

Figure 4.2 shows the average proportional gains for segmental and syllabic targets and the differences between trained and untrained targets in both conditions. Untrained segmental targets include only those sharing critical distinctive features with the target, i.e., all other dorsal and labiodental consonants. Untrained syllabic targets are other /s/-clusters and WI coronal fricatives. If exact matches are considered, the segmental condition was more successful than the syllabic for trained targets in this block, since there were no actual matches for trained syllabic targets. However, if development for the syllabic tier is considered in terms of consonant slot matches (with consonantal substitutions or compensatory lengthening), the syllabic condition appeared to have greater overall influence on the phonological system at this time. (As mentioned above, S2 produced more /r/-clusters with two elements as well, another generalization at the syllabic level.)



*There were no exact matches in terms of segments for syllabic trained targets - - WI /sp/, /st/, /sl/, /sw/, /z/
**Includes WI, SIWW, and WF /f/; WI /fl/, WI /v/; SIWW and WF /k/; WI, SIWW, WF /g/ and WI /gl/ as well as /ŋ/
+CC slots include actual consonants or compensatory lengthening of the prevocalic consonant
++Includes /sm/, /sn/, /sk/, WI /s/, /ʃ/, /θ/, /ð/

Figure 4.2. S2: Average proportional gain in matches for trained and untrained targets between Initial Assessment and Block 1 major probes

Segmental Goals

Lower Level Feature Subblock

As stated above, there was only one (low confidence) match in the major probe for dorsals, although S2 had produced tokens of /k/ in single words and short phrases during the treatment sessions.

Higher Level Feature Subblock

On the other hand, S2 generalized labial fricatives, both across phonemes (from /v/ to /f/) and across word positions. Although only SIWW and WF /v/ had been targeted, S2 produced one

token each of WI /v/ and /f/ correctly, as well as three matching tokens of SIWW /v/ (out of eight attempts) and one WF /v/ (out of six). The word scarf also had a WF /f/.

Some mismatches showed progressive change in feature specification as well as a split in establishment of the two features -- the higher level [+continuant] and the lower level Labial Place. The WI /v/ mismatches were [b] and [bv], indicating that Labial Place was specified, and [+continuant] was partially established. One SIWW /v/ token (of five) appeared as [ð], indicating that [+continuant] was specified, although Labial Place was not. Similarly, S2 produced both tokens of WF /f/ as [θ], again indicating specification of [+continuant] without specification of Labial Place.

Comparison of the Lower and Higher Level Features

According to the match data, S2 learned the labial fricatives in advance of dorsal stops. The establishment of the Higher Level Root node feature [+continuant] in conjunction with the Labial Place node appeared to be easier for S2 than establishing Dorsal Place for consonants. As was predicted, the double specification for /v/ did not appear to be more complex than the single specification needed for /k/, since Labial Place and [+continuant] were already established for other phonemes.

Other Feature Changes for the Overall Segmental Data

Other changes are listed here in terms of the feature hierarchy. Where training may have influenced the change indirectly, comments to that effect are made. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

A. Unspecified child forms where adult targets are specified

1. Root node: More segments were present, with specification for the liquid in /r/-clusters and all WF /t/ (but see #5 below). The change for /r/ was a probable generalization from syllabic

condition training of /s/-clusters. There was one SIWW /r/-cluster without epenthesis (/br/ > [bɣ] in Barbara) **

2. Laryngeal node: More voiceless initial stops were aspirated (redundant feature [+spread glottis]), with a 17.73% gain in matches for /p/ and a 5.85% gain for /t/. Training in both conditions probably influenced the increase in [+spread glottis] specification, since the segmental training of /k/ involved highlighting of WI voiceless stops /t/ and /k/ and the syllabic condition cluster training involved contrasting of the allophonically different pairs -- /st/ versus /t/ and /sp/ versus /p/. *, **

3. Branching structure ('complex') was more common for WF /tʃ/ (3/4 versus 2/6 tokens in assessment probe). S2 produced one token of WI /ʤ/ as [dəw] (in the letter name G), possibly indicating awareness of the two components of the affricate. **

4. Place Node: There was beginning generalization, i.e., specification, for WI /z/ (two matches out of four attempts), WI /s/ (one match out of thirteen attempts), and WI /θ/ (one match out of three attempts). These advances probably reflect training in both conditions, since [+continuant] obstruents were targets in both conditions. However, training in the syllabic condition involved sibilants more directly. +, *,++ ,**

5. Place node specification for WF /t/: There was a decrease in proportion of matches and an increase in [ʔ] use. This may reflect an overgeneralization of suppression of coronal default substitutions for /k/ and /v/. &

6. Labial Place for WF /b/ unspecified: The three tokens of WF /b/ were realized as as [d], [p] and a labiodental stop, regression possibly induced by training on /v/. &

7. Root node: [+continuant] was specified for WI /θ/ and WF /θ/ ((one match each for three attempts each). These probably reflect training in both conditions for fricatives. *

8. Root node: [+continuant] was unspecified for WI /ð/, an unexpected regression, considering training of [+continuant]. &

9. Laryngeal node: [+voice] was unspecified for the sole exemplar of WF /ð/ and one of three tokens of WF /ʤ/. **

B. *'Specified'* child forms where adult targets are unspecified or otherwise specified

The one imitative match for WI /r/ (roar), indicated marginal change -- Root node [+consonantal] and Coronal Place [+distributed] specification rather than *Labial* for one token of /r/. *

Areas of No Change in Feature Specification

1. Root node: Some tokens of WF /k/, /v/, /z/, and /r/ missing (no Root node).
2. Laryngeal node: [+voice] was unspecified for WF substitutions for /z/.
3. Place node: Coronal [+*distributed*] interdental place was still observed some of the time for sibilants and coronal stops.

Syllabic Goals

Syllabic changes were assessed with both major probes and session data.

Clusters

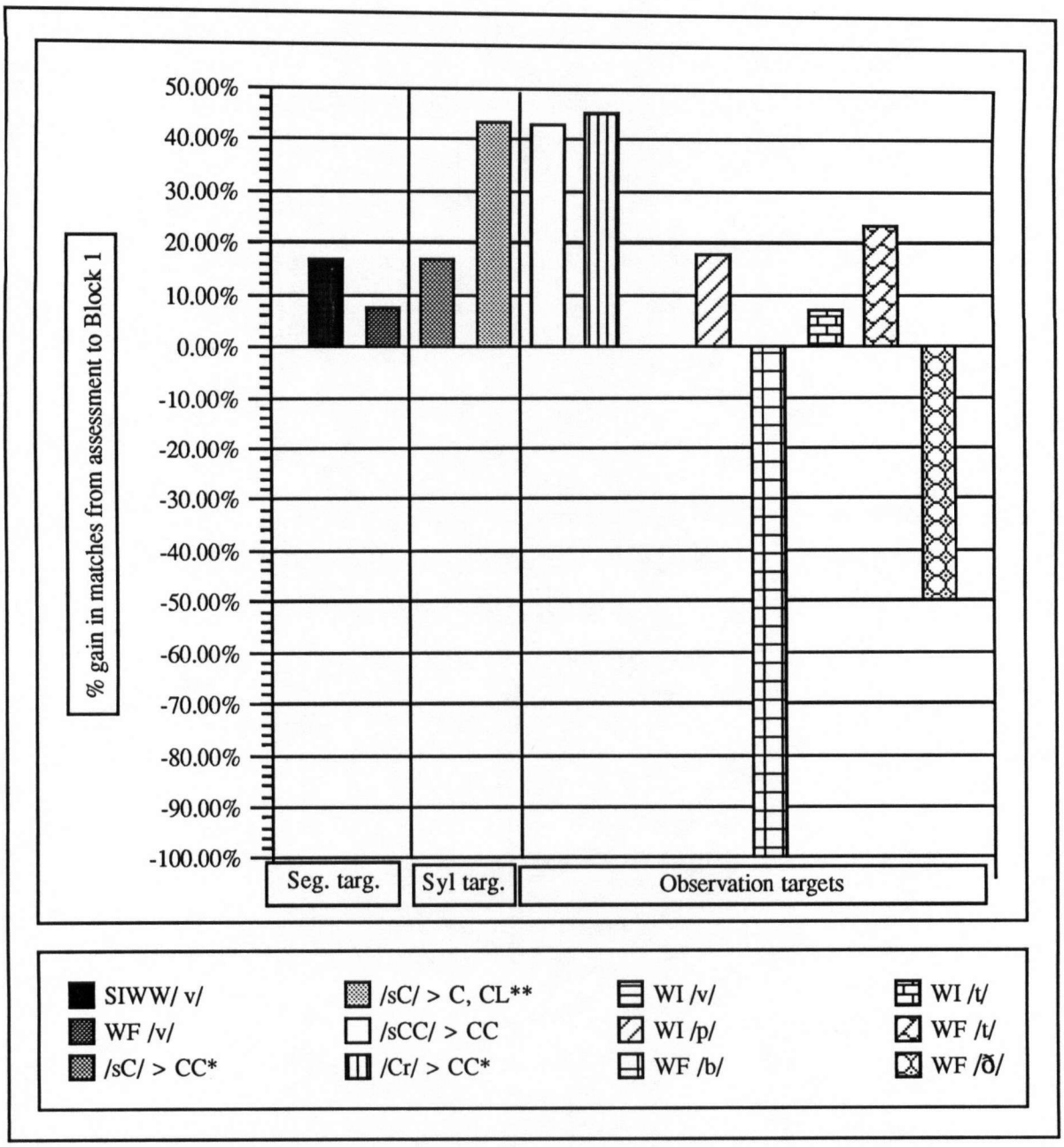
A. Skeletal slot changes noted in major probe

Prior to training S2 produced no two-element /r/- or /s/-clusters. After Block 1, he produced 10/22 two-element untrained /r/-clusters and 4/24 two-element /s/-clusters, including [hl] for a trained cluster -- /sl/ -- and [s:n] for the untrained cluster -- /sn/. (See appendix 4, table 2.1, and figures 4.2 and 4.3.) Although fewer of the *trained* /s/-clusters had two segments, the prevocalic consonant was lengthened in 14/24 of the /sC/ examples, seven by prolongation of the sonorant or stop and seven by aspiration of unvoiced stops. The seven cases of compensatory lengthening were: smooth > [$_{o}$mud$^{ə}{}_{o}$] = nasal emission preceding nasal; snake (2) > [n:{ɛɪ/ʌɪ}ʔ]; snowing > [n•o˘wɪ~ŋ]; slipper >[l•ɪp^{Φ}ʊ^{ə}]; spider > [p•^{h}ɑɪdɛ$^{ə}{}_{o}$]; spy > [b•ɑɪ]. Combining matches plus tokens with any kind of lengthening, syllabic changes were noted for 75% of the /s/-clusters. Discounting aspirated stops, which do not represent two skeletal positions, there were identifiable syllabic changes for 50% of the /s/-clusters. The prevocalic lengthening seems to suggest constitutent status for the onset.

B. Matches for /s/-clusters in the major probe

There were three matches for /sn/ (an untrained cluster) in the words snake and

snakey (S and SE). As observed across the study, the salience of the "hiss" of the snake (WI [s]) plus the coronality shared by /s/ and /n/ seem to facilitate this production. In all of the elicitations S2 prolonged the [s:] -- an expected outcome because of the training methods and the general tendency to lengthen clusters (see assessment data for /l/-clusters).



Note: There was one matching token each for untargeted WI /f/, /s/, and /ɪ/, and SF /ŋ/ and /z/.
There were no other matches, including for segmental condition target /k/
*sC = WI /s/-cluster; /Cr/ = WI /r/-cluster
**CL = 14 cases of lengthening of C_1 in the child's form (including 7 aspirated stops)

Figure 4.3. S2: Proportional gain in matches for trained and untrained targets between Initial Assessment and Block 1 major probes

C. Nonmatch changes other than compensatory lengthening for clusters

1. Triconsonantal /s/-clusters: Prior to Block 1, S2 produced these clusters with only one consonant, but the Block 1 sample revealed three of seven tokens with two elements, one each with /skr/, /spr/ and /str/.

2. S2 produced the /sl/-cluster once as [hl], following the pattern for /s/ production.

3. The two-element /r/-clusters were produced with full epenthetic vowels.

WI Sibilants

Although there were no exact matches for WI /z/, two of the four tokens were close substitutions -- [ʤ] and [z>] -- with Place node marking. S2 generalized Place node specification for WI fricatives, producing one token each of /s/, /θ/, /f/, and /v/. Segmental training probably influenced the emergence of the latter two as well.

Onset-Rime Subblock

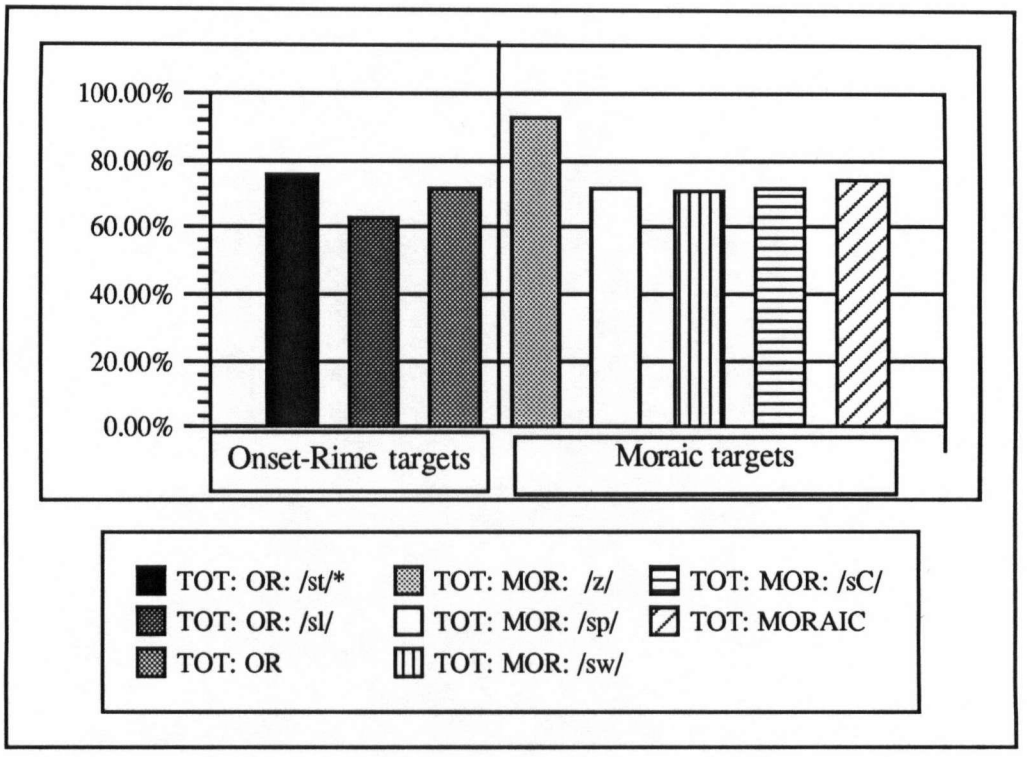
Since there was no change in matches at the major probe level, the session data was utilized in order to evaluate change within target groups for subblock conditions. (See appendix 4, table 2.3, and figure 4.4.)

1. /st/ versus /sl/: The /st/-cluster results were slightly higher than those for /sl/, both in imitated and spontaneous productions during training sessions -- 75% matches versus 65.82% and 76.92% versus 55.56%. The interest generated by games involving "stop" may have bolstered /st/ matches, although the "slot" games also had entertainment value. Feature-sharing for /s/ and /t/ is greater than for /s/ and /l/, which may aslso have contributed to the slight advantage for /st/.

2. WI /z/: No session productions of WI /z/ were recorded. Auditory awareness of the /z/ with the favored song Zip-a-dee-doo-dah and some home practice were the "treatments" provided.

Moraic Subblock

1. /sw/ and /sp/: S2 had greater success with both of these targets in imitated productions -- 94.12% and 86.36% respectively -- than in spontaneous productions, where the success ranking was reversed -- 54.17% and 64.29%.



*All targets word-initial

Figure 4.4. S2: Proportional matches for syllabic targets in Block 1 sessions

Moraic Subblock (continued)

2. WI /z/: During the last session of the subblock, a portion of time was devoted to WI /z/ production of the form CV+C. S2 found both imitation and spontaneous whole-word production easy, as the 90.91% and 100% proportions indicate. He enjoyed saying zoom, which may have enhanced that ease.

Comparison of the Onset-Rime and Moraic Conditions

Overall, the session training results were equivalent across conditions (73.73% for moraic targets and 71.35% for the onset-rime targets). It was not necessary to present isolated syllabic constituents for imitation most of the time, since S2 imitated whole words easily. Without consitutent stimuli distinctions, a portion of the differences between conditions was lost for cluster training. However, the treatments did differ in that the onset-rime sessions focused on activities which contrasted the onsets, whereas the moraic sessions focused on the /s/ as external to the CV(C) unit(s).

Intervention Plan: Block 2

Segmental Intervention Plan

Higher Level Feature Subblock

Target: /k/ --Dorsal Place (extended contexts -- WI, SIWW, and /kl/ WI clusters)

Lower Level Feature Subblock

Target: WF /ʃ/ -- Coronal Place node [-anterior] (including minimal auditory and phonetic stimulation for the affricates)

Rationale

Because generalization of dorsal consonants had not occurred, they were retargeted. The training contexts were expanded to include SIWW position and WI /kl/-clusters in order to strengthen the generalization potential. In the Block 1 major sample, S2 produced both SIWW /k/ and /kl/ as [t] (for all /kl/-clusters, and some of the time for SIWW /k/). Consequently, only Dorsal Place node had to be specified. Since dorsals had been the first targets in Block 1, they were trained first again in Block 2, with the expectation that /v/ or /f/ training would follow.

However, at the end of the dorsal consonant subblock, it was evident that the labiodentals were sufficiently established except in WI position. In this way, the labiodentals were then similar to the coronal fricatives, and as such became syllabic rather than segmental targets. Segmental goals could have included /r/ or the alveopalatals at this point. The training of /r/ would have permitted training of a higher level set of features ([+consonantal]/[+sonorant]) in conjunction with a lower feature ([+distributed]), similar to the training of /v/ in the first block. However, the /r/ was less stimulable phonetically than the /ʃ/. For S2, who had a mild attention deficit, it was necessary to have attainable session goals in order to maintain his interest. Thus the alveopalatals were chosen in spite of the fact that the [-anterior] feature of the Coronal Place node could be considered "lower" than the Dorsal Place node. (Working with human subjects requires that practical and ethical considerations override experimental design from time to time.) The WF /ʃ/ was targeted because WF position was established for sibilants.

Syllabic Intervention Plan

Onset-Rime Subblock

Targets: 1. WI /f/, /fl/ - 2 sessions

2. WI /s/ before lax vowels (sVC) - 1 1/4 sessions

3. /st/, /sl/ - 3/4 session with homework after first WI /s/ session for /st/

Moraic Subblock

Targets: 1. WI /z/, /v/ - 1/2 session each

2. WI /s/ before long vowels or diphthongs (sV V[C]) - 1 1/4 sessions

3. /sp/, /sw/ - 1/2 session each

Rationale

A. Goal expansion

As noted above, S2 began to generalize labiodentals at the time of the first major probe, continuing to do so during the first part of the Block 2 segmental training period. Word initially, they continued to be realized like the other fricatives (with an [h] substitution), and thus were transferred to the syllabic condition. The /f/ was selected in addition to /v/ because of its greater frequency in English. In order to maintain equivalence across subconditions, WI /f/ and the /fl/ cluster were trained in the onset-rime condition, and WI /z/ and /v/ in the moraic. Although the /z/ may have had some advantage from being a target under both conditions previously, less than half a session per condition had been the time allotment in Block 1, insufficient time to result in learning. In addition, WI /s/ was also targeted in this block. Because it was a target in both subconditions, different vowel contexts were chosen to provide a distinction in word sets (lax for O-R, in which VC rime units were obligatory, versus tense vowels and diphthongs for moraic stimuli, in which CVV units needed to stand alone). Increasing the number of training targets for establishment of WI Place node for fricatives maximized generalization potential.

B. /s/-clusters

Because /s/-clusters had not generalized at the end of Block 1, they were retargeted in their respective subconditions.

Results of Block 2 Intervention

Syllabic goals were met during this period. There was some restricted progress with segmental goals of dorsal consonant and /ʃ/ production (see appendix 4, table 2.2, and figures 4.5 - 4.8). The generalization of training session proficiency to conversation occurred within a two-week period at the end of the block, following the three "events" listed below:

1. E informed S2 that he made E happy when he used his new way of talking and when he did not act "silly".

2. S2's grandfather had a major heart attack, which brought a serious mood to the home environment.

3. S2 took swimming lessons, during which time he had many opportunities to use the /sw/ cluster and the /sp/ cluster (Speedo, the brand name on his swimsuit).

Segmental Goals

Lower Level Feature Subblock

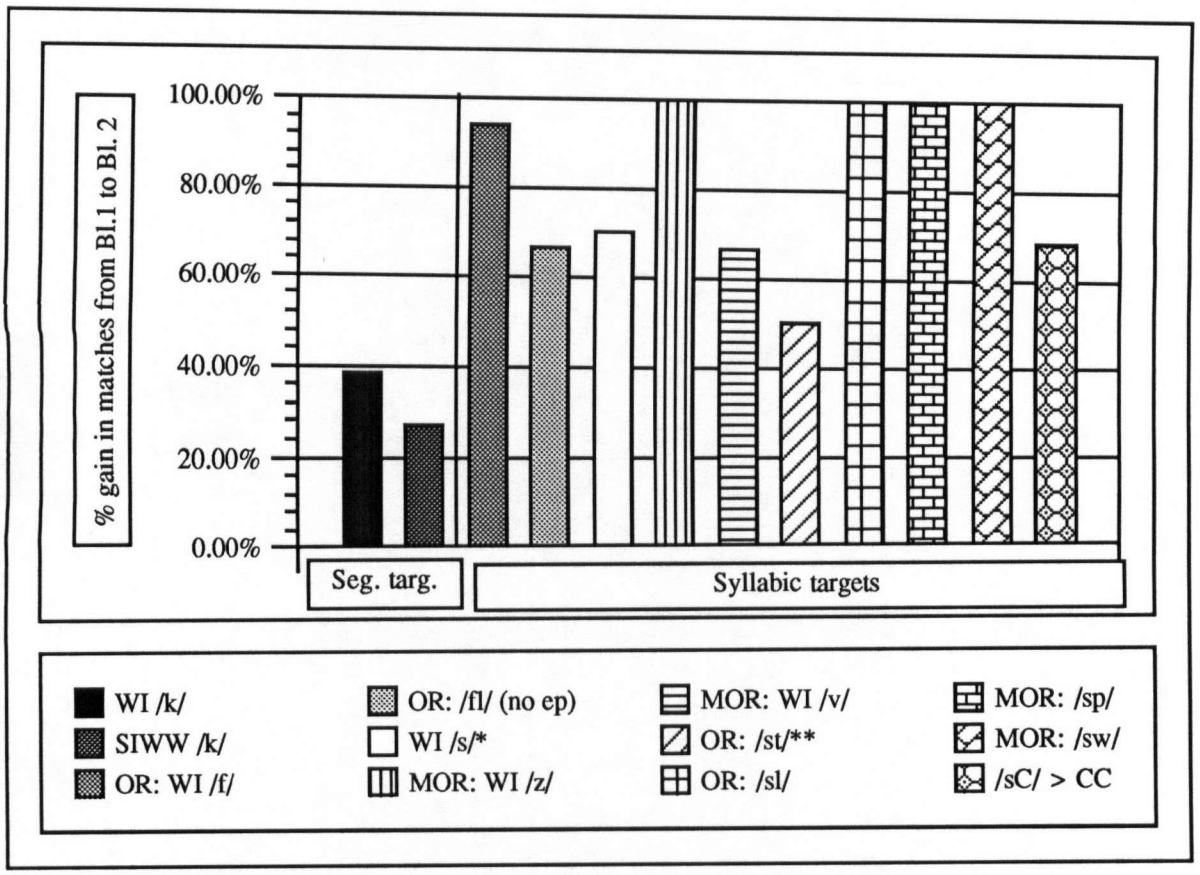
As noted above, there was advancement in conversational use of dorsal consonants, primarily for the trained segment /k/ in WI and SIWW positions (12/31 [38.71%] and 3/11 [27.27%]). S2 produced one matching token each for WI and SIWW /g/ and one WF [g_o] (all echoic), as well as two tokens of [ŋ].

Higher Level Feature Subblock

The major probe had one matching token of an alveopalatal: WI [ʃ] in sheep (E), where the /ʃ/ was in an untargeted word position. The other four WI /ʃ/ productions were [s] (three) and [sp] (sheep - S). In other words, the syllabic goal to establish Place node for sibilants was attained, but the segmental goal to establish [-anterior] was still to be attained.

The overgeneralization of [sp] for the /ʃ/ in sheep in an assimilatory context was an unexpected and interesting mismatch. It indicated a phonological awareness of the need for both Place node marking and a sibilant prevocalically, but uncertainty with respect to the actual specified values for that sibilant. In nonlinear terms, the lack of definite place specification prevocalically led to Labial Place spreading from the postvocalic consonant to the prevocalic position. Rather than producing [f], however, which could have been the result of the specified

[+continuant] value coalescing with Labial Place, S2 produced a cluster with the feature [+continuant] and Labial Place realized on separate segments. The need to produce a coronal sibilant and a specified place was stronger than the need to produce a syllabic match. This was in tune with the epenthesis noted for liquid clusters, where the syllabic timing was sacrificed for segmental realization.

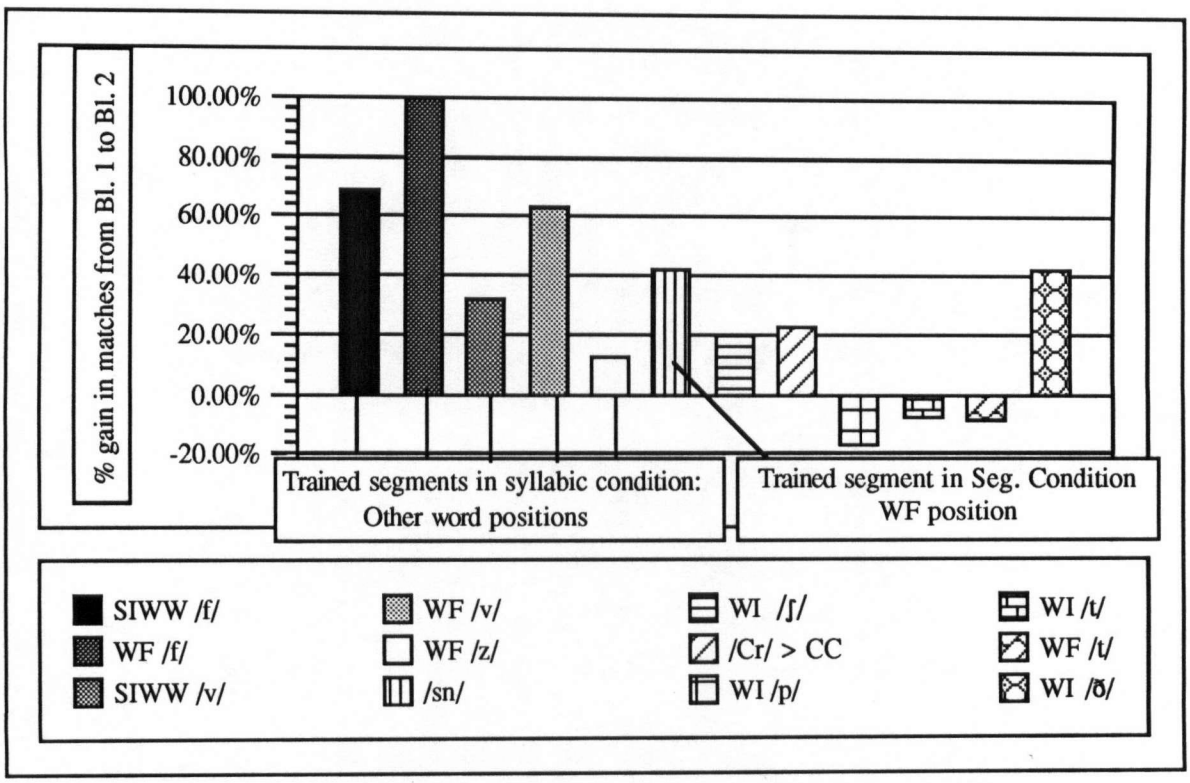


Note. There were no matches for trained targets /kl/ or WF /ʃ/.
*Four /s/ words were realized with dentalized [S] and counted as matches.
**All /s/-clusters were word-initial.

Figure 4.5. S2: Proportional gain in matches for trained targets between Block 1 and Block 2 major probes

Another aspect of the [sp] substitution concerns its unity as a constituent. On the one hand, one could surmise that the sharing of features across two segments indicates that the two are a constituent with an onset boundary. The moraic condition cluster [sp], although never introduced as a constituent in therapy, was possibly identified as such. However, the separate segment production could also be a result of the moraic condition methods, which deliberately encouraged

the "addition" of [s] to a /p/ or /w/ word. Without specification of the prevocalic consonant beyond the recognition that a sibilant was required, spreading to the prevocalic position led to a [p]. To satisfy the sibilant requirement, an [s] may have been adjoined at the output stage.

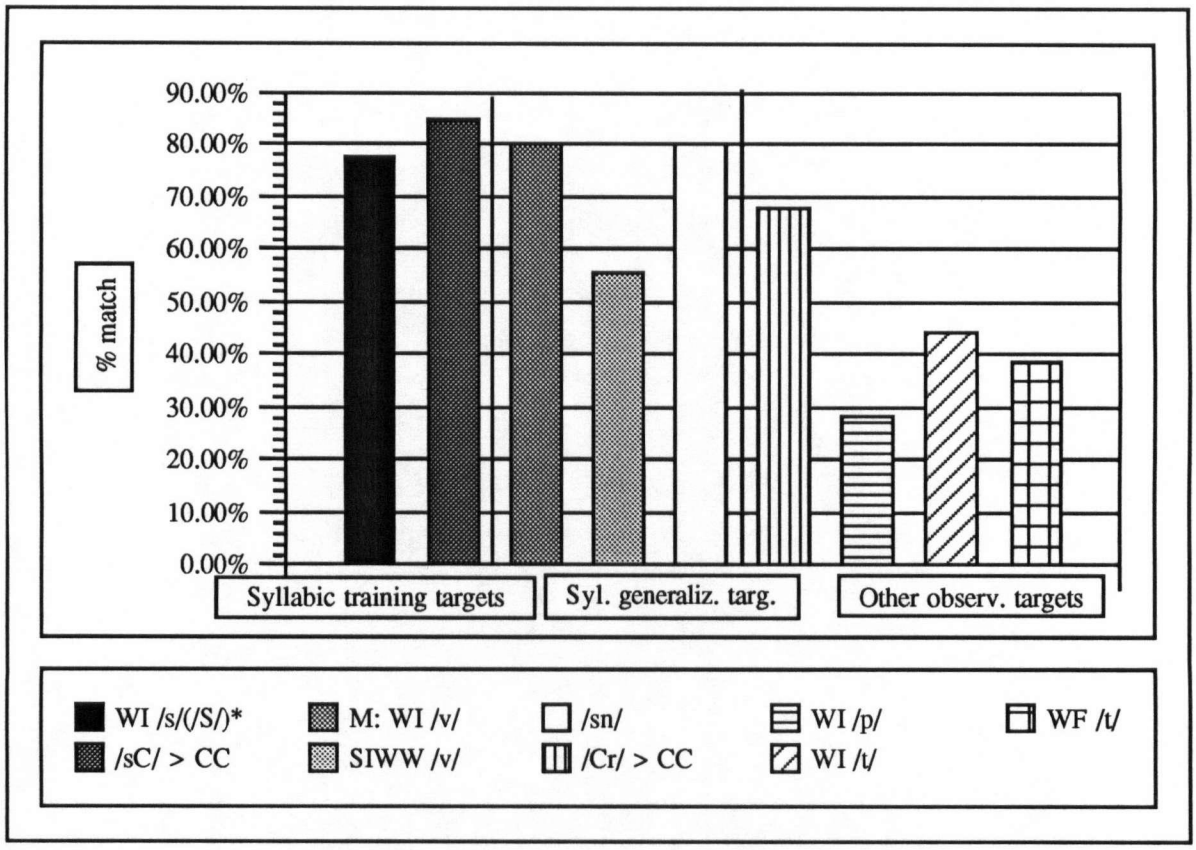


Note: In addition, there was one match each for WI and SIWW /g/ and WF /b/, and two for /ŋ/.

Figure 4.6. S2: Proportional gain in matches for untrained targets between Block 1 and Block 2 major probes

Comparison of the Lower and Higher Level Features

The dorsals developed in advance of the alveopalatals, which reflects the longer training period for the former. However, the fact that even one token of /ʃ/ appeared after one subblock of training demonstrates the relative difficulty of establishing Dorsal Place for this child, in comparison with the establishment of the lower level feature [-anterior].



*For /s/, 4/14 matches were dentalized variants.

Figure 4.7. S2: Proportional matches in Block 2 major probe for targets with match proportions differing from those shown in figures 4.5 or 4.6

Other Feature Changes for the Overall Segmental Data

Changes other than those noted above are listed here in terms of the feature hierarchy. Where training may have influenced the change indirectly, comments to that effect are made. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

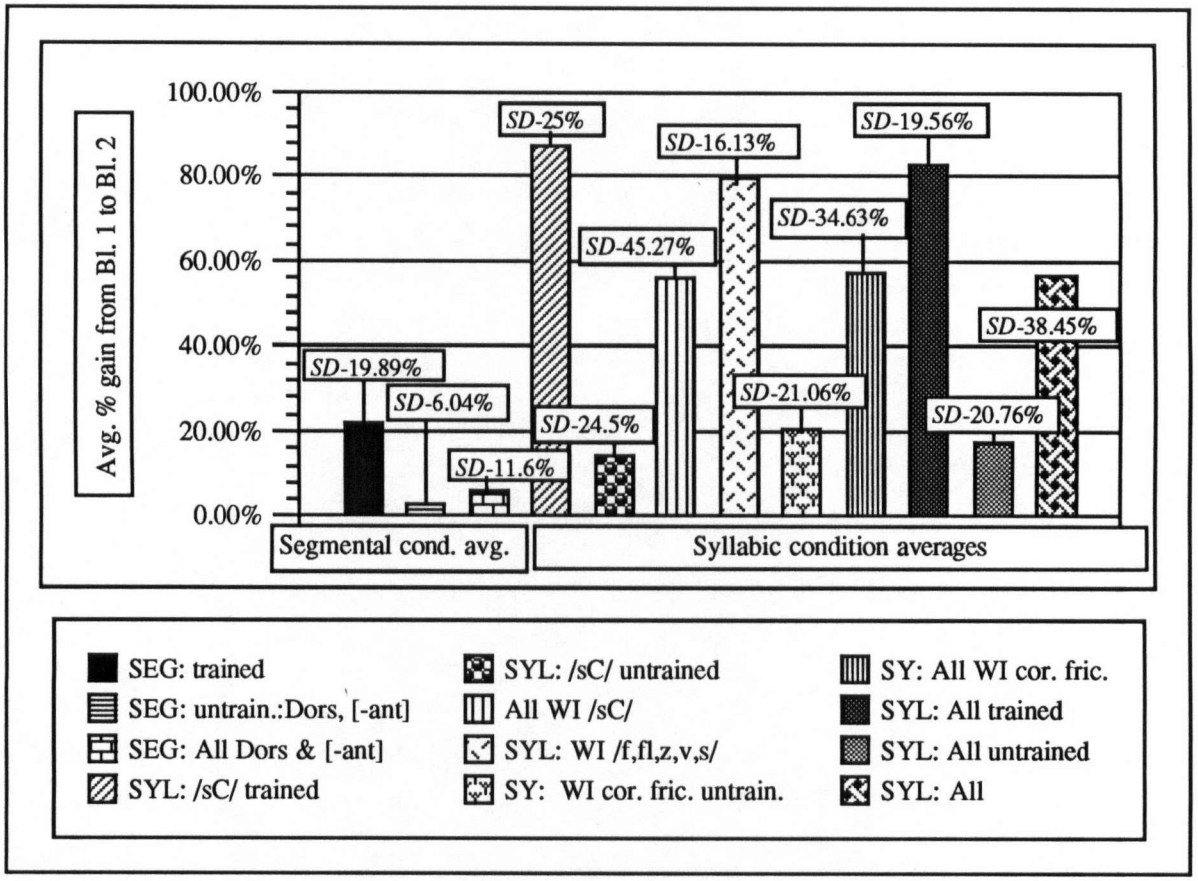


Figure 4.8. S2: Average proportional gain in matches for trained and untrained targets between Block 1 and Block 2 major probes

Feature changes (continued)

A. Unspecified child forms where adult forms are specified

1. Place node: As a result of syllabic condition training, Place node was specified for WI /z/, /v/, and /f/, and an increased number of /s/ tokens (55.56%) +,++

2. Root node: Except for a few tokens of /r/ (WF singletons and WF and WI clusters) and 4/5 /s/ tokens in triconsonantal WI /s/-clusters, all consonants were specified with Root nodes. **

3. Laryngeal node: Fewer voiceless initial stops were aspirated (redundant feature of [+spread glottis] less in use), with a 16.43% regression in matches for /p/ and a 4.44% regression for /t/. This regression may be spurious, as the increase may have been for Block 1, or may reflect an overgeneralization from the proficiency gained in /s/-cluster production, where unaspirated stops are required. &

4. Root node: [+continuant] was specified for all fricatives except two tokens of /θ/

(one WI and one SFWW, missing Root node), one WI /ð/, and one WF /v/ (of > [ʌd]). One SIWW /f/ and /v/ each had labiodental place but a [-continuant] (stop) value. **

5. Place node specification for WF /t/: Match proportions increased and number of [ʔ] substitutions decreased (9/44 total tokens compared with 17/49 in Block 1). This change is similar to the general decline in missing Root nodes. *,**

6. Labial Place for /b/ specified: The temporary regression noted for /b/ disappeared. *

7. Place node: A marginal change for WF /k/ was Place node specification for one token (as [t], a change from only [ʔ] substitutions). **

8. Branching structure ('complex') was in place for SIWW /ʧ/ once.

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Place node: Coronal [+*distributed*] interdental place was observed less of the time for sibilants. This directly reflects the training with sibilants, although it was not an explicit goal. +

2. *Labial* Place for Coronal Place was observed for the majority of WF /θ/ tokens, once each for WI and SFWW /θ/. &

3. Coronal Place [+distributed] rather than *Labial* was specified for one token of /r/ in SIWW /br/ (similar to Block 1 results but for a different word position). **

Areas of No Change in Feature Specification

1. Root node: [+consonantal]/[+sonorant] remained unspecified for /r/.

2. Laryngeal node: [+voice] remained unspecified for WF sibilants/affricates.

Syllabic Goals

Clusters: Skeletal Slot Changes Observed in Major Probe

After Block 2 training, S2 used all /s/-clusters in conversation except /sk/ and /sm/, for which the single token each showed a missing /s/. The most successful clusters were trained targets /sp/, /sw/, and /sl/ (all 100%) with untrained target /sn/ at 80% (similar to the score at the end of Block 1) and trained target /st/ at 50%. This represented two-element /s/-cluster production for 85% of the total, and a proportional gain of 68.33%.

The eight triconsonantal clusters were realized with two consonants, and there was one with three.

S2 also increased his production of /r/-clusters with two elements to a total of 68.18%, representing a 22.73% gain. In other words, there was an observable difference between trained and untrained targets, but an overall increase in syllable structure realization (see appendix 4, table 2.2, and figures 4.5 - 4.8).

WI Fricatives

All attempts at WI /z/, /v/ and /f/ were matches, and 55.56% of the WI /s/. Both the previous training with WI /z/ and the /v/ in Block 1, plus the very few word types to remember in English for /z/ and /v/ probably contributed to the higher success rate for the other fricatives over /s/. It is also possible that the /s/, as the least specified fricative, is less accessible than the others because of lack of specification. The other interdental fricatives showed less change word-initially, particularly the /θ/, for which three of the four nonmatches continued to be [h] substitutions.

Onset-Rime Subblock

Block 1 session data was utilized to evaluate change within target groups more exactly (see appendix 4, table 2.4, and figure 4.9).

1. /st/ versus /sl/: Contrary to the outcome of Block 1, there was a marginal facility noted for /sl/ over /st/, although only in imitated and not in spontaneous productions (both 68.18%) during training sessions -- 77.78% matches versus 69.73% with a total of 72.5% versus 68.67%. The overall scores represented a decline in session proficiency from Block 1 for /st/ (down from 75.77%) and a gain for /sl/ from 62.5%.

On the major probe S2 pronounced the two /sl/ words with [sl], whereas two of the four /st/ words lacked /s/. Whether the difference in tokens is significant, or whether the sharing of features of /s/ and /t/ turned out to be a disadvantage for faster generalization (as it was for S1, S3 and S5) cannot be determined.

2. WI /f/ and /fl/ versus WI /s-VC/: Session data demonstrated an equivalence for total productions of /f/ and /s/ (73.38% versus 72%). However, spontaneous productions of /s/ were at

a lower level of proficiency -- 56.25% versus 75.86% for /f/. The session data for spontaneous /s/ production was equivalent to the major probe match data of 55.56%, but the /f/ data in the major probe showed complete mastery at 100%. The /fl/ data was better overall than /f/ and /s/ data with an 83.33% total. Contributing to this was the high level of imitative matches at 95.65%. On the major probe S2's productions matched two of the three /fl/ targets, *without* epenthesis.

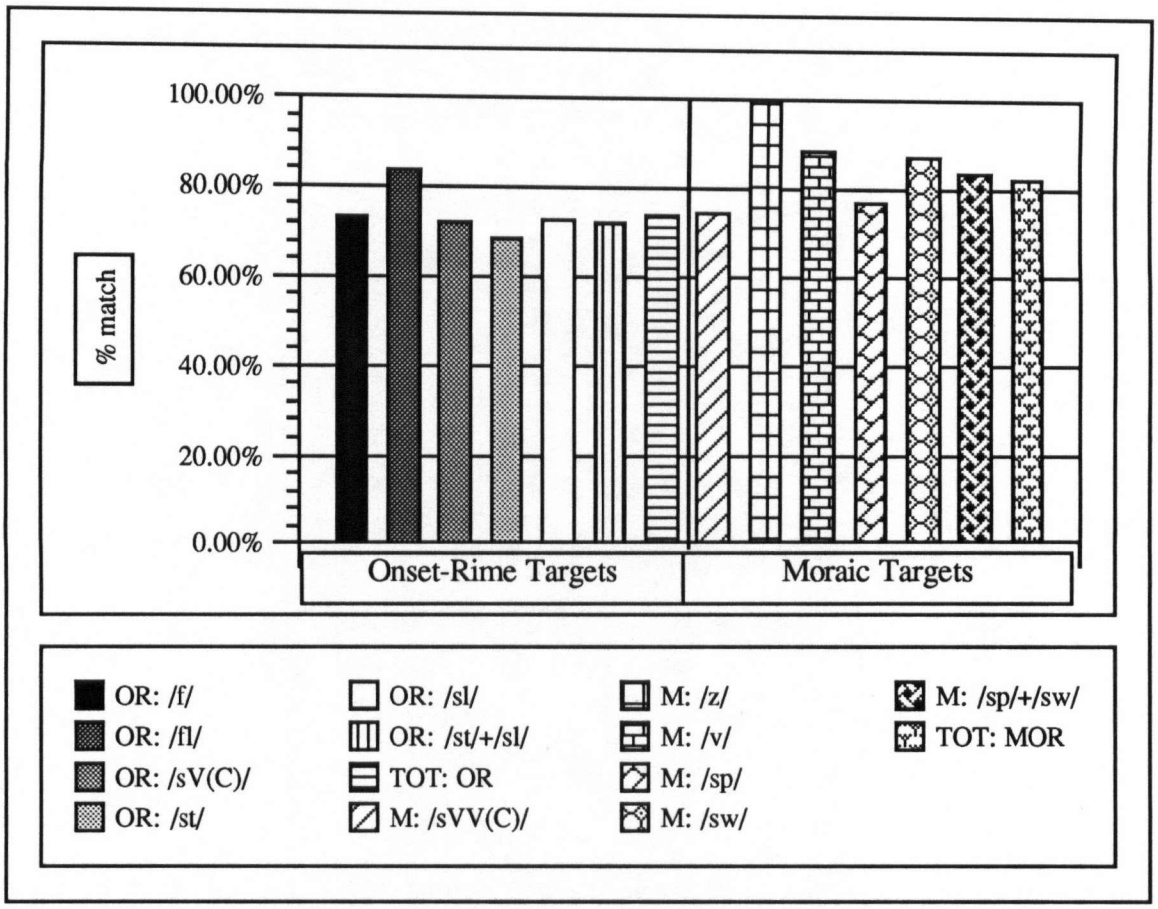


Figure 4.9. S2: Proportional matches for syllabic targets in Block 2 sessions

Moraic Subblock

1. /sw/ and /sp/: As in Block 1, there was greater success both of these targets in imitated productions -- 92% and 90.48% respectively -- than in spontaneous productions, where the success was greater than in Block 1 and consistently better for /sw/ this time at 61.11% and 71.43%.

2. WI /z/, /v/ and /sV V(C): S2 was 100% successful with the previously introduced WI /z/ in both the sessions, and the major probe. Success with the WI /v/, a segmental target in WF

and SIWW positions in Block 1, was slightly lower, but still higher than clusters, showing an 85.24% total match level, with 95.45% matches in imitation and 75% spontaneously. WI /s/ before long vowels or diphthongs matched less consistently than the voiced fricatives, but at a slightly higher level than the /s-VC/ from the O-R condition (possibly showing a sequence effect), with a total of 74.47% matches, averaging from 86% matches in imitation and 60% in spontaneous productions.

Comparison of the Onset-Rime and Moraic Conditions

Overall, the session training results showed a slight advantage for moraic targets in this block (82.61% for moraic targets versus 73.98% for the onset-rime targets). (See appendix 4, table 2.4, and figure 4.7). There was little difference between the overall block results for O-R targets (71.35% in Block 1), although there was a gain for the moraic targets (73.98% in Block 1). This probably reflected the ease noted for voiced WI fricatives rather than the methodology.

In the major probe, there was no difference between WI /s/ targets before lax versus tense or long vowels and diphthongs, the criterion of difference across conditions. Each group showed five matches and four nonmatches. As noted above, the session data seemed to favor the tokens in the moraic condition, but this may have been a sequence effect. In any event, it did not carry over to the major probe sample.

In terms of clusters, S2 mastered the /sp/ and /sw/ moraic targets by the time of the major probe, whereas the O-R /st/ target was still in flux. This may reflect (1) training differences, or (2) difficulty with two relatively underspecified adjacent coronal consonants, or (3) the fact that motivation to pronounce swim and Speedo was high at the time of the major probe sample, the use of these promoting more rapid generalization for /sp/ and /sw/.

During this syllabic subblock, S2 began to engage in sound play which consisted of replacing the prevocalic consonant (the therapy target) with labial consonants, both during onset-rime and moraic sessions. This suggested he was segmenting words according to onset and rime constituents. For example, in session 31 (an O-R session) a substitution for slip was [bɪp], for funny was [bʌni] and for stupid was [bupɪd]. In session 32, he reconstituted piano as [vijænou] and [wijænou], and sandwich as [bænwɪtθ]. In rehearsing an O-R series of tan-fan-stand-sand

during session 35, he added his own set of [bæn] and [spæn]. The latter substitution recalls [spip] for sheep discussed earlier, and might suggest that the [sp] was a unitary onset consituent, rather than an assimilated [p] with extrametrical [s] adjunction.

Block 3 and Beyond

A final cycle was necessary to stabilize dorsal stop production in conversation. Alveopalatals were also retargeted due to some inconsistency in conversation. In order to reduce S2's frontal lisp, a contrast program with /z/ and /ð/ was conducted. One year post-therapy, S2 used alveopalatals inconsistently (substitutions were [+anterior]), and had not yet developed /r/ (at least WF /r/), according to mother's report.

Discussion

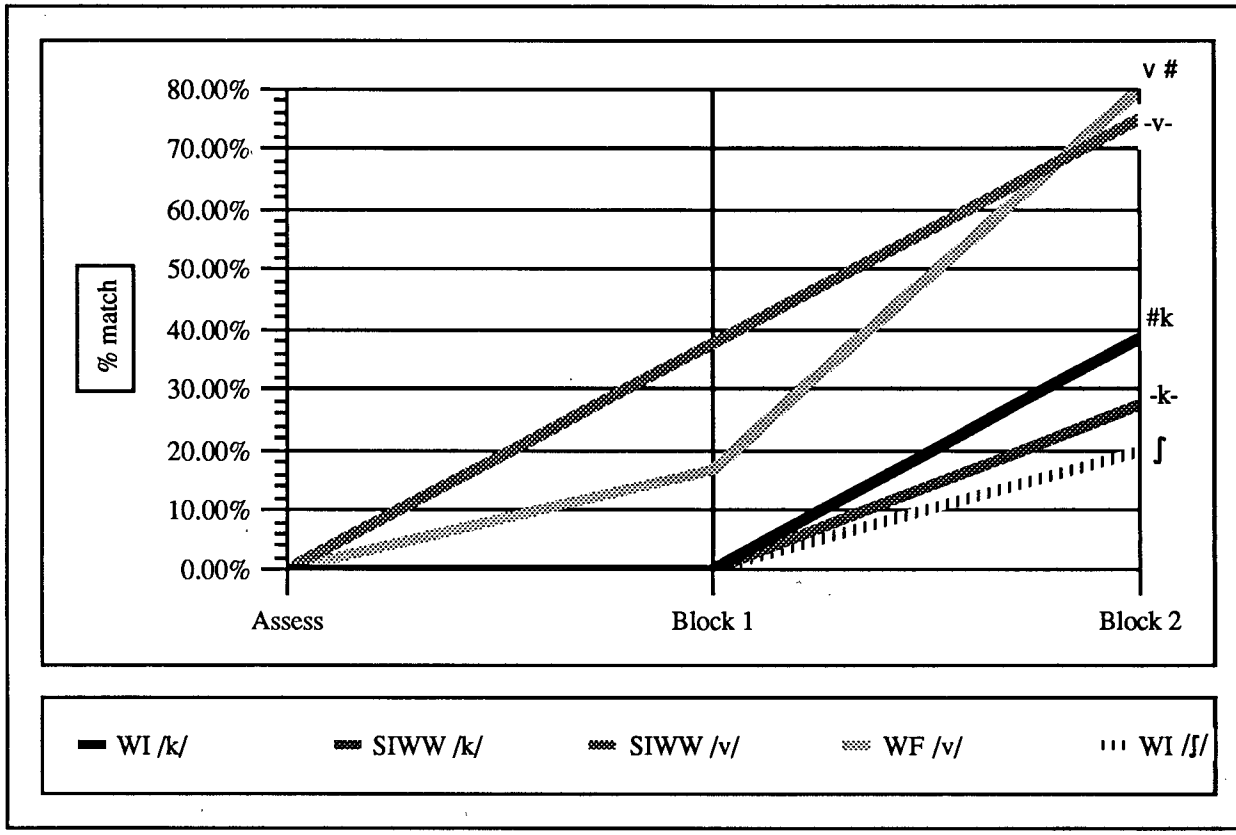
In terms of the research questions the following interpretations are offered.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

As with the other subjects, the nonlinear frameworks did lead to reasonable targets for intervention. The intervention for S2 may have been successful for reasons other than the choice of targets, such as the intensive stimulation and the mutually enhancing effect of a variety of approaches. However, the nonlinear frameworks did lead to attainable goals.

Conversational Intelligibility Gains

There was improvement in intelligibility due to the attainment of conversational proficiency for dorsal consonants, fricatives and clusters. (See figures 4.10 - 4.12.)

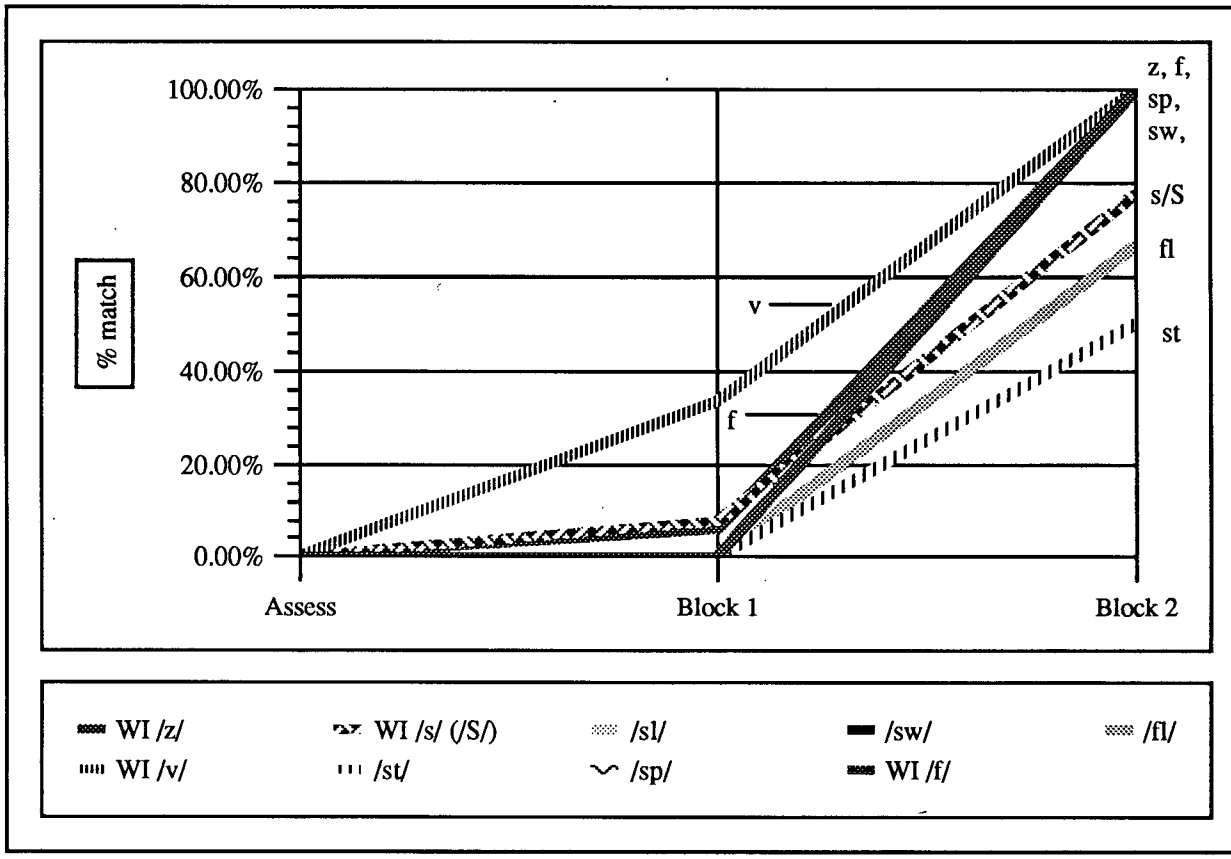


Note: /v/: Block 1 only. /ʃ/: Block 2 but in WF position. There were no matches for /kl/.

Figure 4.10. S2: Developmental progression in proportional matches for trained segmental targets across the intervention period

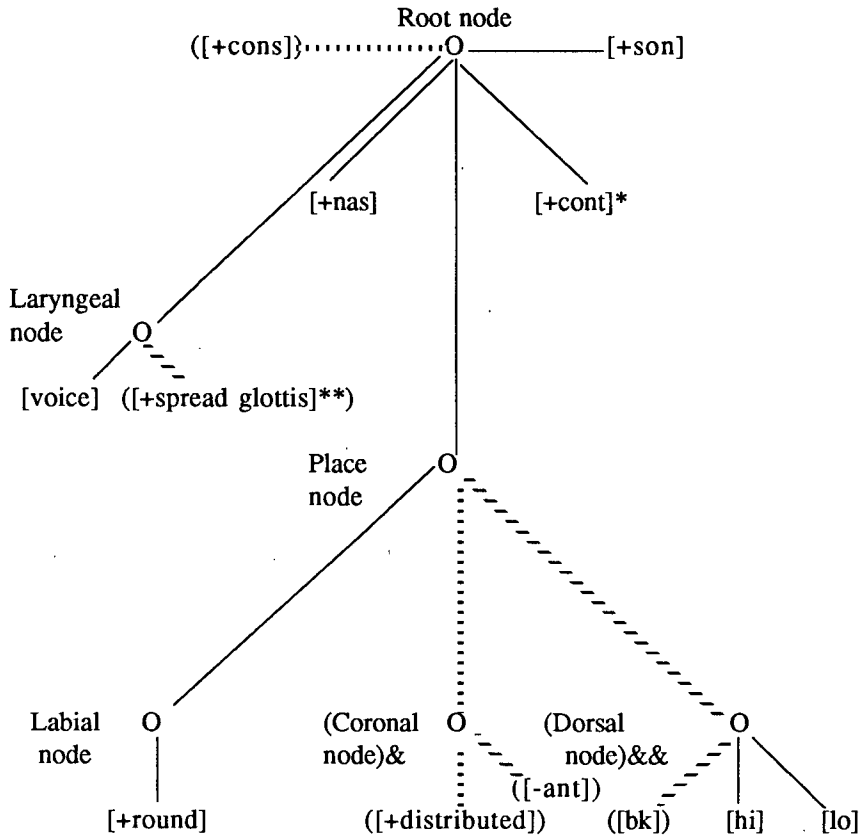
That the system reflected phonological change as a result of training can be inferred from (1) the changes in trained targets detailed above, (2) the types of generalizations which occurred, and (3) lacks in development for observation targets. S2 generalized within voicing cognate pairs, such as from WF /v/ to WI /f/ or WI /z/ to WI /s/ in Block 1. He also generalized between word positions for fricatives, e.g., from trained SIWW and WF /v/ to WI /v/ and /f/, from WI /f/ to WF /f/, from WI /z/ to WF /z/, from WF /ʃ/ to WI /ʃ/. Within sound class generalization occurred, from Place node specification for /z/ to the same for /θ/ and from Dorsal Place stop /k/ to Dorsal Place nasal /ŋ/. Between sound class generalization occurred for the assignment of cluster skeletal slots, such as from /sC/-clusters to /r/-clusters. Lack of development for untrained targets such as /r/, affricates and liquid cluster epenthesis also demonstrates that the training had an impact on the changes. Those phonemes not completely mastered at the end of the phonological intervention

project were still not in use one year following the project, suggesting that the therapy was responsible for change.



Note. Only the clusters and WI /z/ were Block 1 syllabic targets. See /v/ in figure 4.8.

Figure 4.11. S2: Developmental progression in proportional matches for trained syllabic targets across the intervention period



Note: Single parentheses and dotted lines indicate partially established nodes or features. Italics indicate nonmatching feature.
*'Complex' branching structure in place for SIWW and WF affricates
**[+spread glottis] partially in use for WI stops
&Coronal node partially established for [-anterior] and [+distributed]
&&Partially established for consonants

Figure 4.12. S2: Feature geometry at end of Block 2

Language Test Results

All comprehension language test results at the end of the project showed small positive changes in performance -- scores were still within normal limits but at a slightly higher level.

Table 4.3.--S2: Language test scores at Initial Assessment and end of Block 3

TEST	PRETEST SCORE	POSTTEST SCORE
Peabody Picture Vocabulary Test (Form L)	*S.S.*: 100	*S.S.*: 102
Test of Audit. Compreh. of Lang. (Rev.)	*S.S.*: z = -.33	*S.S.*: z = +.20
Test of Lang. Dev.-(Primary): Audit. Discrim.Subtest	Raw score: 18/20 (normal limits)	Raw score: 20/20

In terms of language production, observation of language sample data and the Structured Photographic Expressive Language Test - Preschool (SPELT-P) revealed gains in sibilant morphophonology, with continuing pronominal case errors and inconsistent omission of BE. Language test results were as expected -- small gains in vocabulary, phonemic discrimination and sibilant morphophonology alongside minimal gains in syntax -- and as such lend support to the claim that the changes in phonology were a direct result of intervention.

2. *Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real ?*

At the end of Block 1, there were changes in both segmental inventory and syllable structure. Changes in syllable structure were proportionately greater and more pervasive across the total system. The segmental inventory changes were limited to the labiodental fricative category, most for SIWW /v/ (3/8 = 37.5%) and including one token each for WF and WI /v/ and WI /f/. Dorsal consonants remained unchanged, except for one low confidence transcription of /ŋ/. Syllable structure change showed 75% of the /sC/-clusters with either two elements (16.67%) or compensatory onset lengthening (58.33% , or 29.17% excluding aspirate stops). This change facilitated two-element realization of three /sCC/ clusters (out of eight), as compared with none

previously. Likewise, an increase in number of two-element /r/-clusters was observed (10/22=45.45%). The syllabic condition minimal stimulation of WI /z/ may have facilitated the appearance of one WI /s/ and one WI /f/, or this may also have arisen as a result of the /v/-training in the segmental subblock.

At the end of Block 2, conversational proficiency was apparent for all syllabic condition targets except WI /s/ and /st/ (in the 50% range), with segmental condition dorsals and alveopalatals just beginning to emerge.

Interaction of the Syllabic and Skeletal Tiers

It was possible to set separate goals for syllable structure and segmental development, and gains in skeletal slot development as separate from segmental change were an indication of tier autonomy. However, for this particular subject, there were many interactions between tiers affecting the developmental process.

1. From the time of the assessment until the end of the second block, syllable/word position affected the type of segmental realization for both most sound classes. For example, WF /k/ and often /t/ were unspecified for Place node, something which never occurred in WI position. Fricatives had no Place node specification in WI position, something which occurred rarely in other word positions. The liquid /l/ was specified for [+consonantal] only in SI position.

2. Epenthetic vowels appeared to be necessary for pronunciation of two liquid cluster elements.

3. The earliest /s/-cluster was /sn/, suggesting that the sharing of Coronal Place facilitated realization of two skeletal slots (although it was not the sole factor, since /st/ did not yet appear).

4. There was a different rate of development for /s/-clusters in general (/sp/, /sw/ and /sl/ > /sn/ > /st/ > /sm/, /sk/), suggesting that certain phonemic combinations may have been more difficult to acquire, in spite of skeletal slot marking.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of intervention methods that contrast the onset and rime versus those that utilize the mora as a constituent?

Major probe data was unrevealing for Block 1 with respect to this queston. Block 1 session results were essentially equivalent across conditions for the two subblock conditions (73.73% for moraic targets and 71.35% for the onset-rime targets). Block 2 session results showed a slightly greater advantage for moraic targets (82.61% versus 73.98% for the onset-rime targets). S2 mastered moraic targets WI /z/ and /v/ and the clusters /sp/ and /sw/ by the end of Block 2, whereas the onset-rime target cluster /st/ was still emerging (50%). The targets themselves may have been more relevant than the conditions for the difference, however, since there were equivalent results for the singleton WI /s/, a target in both conditions.

Using the Kolmogorov-Smirnov measure of difference, the following null and alternative hypotheses were tested for eleven measures across the study (seven major probe and four session total measures/condition):

H_o: There will be no differences in proportional matches between moraic (m) condition measures and onset-rime (n) condition measures across the study.

H_1: Moraic condition measures will be higher than onset-rime condition measures across the study.

The largest discrepancy is 3/11, yielding a test statistic of (11)(11)(.2727)=33, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed).[13]

Table 4.4.--S2: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test

	<10%	46-50%	61-65%	66-70%	71-75%	81-85%	100%
s_m (x)	2/11	2/11	3/11	*4/11*	*6/11*	7/11	11/11
s_n (x)	2/11	4/11	4/11	*7/11*	*9/11*	9/11	11/11

$p > 0.1$

In terms of linguistic knowledge, S2's sound play, interchanges of onsets in Block 2 syllabic training -- [sp] for /s/ or /ʃ/, [b] for [st] or [sl], as well as single labial consonants for other singletons-- indicates awareness of word constituency as onset and rime. That [sp] was one of

of those sound play units also demonstrates an awareness of the unity of the cluster, even though that cluster was never presented as a unit in training.

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

By the end of Block 1, specification of the higher level Root node feature [+continuant] in conjunction with the Labial Place node occurred, resulting in some productions of /v/ and /f/. Consonants with Dorsal Place node, the lower level feature target, emerged only at the end of Block 2, reaching mastery at the end of Block 3. Emergence of the Coronal Place marked feature [-anterior] began at an earlier stage than similar emergence of the Dorsal Place features, i.e., after one block. Height in the feature hierarchy was apparently relevant in Block 1, but was not as relevant in subsequent blocks. However, type of nodes appeared to be relevant. The establishment of a new marked Place node, for which new articulatory innervation was necessary, was more difficult than establishment of terminal features, or the conjunction of features established for other phonemes or sound classes.

Summary

S2 attained conversational proficiency for trained target fricatives and clusters, some of the singleton fricatives by the end of Block 1 and the remainder by the end of Block 2. By the end of Block 3, he consistently used Dorsal Place consonants, which had begun to emerge in conversation at the end of Block 2. Trained alveopalatals began to appear at the end of Block 3. As predicted, there was more generalization to untrained targets related to those trained -- across voicing cognates, word positions and, for cluster skeletal slots, sound classes -- than to unrelated untrained targets, particularly /r/.

In both blocks, as predicted, S2 learned syllabic targets more quickly than segmental targets. Learning at the syllabic level in Block 1 was evident both from exact matches as well as from compensatory lengthening of the prevocalic consonant -- signalling awareness of a missing cluster consonant. Beyond the autonomous learning, it was evident from the outset, however,

that the segmental and syllabic tiers interacted in many ways for S2. The positional constraint against WI fricatives, the appearance of untrained /sn/ as the first /s/-cluster (as with three other subjects) and the use of epenthesis as an element realization strategy for cluster production are some interaction examples.

Overall, in terms of the syllabic constituent conditions, S2 acquired more of the moraic targets at a faster rate. Whether this was target- or condition-specific is unclear, however. A Block 2 observation demonstrating the child's awareness of the onset-rime division was sound play inserting contrasting labials into onset position. A Block 1 observation demonstrating awareness of /s/ as a separate constituent (as trained in the moraic condition) was the prolongation noted in [s::n] -- an untrained generalization.

Feature hierarchy levels appeared relevant for S2's learning, since in both blocks the higher level feature developed at a faster rate. Generalizations from trained to untrained related segments demonstrate the general relevance of feature theory for describing phonological development.

CHAPTER 5

SUBJECT 3: SUMMARY

[baɪbaɪ bʌmbʊbi]

Case History Information

Subject Characteristics

S3, the second of two boys, was 3;4 - 3;8 during the period reported here. Associated with his phonological disorder was a general delay in language production. Comprehension appeared to be within normal limits, as did general cognitive and motor skills (see table 5.1).

Prior Treatment

For five months prior to the study, he participated in weekly language and speech stimulation therapy at a local health unit. In the three-month interval immediately prior to the study, the speech-language pathologist introduced new vocabulary by phoneme group: words beginning with /w/, /m/ and /l/, and words ending in /s/. S3 overgeneralized WF /s/ to other final consonant slots at the end of that period. (Previously, final consonants had been missing.)

Phonological System at Initial Assessment

Phonotactics: Syllables and Words

Overview

Of the 431 reported target words, the total number of matches for syllable number and skeletal slot realizations was 153 (35.5%). The CV and CVV units appeared to be established. However, all other permutations and combinations of syllable/word shapes were either developing or absent. An overgeneration of a child default segment [*s*] in WF position was evident both for CVC targets and multisyllabic targets, the [*s*] often taking the place of entire syllables.

Table 5.1.--Subject information for S3

AGE	3;4 - 3;8 for reported period
GENDER	Male
BIRTH ORDER	Second of two boys; first (three years senior) reportedly had mild difficulty with reading
OTHER FAMILY HISTORY	English-speaking (Canadian-raised parents) Father teacher; mother medical receptionist (not working during study)
HEARING	Screened within normal limits at local hospital, four months prior to study History of ear infections from 12 to 18 months
DEVELOPMENTAL / MEDICAL HISTORY	Age-appropriate motor skills and general cognitive and social skills No unusual pregnancy, birth or medical history
ORAL MECHANISM	Normal for speech production. Stimulable for all sounds of English in isolation except alveopalatals
LANGUAGE SKILLS	Comprehension: Normal limits 1. Auditory Comprehension Subtest of the Preschool Language Scale -- age score of 3;9 at 3;3 2. Peabody Picture Vocabulary Test (Form M) -- age score of 3;11 at 3;3 Production: Delayed development 1. Verbal Ability Subtest of the Preschool Language Scale -- age score of 2;6 at 3;3 2. Restricted word, phrasal and sentence use; most common utterances single words (141/168); longest utterance -- 4 morphemes. Excluding yes and no, low word type-token ratio (.41 - 166/408) 3. Some use of idiosyncratic jargon such as [ə˞] for big; [ʔʌbə̃m] for yes, [ʔə̃n] for deictic pronouns
PREVIOUS THERAPY	Language and speech stimulation therapy weekly five months prior to study by another speech-language pathologist In three months preceding study, previous SLP introduced new vocabulary by phoneme: WI /w/, WI /m/, WF /s/ (overgeneralized to other final consonant slots), WI /l/

S3 produced two tokens of a more complex word form -- CVC.CVC (PR E):

monkey > [mãŋ.ɾɪs]

sewing machine > [mʌ̃n.dɪs]

Each syllable of this "advanced" production conformed to an established monosyllabic word shape in the system -- the first a CVC with a WF nasal, and the second a CV[s] syllable. Thus, when asked to repeat a disyllabic word, he utilized available syllable 'templates' to construct the more complex form.

The system overall appeared to be characterized by word templates which were both syllabic and segmental in nature. Certain segments (i.e., nasals and final [*s*]) closed syllables but, otherwise, word production was limited to open syllables, primarily one per word (see table 5.2).

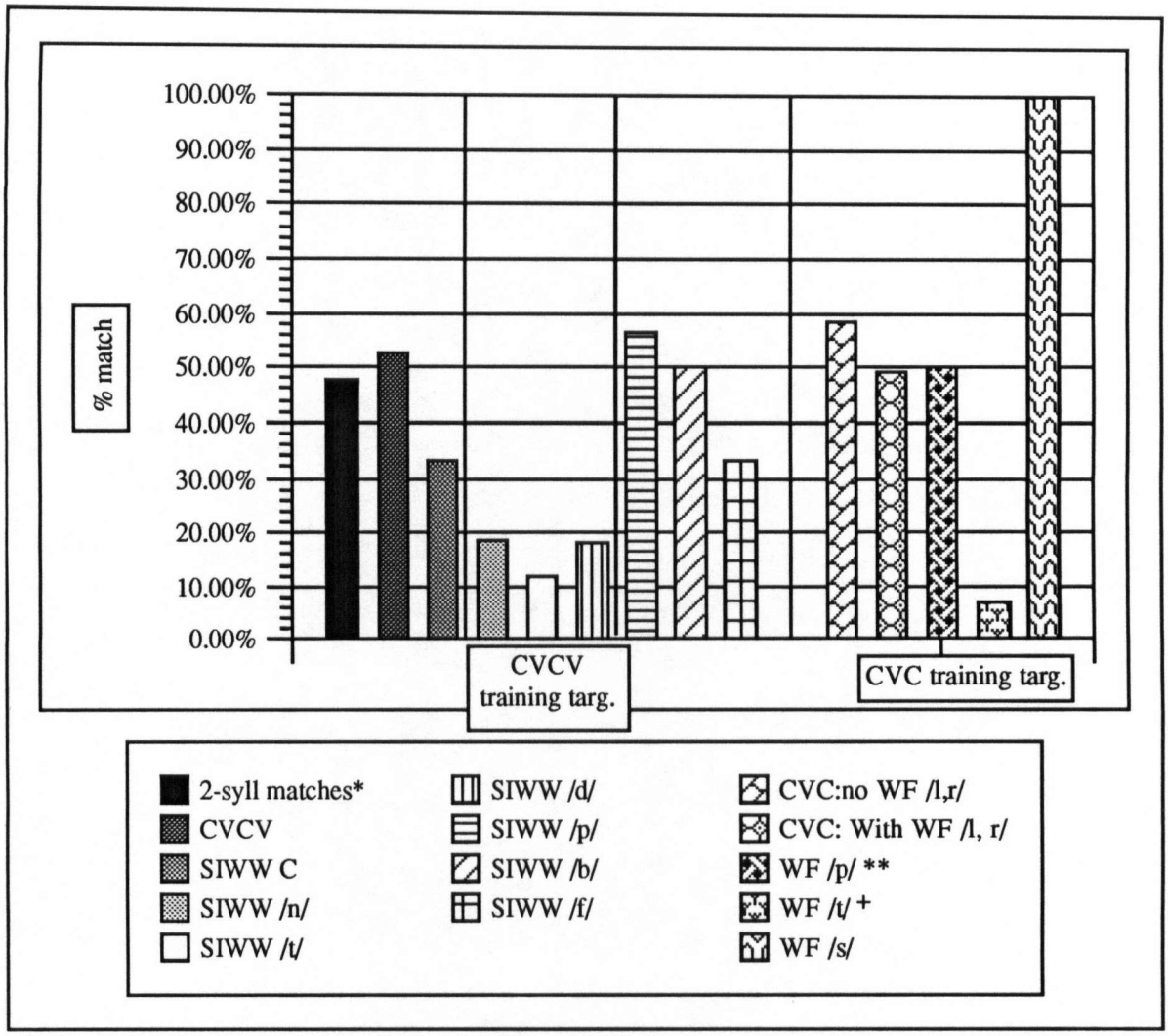
Table 5.2.--S3: Proportion of spontaneous, echoic and prompted utterances per adult word shape

	Adult form			
Type of utterance	Monosyllabic	Disyllabic	Trisyllabic or greater	Totals
Spontaneous	49.23%	7.73%	.44%	57.40%
Echoic (E)	14.13%	7.28%		21.42%
Prompted E	8.17%	10.82%	2.21%	21.19%
(E + PE)	(22.30%)	(18.1%)	(2.21%)	(42.61%)
Total Targets	71.52%	25.83%	2.65%	

Note: 431 words total

Established Word Structures

Word structure matches were found for open monosyllables and reduplicated disyllables in the following order (see figure 5.1):



Note: There were no other matches.
*Denotes syllable/word congruency
**Based on four tokens
+1/14 matches

Figure 5.1. S3: Proportional matches for CVC and CVCV word shapes, and SIWW and WF consonants showing matches at Initial Assessment

Established Word Structures (continued)

1. CV: 46/48 (95.83%)

In a semirandom sample of 100 utterances, there were fourteen CV child forms with no offglide or perceptible lengthening. Of these, ten were tense vowels (/i/, /o/, /u/) and four were lax. There were fewer tokens of CV units with phonetically long vowels or offglides (two tense vowels and seven lax vowels). This suggested that there may not have been a prosodic distinction between tense and lax vowels for S3 at assessment.

2. C_iVC_iV: 7/8 (87.5%) (mommy, daddy, i.e., familiar partially reduplicated forms)

In the semirandom sample, there was only one example of a vowel with an offglide in the first syllable, and that was a lax vowel (/ɪ/). All other vowels in CVCV were short.

3. CVV (VV=diphthong): 23/28 (82.14%)

Developing Word Structures

The following structures were developing at the time of assessment (percentages indicating proportion of matches). (See also figure 5.1.)

A. Monosyllabic targets

1. CVC (Overall): 99/136 (72.79%). CVC mismatches were due primarily to missing final consonants (37/136 [27.21%]) but also to missing WI consonants (17/136 [12.5%]). (See segmental data below for details.)

   a. CVC (Excluding final /l/ or /r/ targets): 92/113 (81.42%)

   b. CVC (Excluding final /l/ and /r/ targets and [s] used for any final consonant except /s/): 66/113 (58.41%)

In the semirandom sample of 100 utterances, there were 19 CVC utterances. Of these, eight vowels had offglides (all lax) and none were lengthened in any other way (There were only two examples of CVC with tense vowels, however.) Again the tense-lax distinction did not appear relevant at this stage of development for S3. (For contrast, see this section in chapter 6 about S4.)

2. VC: 7/11 (63.64%)

B. Disyllabic targets

Overall, 55/115 (47.83%) child attempts matched disyllabic adult targets for number of syllables. Also, 7/12 multisyllabic words (three or more syllables) were realized with two syllables. Presence of consonants in disyllabic targets was as follows:

1. WI consonants: Missing in 24/127 (18.9%) cases

2. SIWW consonants: Missing in 13/55 (23.64%) cases (where two syllables were present in the child form)

3. WF consonants: Missing in 10/18 (55.56%) cases (where two syllables were present in the child form and [*s*] appeared as a WF substitution). The WF [*s*]-substitution

appeared in 8/23 (34.78%) disyllabic child forms and in 31/39 (79.49%) monosyllabic child forms (i.e., reduced multisyllabic targets). In other words, [*s*] was used to close final syllables regardless of which other elements were missing.

4. SFWW consonants: Two [n] realizations (see monkey and machine above), otherwise missing.

C. Diphthong development

As stated above, diphthongs were established in CVV type monosyllables. Table 5.3 shows their partial establishment in closed monosyllables (45.45%) and their marginal establishment elsewhere. (General word form constraints undoubtedly affected diphthong realization.)

Table 5.3.--S3: Diphthong realization in syllable/word targets containing diphthongs at Initial Assessment

Word target type including diphthong	Matches
Open monosyllables ((C)VV)	25/30 (83.33%)
Closed monosyllables ((C)VVC)	10/22 (45.45%)
Open first syllable ((C)VV.(C)V)	4/5 (80%) (one syllable only for 2/4 items)
Open second syllable ((C)V.(C)VV)	2/5 (40%)
Open syllables ((C)VV.(C)VV)	0/4 (one VV match in second syllable)
Closed first or second syllable (VV in either σ)	0/8 (two with VV but only one syllable/word)

Note: Open/closed designation refers to type of syllable in which diphthong appears in adult form. Diphthong = VV, tense or lax vowel = V.

Undeveloped Structures

The following were absent at Initial Assessment:

1. Words of more than two syllables (i.e., words with an extrametrical syllable adjoined by Stray Syllable Adjunction, or words of more than one foot)

2. Consonant clusters postvocalically or prevocalically.

Established Syllabic System Components according to Moraic and Onset-Rime Theories

A. Moraic theory

In moraic terminology, a basic bimoraic system had been established before intervention. As the bimoraic word is considered a universal 'minimal word' by McCarthy and Prince (1986), S3's syllabic system may have reflected this universal default rather than any learning of English.

1. The second mora was limited to vowels (of diphthongs) and /m/. This second mora could be tautosyllabic with the first (CVV: $V_2 = M_2$) or heterosyllabic (C_iVC_iV: $V_2 = M_2$).

2. In the case of CVCV (V=tense or lax), a single branching foot was licensed. The maximal word was one foot in length with no more than two morae.

3. A matching prevocalic consonant could be adjoined to the second mora when identical *segmentally* to the first prevocalic consonant in the word (in familiar words with reduplicative forms, such as mommy and daddy).

B. Onset-rime theory

In onset-rime terminology, the basic onset-rime branch had been established, again a possible reflection of the universal O-R default rather than language-specific learning.

1. Branching at the foot level was licensed when there were identical onsets *segmentally*. Word constraints were 'relaxed' when complexity was reduced at the segmental level through iterative word formation -- O-R reduplication -- demonstrating the relevance of tier inateraction for word realization.

Developing Syllabic System Components according to Moraic and Onset-Rime Theories

A. Moraic theory

In moraic terminology, the following developments were taking place at the time of assessment:

1. A consonant was optionally licensed as the second mora of a monosyllable, (according to the hypothesis for this study that monosyllabic final consonants may project a mora in English). There were segmental constraints on this licensing, however. The only consistent WF consonant was [m], with [*s*] being frequently used in place of nonnasals (and for 6/15 nonmatching /n/

tokens, the other nine being omissions--[58/73] matches) . Simplicity at the segmental level appeared to be facilitative of development at the syllabic level.

2. At the word level, there was no difference between established and developing structures in terms of number of feet/word, i.e., the maximum word was one foot in length. However, there was beginning development in the permissible syllabic complexity of that single foot. Whether vowels or consonants were counted as morae, the maximum countable morae/word were three, e.g., (C)V.CVV or (C)V.CVC. The child's productions of monkey and machine (CVC.CVC) had four morae according to the counting conventions used in this study, but these four morae were produced only within strict segmental bounds.

3. Consonant adjunction was still developing prevocalically for single consonants in both monosyllabic and disyllabic child forms.

4. Postmoraic consonant adjunction (after the second mora) was limited to items where the second mora was a vowel of a diphthong (in 10/22 cases).

B. Onset-rime theory

In onset-rime terminology, the following developments were taking place at the time of assessment:

1. Branching at the level of the rime node itself was developing, licensing single final consonant production.

2. Although word complexity was limited to the single foot, in either of the O-R units of the foot, a second level of branching was allowed, either at the level of the rime node itself (e.g., CV.CVC), or below the nucleus (CVV.CV). The examples of monkey and machine showed developing potential for words with a second level of branching within both O-R units.

3. Onsets were still developing segmentally, and hence were not always realized. Glottal stops often appeared in place of completely unestablished WI target phonemes (such as /h/, /r/), but often no consonant-like segment appeared in SIWW position.

4. There were a few examples containing two branches within the rime, at the level of the rime node simultaneously with branching of the nucleus ((C)VVC).

Undeveloped Structures according to Moraic and Onset-Rime Theories

A. Moraic theory

In moraic terminology, there was an absence of:

1. Words of four morae or more (exceptions being monkey and machine)

2. Multiconsonant adjunction premoraically; postmoraic consonant adjunction to a second consonantal mora. Since clusters require consonant adjunction either pre- or postconsonantally, the lack of edge consonants appeared to be an equivalency in the system and well expressed as such in moraic theory.

B. Onset-rime theory

In onset-rime terminology, there was an absence of:

1. Disyllabic words with double branches at the level of the rime

2. Branching onsets

3. Consonant adjunction to the rime node subsequent to a primary N-C branching of the rime.

Segmental Development

Segmental Matches

With the exception of affricates, all segments were realized correctly at least once as singletons in the assessment sample. (The [ŋ] of monkey was a match for the target, but was unexpected before the [d] for /k/. [ŋ] also appeared word initially as a nonmatch in milk [ŋʌs], [ŋ^{m}ã^{ə}s]. Hence, it has marginal status as a match.) However, degree of establishment both within and across sound positions varied greatly across phonemes. Both the latter fact and the constraints noted above for syllabic development indicated that S3's phonological disorder was more *syllabic* than segmental.

Match data was as follows (see table 5.4 and figure 5.2):

1. Vowels were adequate for intelligibility, hence were not examined in detail. (There was some variability in the low and front-mid vowels. A slight tendency for hypernasal quality was observed at Initial Assessment, but not in subsequent probes.)

2. The order of sound class establishment across positions (most to least) was nasals > glides > stops > fricatives > liquids.

3. The order of place establishment (most to least) was Labial > Coronal > Dorsal.

4. The order of match data across word positions was WI position (48.31%) > WF (36.23%) > SIWW (25%) > SFWW (8.33%). (WI and WF data includes cluster data with the cluster counted as one element.) The very frequent nasal and labial words skew these percentages. Adjusted data (without /m/, /n/, and /w/) is as follows: WI (28.91%) > SIWW (25%) > WF (7.51%).

5. Specific segments that were adequately established across word positions were /m/ and /w/. In WI position, /b/, /f/ and /n/ were sufficiently robust. As stated earlier, WF /s/ was overestablished and had a default status.

Developing Segmental Inventory

By sound class, the following order (most to least) of partially established phonemes was noted:

1. Nasals: /n/ in all positions except WI. The WF nonmatches were a result of missing segments (i.e., missing Root nodes) or [s] adjunction.

2. Stops: /g/; /d/ (WI only), /p/ (all positions); /b/(SIWW);/t/ (WI only). The WI nonmatches for voiceless stops were mainly the result of lack of marking of [+spread glottis]. For voiced stops, the WI nonmatches were often the result of spreading from other consonant positions or metatheses to accommodate final [s].

3. Fricatives: /f/, /s/ : SIWW.

Table 5.4.--S3: Summary of singleton consonant acquisition at Initial Assessment

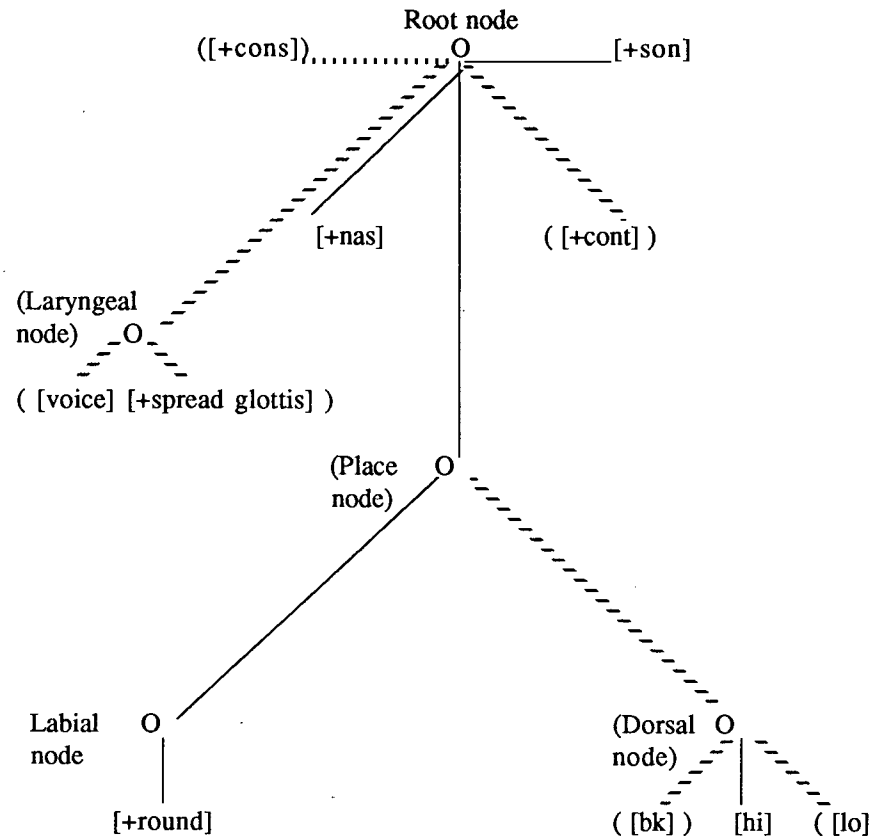
Sound class	Word position matches	Word position nonmatches	Main feature differences
Glides -- /w, j/	/w/: WI, (SIWW)[1] /j/: WI	/j/: SIWW	Final [*s*][2] adjunction (2/4) R: Ø (1/4)
Nasals	WI /m/: WF, (SIWW) /n/: (WF- 79.45%)	/m/: SFWW /n/: (SIWW), (SFWW)[3] ((/ŋ/))	/n/: WF: R:Ø (9/15 mismatches) : [*s*] (6/15) /ŋ/: [*s*]
Stops [-voice]	/p,t/: (WI) /p/: (SIWW), (WF 2/4)	/t/: (SIWW), ((WF)) /k/: (WI), WF All: SFWW	WI: LN: [+sp gl] u/ ([+*voice*] **m*[2]) SIWW: R:Ø (+ other, including final [*s*]) WF: [*s*] : /t/:R:Ø (4/13)
Stops [+voice]	/b/: WI /d,g/: (WI) /b/: (SIWW)	/d/: (SIWW) /g/: SIWW All: WF, SFWW	WI: Assim.< WF /C/ or metathesis to allow final [*s*] SIWW: R:Ø; [*s*] WF: [*s*] -- 12/15 ; LN: [+voice] u 3/15
Fric/Affricates	/f, v/: WI /s/: WF	/f, s/: (SIWW) All others	/s, z,θ, ð/: WI: R:[+cont] u /θ/: WI: *Lab* for Cor Affricates: 'complex' u SIWW: SYL reduc./[s]# WF: [*s*] except /z/ > LN: [+voice] u /ʃ,s/: Imprecise place
Liquids	None	/l/: (WI): 2/13 (15.38%). :Stim. for SIWW /lalala/ /ɹ/: ((WF)) (1/16) All others	WI: R: Ø: 6/23 : *Lab* / Cor: 16/23 SIWW: R: Ø WF: R: Ø: 16/32 /l/ : R: [+cont] u: 3/16 /ɹ/ : [*s*] : 6/16
/h/	None	((SIWW)) -1/2 (redup)	LN: [+sp gl] u

Note: Vowels sufficiently established

[1]Single parentheses indicate partial establishment -- 40% - 80% in the matches column, 10% - 40% in the nonmatches column. Double parentheses denote marginal establishment -- 1 - 10% .

[2]u= unspecifed; *italics*, **m* = specified inappropriately according to appendix 2

[3]Except for [n] twice, no SFWW consonants were realized across sound classes.



Note: Parentheses and dotted lines indicate marginal constituents in system development.

Figure 5.2. S3: Feature geometry at Initial Assessment

Marginal segments were:

1. Stops: /k/ (WI); /d/ (SIWW); /t/ (SIWW and (WF)). (See note on stops above for feature differences information.)

2. Liquids: /l/ (WI - 15.38%) and reduplicated (SIWW); /r/ ((WF)). In WI position, nonmatches resulted from *Labial* for Coronal Place node [w] (16/23) or what appeared to be missing Root nodes (6/23). Although the glottal stop onset may have been a phonemic Laryngeal node substitution, it was considered to be phonetic (1) in order to avoid the complexity of having two alternate substitutions, and (2) because vowel-initial words have phonetic glottal stop onsets in the default case.

3. /h/ (WI - 9.38%) and reduplicated SIWW (heehee). For nonmatches, lack of [+spread glottis] and/or Root node specification resulted in glottal stop onsets before the vowel (e.g., hug > [ʔaᵊs]). It was not possible to determine whether the glottal stop was a phonemic substitution for /h/, or merely a phonetic onset to the vowel. (In fluent connected speech one often suppresses phonetic glottal onsets to vowel-initial words, but S3's "connected" speech was more a concatenation of single words.) As a phonemic substitution, [ʔ] would result from specification of both Root node feature [+consonantal] and Laryngeal node (without specification of [spread glottis]). If [ʔ] were a phonetic onset, lack of /h/ production would result from a missing Root node. The parallel with the marginally established liquids is evident.

Missing Categories by Word Position

1. SFWW position: (Except for two lingual nasal tokens [N] and [n] -- in monkey and machine respectively)

2. Glides: SIWW /j/

3. Nasals: /ŋ/ (Tokens of [ŋ] were nonmatching in terms of the adult target for milk, and unexpected before [d] in monkey.)

4. Stops: /k/ (all positions except WI); voiced stops (WF); /g/ (SIWW). (The SIWW and WF nonmatches resulted from missing Root nodes or final [s] adjunction. In three cases, WF voiced stops matched except for voicing.)

5. Affricates presumably because of lack of 'complex' branching structure

6. WI coronal fricatives as a result of lack of Root node feature [+continuant] specification and, in addition, *Labial* for Coronal Place for /θ/

7. WF fricatives: /z/ because of lack of voicing, /s/ and /ʃ/ because of imprecise tongue placement

8. Liquids: Nonreduplicated SIWW /l/ missing; SIWW /r/)Missing; SF liquids either missing completely (16/32), unspecified for [+consonantal] (/l/ - 3/16), or replaced with [s] (/r/ - 6/16).

Summary of Feature Differences

(Because the absolute numbers of individual feature differences depend on the particular words elicited in a sample, the following descending order -- most exemplars to least -- of feature differences can only be approximate.)

A. Unspecified child forms where adult forms are specified

1. Root node: Because of constraints on syllable structure and undeveloped segmental inventory, many consonants were missing (no Root nodes). Undeveloped segmental inventory accounted for missing WI liquids and /h/, syllable constraints for missing consonants in other word positions.

2. Laryngeal node: [+voice] was unspecified for WF voiced obstruents.

3. Root node: No [+continuant] WI Coronal obstruents were realized.

4. Laryngeal node: [+spread glottis] was unspecified on /h/ and some WI voiceless stop exemplars (the later being a redundant specification).

5. Root node: [+consonantal] was unspecified for liquids and probably /h/.

6. Branching ('complex') structure was undeveloped for affricates.

B. '*Specified*' child forms where adult forms or unspecified or otherwise specified

1. *Final* [*s*] *adjunction*: Syllable structure constraints on disyllables and closed syllables as well as segmental underspecification across categories led to this child's default final consonant.

2. *Labial* for Coronal specification was observed for liquids and /θ/ (see discussion below on rationale for segmental target selection).

3. Feature spreading (place assimilation) or segment movement (metathesis) accommodated syllabic constraints and underspecification of segments, usually in the stop category.

Segmental Realization of Clusters

A. Initial clusters

As was mentioned in the section on phonotactics, no initial clusters were realized with two elements. In targets including stops or nasals, the stop or nasal was realized (except /br/ > [m] once).

Both /sl/ and /sw/ targets ended in [s]:

sleeping > [mɪs], [bɛᴵ s>], [boᴵ ʔɪs]

sweater > [wɛ̌ʔɪs>]

The [s] may have been a result of the pervasive WF [*s*] adjunction or may have been a result of metathesis, or both. For sleeping, a metathesis interpretation is supported by the position of the labial segment, especially for [mɪs], where the labial segment is also nasalized, suggesting movement from the suffix [ɪŋ].

Apparent glide-vowel coalescence seems to indicate that /Cj/ is less a cluster than /ju/ is a diphthong for this subject.

fume >[fim]

music >[my̌s]

B. Final clusters

As stated earlier, no final clusters were realized with more than one element. Clusters with nasals and stops were realized as [s] or with neither element, except for /nd/ > [n]. If a cluster target contained a fricative, [s] was the surface realization. A trace of the [+sonorant] feature of liquids sometimes appeared preceding a sibilant, e.g., candles > [dahũⁿᵗs], with rounding on the

vowel in the second syllable. In two cases, there appeared to be stop metathesis from WF position to the closest onset position as shown below:

icecubes > [ʌ̃bIs]

desk > [gʌs]

Intervention Plan: Block 1

In Blocks 1 and 2, conditions for S3 followed the pattern: syllabic/segmental. The syllabic subblock order was moraic/onset-rime; the segmental subblock order was higher level feature/lower level feature.

Syllabic Intervention Plan

In general, the goals were:

1. To decrease the use of WF [s] adjunction, thereby expanding the range of consonants realized in final position (CVC)

2. To strengthen the disyllabic word shape.

The C_1VC_2V word shape was chosen as the disyllabic target, because $C_iVC_iV(V)$ was already established. A logical step was expansion of the range of permissible consonants in C_2 position (C_1VC_2V word shape).

Moraic Subblock

Targets: 1. WF /p/

2. SIWW /n/ following lax vowels in σ_1

Rationale and methodology

Because this particular child was shy and sensitive about his speech delay, it was psychosocially necessary to find immediately attainable goals. Since both of the above segmental targets had some matching exemplars in the assessment sample (being part of the strong nasal and labial categories), the potential for expansion of range of distribution across words was good. Informal probing prior to initiation of intervention indicated that the degree of use of the chosen targets was less than it had appeared during the assessment, making their choice justifiable.

To promote generalization across the system and at the same time inhibit the overgeneralization tendency noted with WF [*s*] adjunction, E decided to target segments from two different sound classes and in two different word positions.

For CVC development, E presented stimuli with extra-long tense or lax vowels (CV:::) and separate final consonants. Without the exaggerated vowels, S3 produced a CV[s] response.

With respect to C_1VC_2V word types, S3 usually pronounced them as CVV, e.g., funny as [fʌI] but, during the assessment, he self-corrected once when attempting this "favorite" word, saying [fʌn]-PAUSE-[ni]. This production demonstrated knowledge of an underlying SIWW /n/, with an apparent output difficulty for production of C_1VC_2V. He appeared to start with the intention of producing the SIWW /n/ but found it difficult, so ended up by (1) closing the first syllable with the nasal (a permissible SFWW consonant, see monkey and machine) (2) pausing, and (3) then finishing the word restarting with the same nasal, rather than the [i]. Starting the second syllable with [n] matched the adult target for σ_2 and may have indicated ambisyllabicity.

According to the counting methods used in this study, the audible portion of [fʌn]-PAUSE-[i] (i.e., not counting the pause as prosodic, which in retrospect was probably prosodically relevant) represented a sequence of three morae (V=1 each, WF [n] = 1). In order for S3 to produce funny correctly, the mora for [n], and the pause would have to be deleted. One way to accomplish this, E surmised, was to begin with similar stimuli with three morae -- [CVn]-PAUSE-[ni], demonstrating the "beats" for fun, bun, etc. (=2 "beats") and [ni] (=1 "beat") on one's knee. By increasing the speed of the verbal stimuli, and dropping one of the "beats" on the knee, E assumed that the mora of [n] would be dropped, leaving [fʌ] (=1 mora or "beat") and [ni] (=1 mora or "beat").

Although E did not distinguish between tense and lax vowels for CVC development in the two conditions, only lax vowels were used for CVCV moraic development in order to follow the pattern for funny.

Onset-Rime Subblock

Targets: 1. WF /p/

2. SIWW /n/ after tense vowels or diphthongs

3. SIWW /t,d/

Rationale

The use of the same targets (WF /p/ and SIWW /n/) for both conditions allowed treatment session comparison of conditions, whereas the different targets for SIWW allowed major probe comparison.

The use of tense vowels or diphthongs for /n/ targets facilitated an onset-rime presentation method for C_1VC_2V targets which contrasted with the moraic presentation. For example, E presented pony as [p^hou]-PAUSE-[ni], O-R followed by O-R. Between the separate stimuli [p^hou] and [ni] and the final output form [p^houni] there was no change in number of morae, as noted above for [CVn]-PAUSE-[ni] in the moraic condition, nor was any focus given to the number of beats through physical or rhythmic stimuli. Focus was solely on the O-R sequences as units.

Usable exemplars with diphthongs were few, necessitating addition of a second target set for SIWW position. The alveolar stops were treated undifferentially as the flap [ɾ], and were considered sufficiently robust as WI segments to enter into the syllabic condition. In contrast with the /n/ subset, lax vowels as well as tense vowels and diphthongs were permitted in targets, since the /t/ and /d/ targets were not moraic condition targets. In order to contrast with the moraic presentation, for /n/ with lax vowels, the underlying roots were not presented in conjunction with the derived form. For example, E always presented a word such as muddy as [mʌ]-(PAUSE)-[di], without drawing attention to its relationship with mud. This provided a means of evaluating the effect of vowel length (or tenseness) on production.

Segmental Intervention Plan

Because all segments except affricates were used at least once in the sample, affricates seemed the most likely segmental condition choices. Affricates were not chosen because: (1) their establishment would have entailed two types of specification, 'complex' structure plus Coronal Place: [-anterior], and (2) they were not phonetically stimulable, a therapeutic concern for a child who was very sensitive about speech correction. If affricates had been one of the target sets, any other target (all of which were stimulable) would have had a distinct advantage from phonological,

phonetic and psychosocial points of view. These factors left the (very) marginally established /h/, /ŋ/, /l/ and /r/ as target choices.

Higher Level Feature Subblock

Target: WI /h/ -- (Root node [+consonantal]??) and Laryngeal node [+spread glottis]

Rationale

The proportion of matches for /h/ (3/32 = 9.38%) and the actual tokens produced showed that /h/ was very marginally established. Two of the /h/ matches were echoic versions of hanger > [hæs], and the third was an onomatopoetic horse sound -- heehee > [hihi] (i.e., a type of nonsense word). The commonly used /h/ words home and happy had glottal stop onsets rather than [h]. According to the feature hierarchy, realization of /h/ requires specification of [+consonantal] and [+spread glottis]. Although two features would need to be specified, the single Root node feature was judged accessible because it was already specified for other consonants. (It may already have been established for /h/. The [ʔ] substitution may have had phonemic rather than phonetic status.) (See also table 9.2.)

Lower Level Feature Subblock

Target: WI /l/ -- Root node [+consonantal]/[+sonorant], default Place node

Rationale

To contrast with /h/, E selected a liquid rather than the marginally established /ŋ/, since liquids were only a marginal sound class in the system, whereas nasals were the best-established class. Between the liquids, /l/ was the target of choice. The /l/ is less complex than /r/ in terms of features, and therefore more equivalent to the other target -- /h/, a minimally specified segment, although the feature [+distributed] for /r/ would have possibly provided a better contrast in terms of feature levels (definitively low).

The marginal level of /l/ establishment was evident from the small number of matches (2/13 = 15.38%) and the particular tokens -- a prompted echoic word Lyle > [læ^{r}ɔ^{ʊ}] and an echoic onomatopoeic syllable 'la(lala)' > [lalala]. In these ways, /l/ was essentially equivalent to /h/ at the beginning of intervention.

For both of the WI liquids, substitution types were similar, showing a within-class neutralization. The predominant substitution for both was [w], although [ʔ] also appeared (more for /l/, i.e., four of eleven nonmatches). Whether the [ʔ] was a default phonetic vowel onset, i.e., denoting a missing Root node for the liquids, or a phonemic Laryngeal default substitution could not be determined (as above for /h/). In either case, Root node feature [+sonorant] would need to be specified, and, if phonetic, [+consonantal] in addition. In this case, specification for /l/ would entail specification of higher level features than for /h/ (giving an intervention sequence opposite to what was initiated for S3).

However, since the most frequent liquid realization was [w], E assumed that [+sonorant] was partially established as a specified feature for liquids. According to appendix 2 Feature Specifications, the [w] glide substitution for /l/ would result from (1) lack of specification for Root node feature [+consonantal] in the context of specification for [+sonorant], and (2) *Labial Place* rather than default Place -- Coronal ([w] being the "consonantal" realization of /u/ by syllable position). Once [+sonorant] is specified for a nonnuclear syllable position, a glide will be realized. Options for glide substitutions are [j], a coronal segment related to /i/ (i.e., with a redundant [-back] feature) and [w], a labial segment related to /u/ (with a redundant [+back] feature). Randomness in the system may result in either glide being a liquid substitution (S1 and S5 occasionally deviated from their general patterns of using [j] and [w] respectively to using the opposite). On the other hand,there may be a hierarchical relationship between the substitutions. According to appendix 2, [w] is farther away from the target, because of its lack of Coronal Place (tongue blade) articulation. In a sense, then, the [*w*] is a default which does not concord with the default Place for English. (There are other examples of *child defaults* which do not match the adult defaults, such as the [+*distributed*] Coronal of S1, S5, S2 and S6, and the laryngeal substitutions of S2 and S6). Even if Labial Place is a redundant feature at some point in the derivation for liquids, they are articulated with the blade and tip of the tongue, as other coronals. Development for /l/, then, for S3, necessitated the specification of [+consonantal] for the Root node (and for a minority of items [+sonorant] as well) and Place node specification (the default C-Place being Coronal Place, not Labial).

With the feature hierarchy used (see figure 1.2), distinctive features for /l/ establishment versus /h/ establishment were ambiguous as to relative height, particularly since both required Root node specification of [+consonantal]. However, both segments also required changes at lower levels in the hierarchy. Place node specification for /l/ development was considered to be at a lower level than the Laryngeal node [+spread glottis] specification necessary for /h/ development, since Laryngeal node was considered higher than Place node in this study (see the chapter 2 section on segmental condition target selection). (If a feature [+lateral] were specified at the Place node or Coronal Place level, the features for /h/ would be more clearly at a higher level given the general assumptions of the study, but a feature [lateral] was not used.) A further prediction of /h/ precedence in development (analogous to height predictions) might follow from markedness, in that conjoint specification of [+consonantal] and [+sonorant] plus Place node could be considered more marked than [+consonantal], Laryngeal node, i.e., no need for conjoint Root node specification, nor oral cavity shaping.

Results of Block 1 Intervention

General Results

Changes in syllable and word structure improved S3's conversational intelligibility dramatically. The average gain for trained syllabic targets was 60.75% (*SD*: 9.85%) from the Initial Assessment probe. For skeletal slot marking (i.e., specification of CVC and CVCV), the average gain was 39.84% (*SD*: 10.06%). Generalization of trained to untrained targets in conversation occurred within the syllabic subblock, i.e., within three weeks of intervention. In comparison, the average gain for trained segmental targets was 13.53% (*SD*: 12.27%) with no change for untrained segmental targets (see figure 5.3 for the comparison).

Syllabic Goals

1. WF [*s*] adjunction was eliminated in all but seven tokens, and completely for CVC targets.

2. CVC became established as a basic word shape with 90/98 [91.84%] matches (excluding WF liquids).

The eight mismatches at the syllabic level included six missing onsets and two expansions to final cluster production.

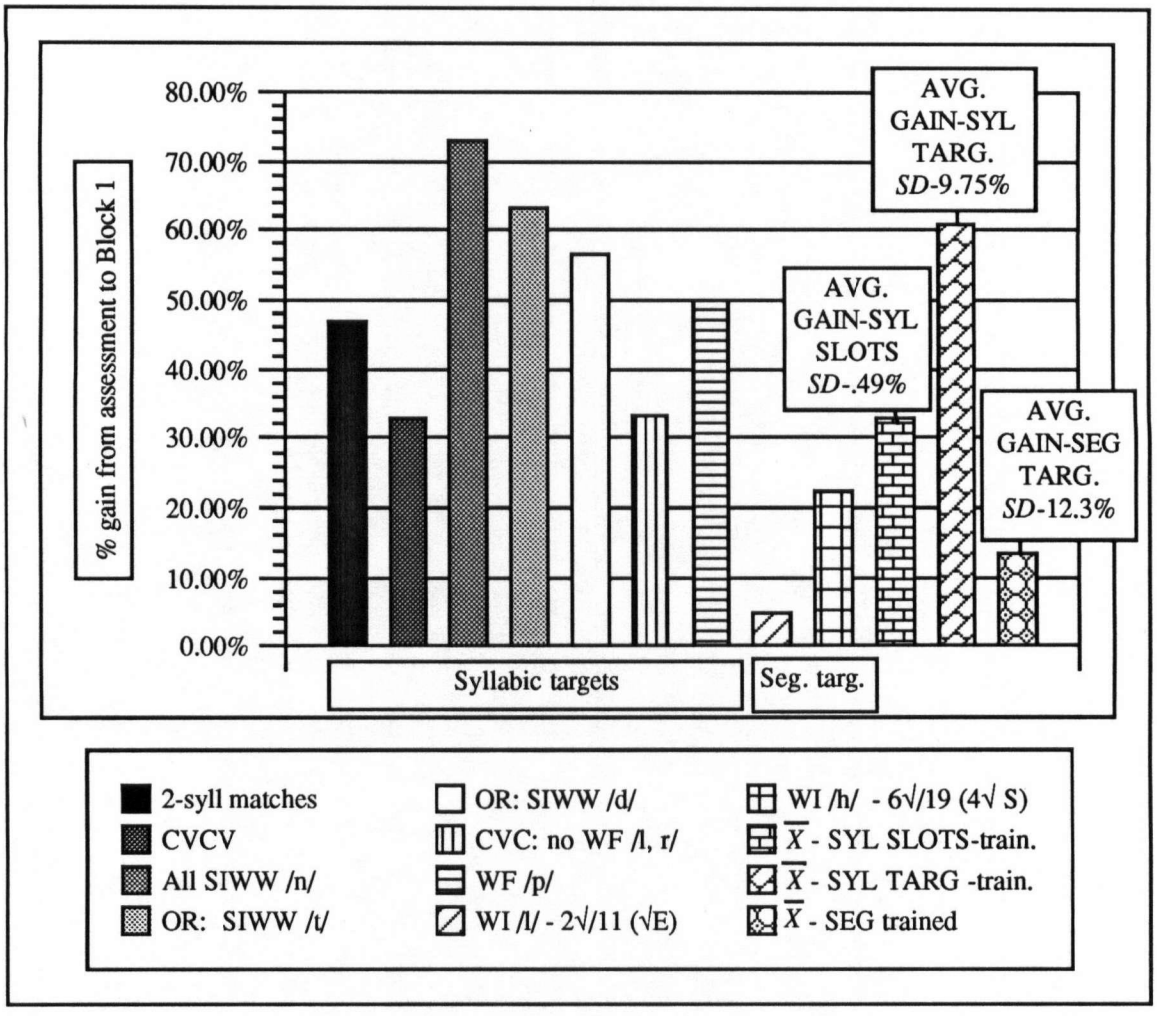
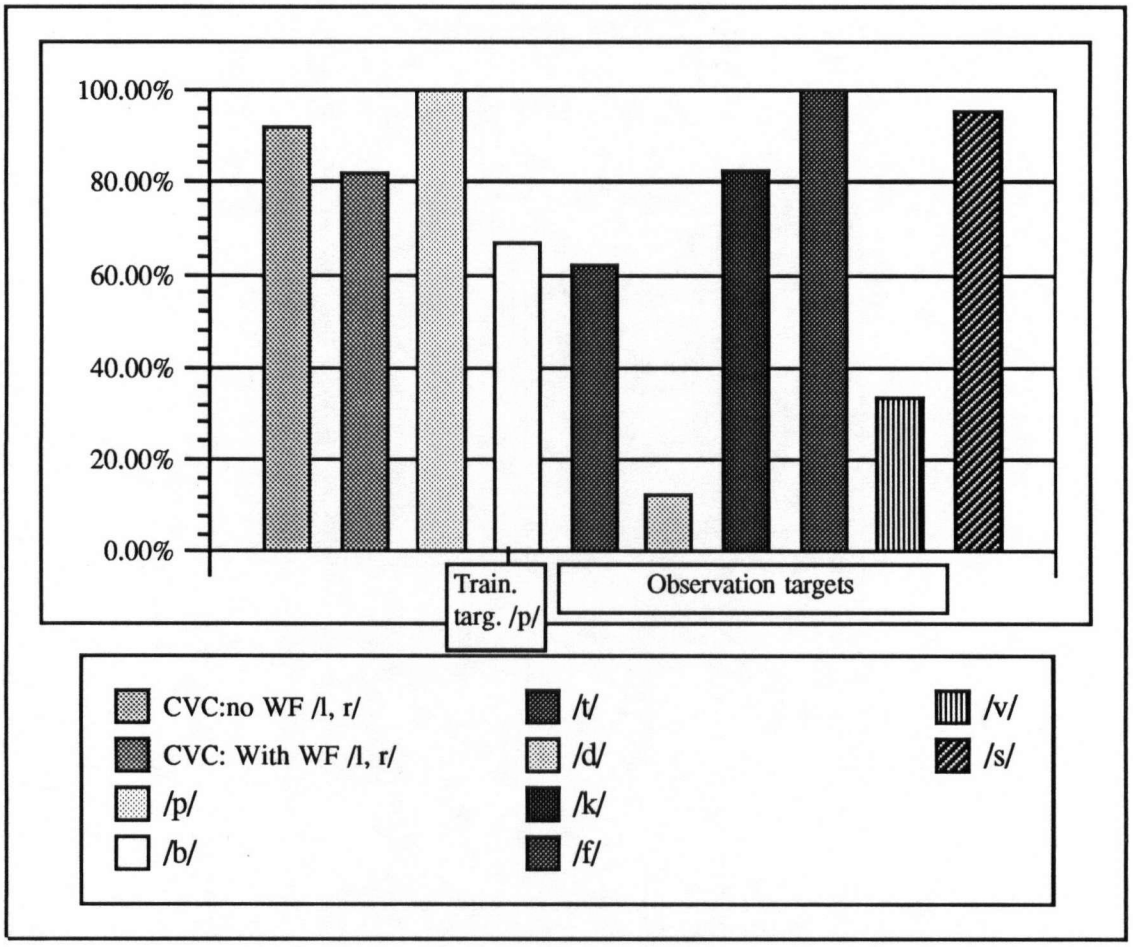


Figure 5.3. S3: Proportional gain in matches for syllabic and segmental targets between Initial Assessment and Block 1 major probes

At the intersection of the syllabic and segmental levels, 9/48 (18.75%) C_1VC_2 targets mismatched because of syllabic type processes such as assimilation, dissimilation and metathesis (See figure 5.4 and appendix 4, table 3.1 for segmental information about CVC). The generalization to targets other than WF /p/ show that syllable development was occurring, rather than just the learning of trained final segments. The most predictable generalization was WF /f/ (100%). Since there was already an underspecified continuant obstruent [s] in WF position, the

training of the Labial /p/ facilitated the transfer to /f/. Other predictable generalizations were within the voiceless stop category.



Note: There were no other matches.

Figure 5.4. S3: Proportional matches for WF (CVC) targets in Block 1 major probe

3. C_1VC_2V became established as a basic word shape (14/20 [70%]). Overall, there were 35/41 (85.37%) CVCV matches. Again, generalization to targets other than the trained ones indicates that syllable development was occurring. Most improved untrained segments were /f/, /k/ and /g/. The stops were predictable from the work on the /t/ and /d/, and the /f/ was possibly predictable as a transfer from SIWW /p/, which was reasonably well established at Initial Assessment. (See figure 5.5.)

4. Disyllabic targets were realized as such 127/134 (94.78%) times. The most frequently matching disyllabic target with one closed syllable was the CV.CVC word shape. The most complex of the disyllabic child forms was CVVC.CVC.

5. Trisyllabic targets were realized as disyllabic tokens six out of seven times. One echoic trisyllabic token (CV.CV.CVC for musicbox) was noted.

6. The SIWW consonant was realized 126/141 (89.36%) times in multisyllabic words.

7. Diphthongs were produced in all open syllables, but only in 25/34 (73.53%) closed monosyllables, and in 4/24 (41.67%) multisyllabic words with at least one closed syllable.

8. Two-element cluster production was beginning, with 5/89 (5.61%) onset clusters produced (with [fw] and [sn]) and four final nasal-stop clusters produced (as mismatches for singletons).

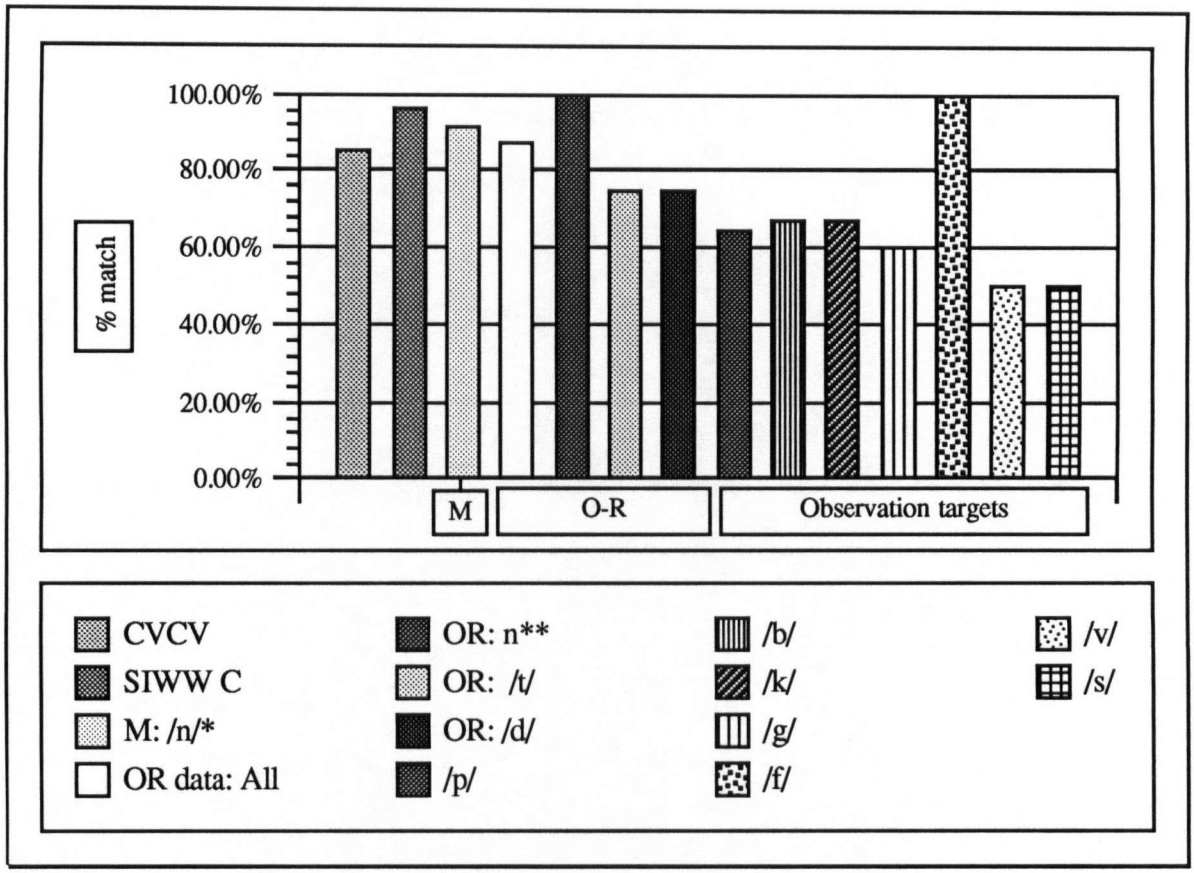
9. The 'complex' structure of affricates was realized 11/21 (52.38%) times, with the highest match noted for WF position (six out of nine instances). If the branching aspect of affricates is considered a prosodic phenomenon rather than a segmental one, the development of the branching structure might be attributed to the general gains in prosodic structure, which can be expressed in onset-rime terms as fundamental gains in branching at all levels.

Summary of Changes in the Syllabic System according to Moraic and Onset-Rime Theories

A. Moraic theory

In moraic terminology, the following developments took place during Block 1:

1. Single consonants were now fully licensed as second morae in syllables with lax vowels. Single consonants also appeared in equal proportions after tense vowels /i/ and /u/ and diphthongs, suggesting that vowel length was irrelevant or moraic development was not at issue, but rather final consonant adjunction. (Nasals and unvoiced obstruents produced in other word positions appeared as WF consonants. Consonants which were realized, but not as matching segments were (1) liquids -- produced as vowels, i.e., no [+consonantal] component, (2) /ŋ/, produced as [n], (3) affricates, produced as [+anterior], and (4) voiced obstruents, produced as [-voice].)



Note: There were no other matches.

Figure 5.5. S3: Proportional matches for SIWW (CVCV) targets in Block 1 major probe

2. At the word level, S3 produced one word with more than one foot (musicbox), showing capacity for change regarding the minimal word. More relevant to word development in this block, however, was development in complexity of the single foot. Word reduction to monosyllables was limited to 7/134 tokens, compared with 65/127 in the first block. Counting both vowels and syllable-final consonants (consonants not preceded by diphthongs) in multisyllabic child forms, 14/383 items had four morae in comparison with the two rote-type items in the assessment. The most complex word in moraic terms was a compound nine-clock [naɪnkʰakʰ] -- CVVC.CVC -- counted as having four morae plus an extra adjoined consonant in the first syllable. The most productive word shape with three morae was CV.CVC (30/52 trimoraic tokens). This was exactly double what was produced in the assessment, when trimoraic words numbered 26, with 15 of those ending in [s]. The [s] appeared to be a place-holder for the

final consonant, which was subsequently realized with a variety of segments. Development was predictable by increasing moraic complexity.

3. Singleton prevocalic consonants were in place all of the time, with the exception of the segmental targets /l/ and /h/. The five tokens of a second prevocalic consonant (two [s]/_[nVC] and three of [w]/[f_V] for /fl/) demonstrated a developing capacity for prevocalic complexity.

4. Postmoraic consonant adjunction (after the second mora) was no longer completely limited to items where the second mora was a vowel of a diphthong. There were four final consonant clusters (mismatches with singleton targets). This was interpreted as showing equivalence in development in pre- and postmoraic consonant adjunction.

B. Onset-rime terminology

In onset-rime terminology, the following developments took place in Block 1:

1. Branching at the level of the rime node itself became fully licensed, allowing single final consonant production.

2. Although word complexity was still limited to the single foot (with the one trisyllabic exception), a greater number of the O-R units of the foot were licensed for a second level of branching, the most common form showing rime node branching (e.g., CV.CV<u>C</u>). There were fourteen examples of words with a second level of branching within both O-R units (e.g., CV <u>V</u>.CV<u>C</u>, CV <u>V</u>.CV<u>V</u>, and CV<u>C</u>.CV<u>C</u>), and one example of double branching within one half of a foot with two branching units (CV<u>VC</u>.CV<u>C</u>). Progress is as would be predicted by developing capacity for branching.

3. With the exception of segmental targets /l/ and /h/, singleton onsets were fully realized. Glottal stops continued to appear in place of missing initial target phonemes. Onsets also became licensed for branching, as the five examples of initial clusters show. The previously omitted /s/ appeared twice before /n/ and the governed member of the /fl/ ([w]) appeared 3/16 times. The [w] may have been a result of left-to-right intraconstituent Labial Place spreading to an underspecified cluster position within the onset constituent, as would be predicted by Kaye et al. (1987). The /s/ of /sn/ may have been facilitated by sharing of Place features with /n/, although,

if a case of spreading, then the direction of spreading is opposite to predictions of Kaye et al. (1987).

4. A further development within the rime was rime node branching simultaneously with nucleus branching ((C)V VC), although this was still limited mainly to monosyllables (upper limit on branching to three branches except for 3/22 tokens). The branching terminology seems useful in describing development at this level.

Moraic Subblock

1. SIWW /n/ following lax vowels

In the major probe, 22/24 (91.67%) targets matched. Because contrasting methods were used with the same phoneme, however, this success may have been a result of the interaction of the methods. Therefore, session data was also examined. (See figure 5.6.) Over the two project-initial therapy sessions with /n/, combined echoic and spontaneous $C_1V[n]V$ responses matched 29/41 times (70.73%). More success was noted for spontaneous responses (13/15 matches = 86.67% compared with 16/26 imitative matches = 61.54%), suggesting that once a word was learned through imitation and auditory bombardment, it could be produced without models, whether or not the model represented any kind of psychological reality with respect to the underlying representations. Most frequent imitation errors were for the word Minnie and were place assimilation of the two consonants to the C_1 or dissimilation with loss of nasality in C_1. There was also some difficulty with imitation of the CVC stimulus across words (loss of C_2 or use of [s] or assimilation).

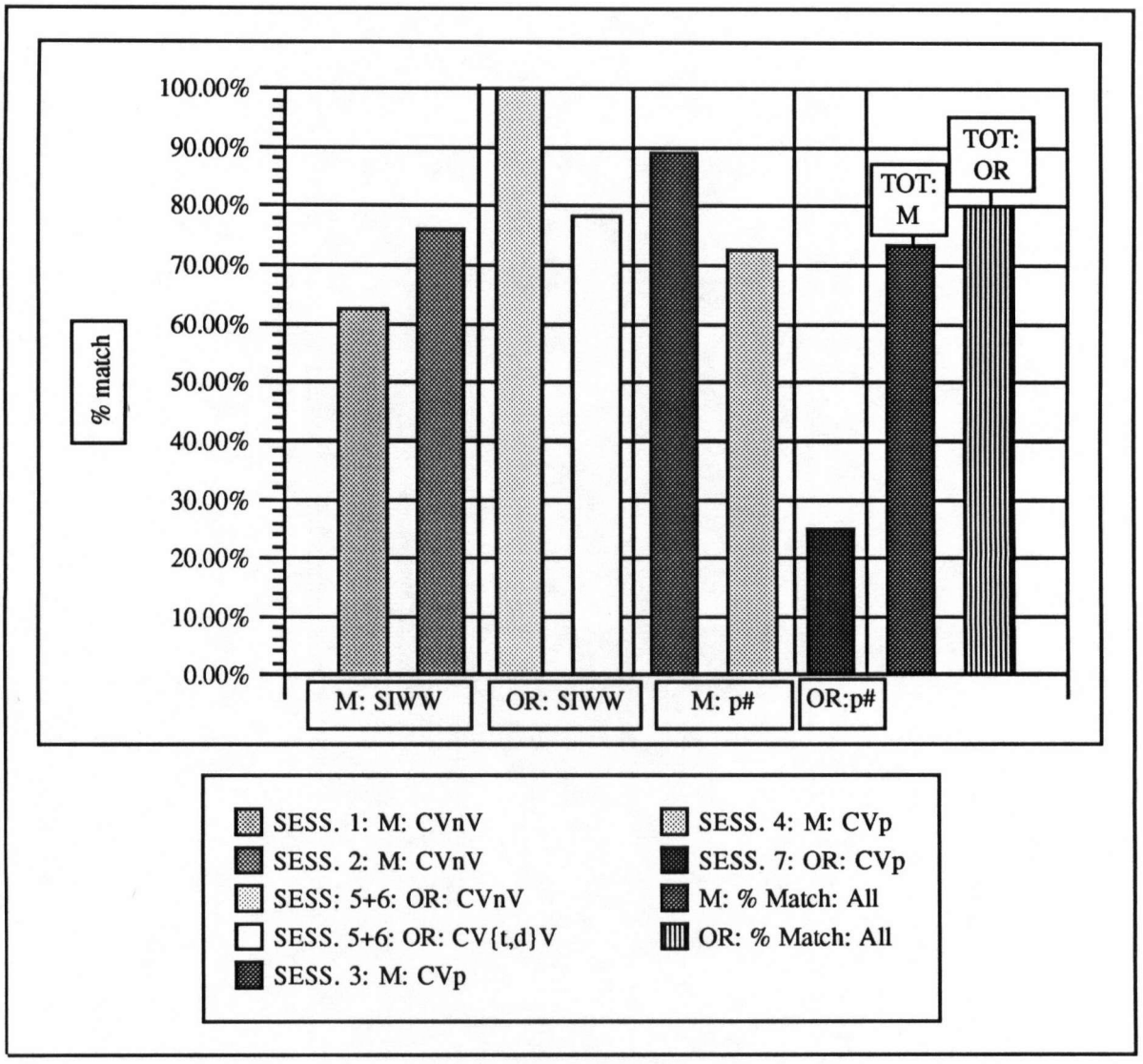


Figure 5.6. S3: Proportional matches for syllabic targets in Block 1 sessions

Moraic Subblock (continued)

2. WF /p/

In the major probe, 14/14 WF /p/ targets were met. Since both methods of constituent presentation were used for this target, the session data were examined. Over both /p/ sessions, there were 56/75 (74.67%) matches for CV[p], equally distributed across echoic and spontaneous responses (75% and 73.91% respectively). S3 easily imitated [CV:] (with a prolonged vowel), then adding a [p], often with a visual or motor cue. This was an effective means of avoiding consonant place assimilations and [s] adjunction. By prolonging the vowel, the final consonant was being adjoined initially to a bimoraic (or multimoraic) [VV::] unit, which, with increased speed

of production, reduced to a VC bimoraic unit. By commencing with a separate CV unit, regressive assimilation from the [p] to the prevocalic slot was avoided. The lack of assimilation also suggests that the [p] was outside of the syllable (extrametrical) until the word was learned.

Onset-Rime Subblock

1. /n/ following tense vowels or diphthongs

In the major probe, 12/12 SIWW /n/ with tense vowels or diphthongs matched the adult targets. In the session data, 29/29 items matched the targets.

2. SIWW /t/ and /d/

In the major probe, generalization results were identical for these two targets (75%), suggesting that the phonetic target [ɾ] was identified as a form common to both. The combined success for these targets in the session data was 78.38% matches (58/74). In other words, there was a similarity between both the /n/ and the /t,d/ targets between session data and generalization probe data. The better results for /n/ perhaps point to a learning effect from the moraic condition to the onset-rime condition. If the condition itself had been responsible for easier access, either because of lack of need for mora deletion or because of generally greater ease with open syllables, one would have expected both sets of onset-rime targets to match at a higher percentage level than the /n/ targets with lax vowels.

3. WF /p/

Success rate was 25% for the onset-rime session data (2/8 items). The low number of trials and low success rate reflect the child's lack of willingness to attempt the (possibly unnatural) C - VC targets. When he tried to imitate either the VC or the entire CVC, regression assimilation resulted. For example, S3 first imitated E's model --[t^{hh} (PAUSE) æp] -- as [t^{h}][pæp]. Once he correctly imitated the separate units, he imitated E's model [t^{h}æp] as [p^{h}æp]. There was an obvious difference between the moraic and onset-rime conditions in imitation capacity (whether articulatorily or psychologically based).

Comparison of the Moraic and Onset-Rime Conditions

In the treatment sessions, S3 had a greater match proportion for CVCV in the onset-rime condition (84.47% to 70.73%) and CVC in the moraic condition (74.67% to 25%). In both conditions, the basic unit was a CVV (i.e., a consonant with a diphthong or long vowel, either underlyingly or by exaggerated presentation), it appears that the default basic bimoraic constituent was the relevant minimal unit onto which other units could be added.

Segmental Goals

Higher Level Feature Subblock

Target: /h/ -- Root node specification of [+consonantal]??; Laryngeal node specification of [+spread glottis]

S3's data showed a 22.2% proportional gain in matches for WI /h/ to 6/19 (31.8%) matches (see figure 5.7).

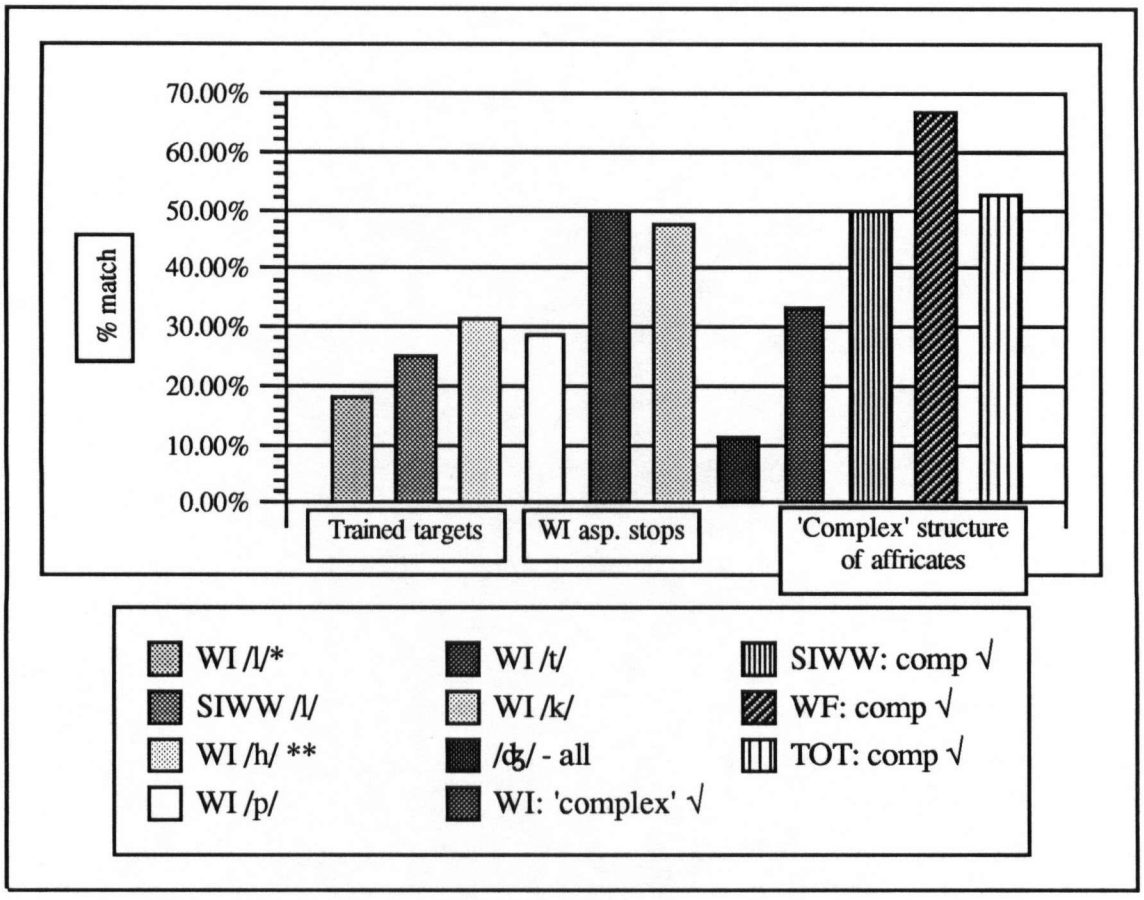
Lower Level Feature Subblock:

Target: /l/ -- Root node marking of [+consonantal] with [+sonorant]; default Place node

As on the Initial Assessment probe, S3 produced two matching tokens of /l/. The slight proportional gain in matches (4.85%) was spurious, as there were fewer total tokens (11 rather than the thirteen of the Initial Assessment probe). All nonmatches for //l/ were [ʔ], which could be looked upon as an progressive rather than retrograde step, in that the default glide [w] was no longer in use as a substitution. Whether a phonemic substitution or a phonetic default, the [ʔ] is unspecified for Place node. The second block feature specification goals for /l/ then became Root node features [+consonantal]/[+sonorant], with place being predictable as Coronal, once those features are jointly specified.

Comparison of the Higher and Lower Level Features

Assuming that Place node is lower than Laryngeal node, and that the focus for development of /l/ in Block 1 was accurately portrayed as blocking of default glide [w], the prediction that the higher level feature(s) of /h/ would be more rapidly acquired was borne out at this initial stage of intervention.



Note: There were no other matches.

Figure 5.7. S3: Proportional matches for trained and untrained segmental targets in Block 1 major probe

Other Feature Changes for the Overall Segmental Data

Changes other than those discussed above under syllabic or segmental results are listed here in terms of the feature hierarchy. Where training may have influenced the change indirectly, comments to that effect are made. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

A. Unspecified child forms where adult targets are specified

1. Laryngeal node: There was an increase in use of aspiration on WI /k/ and /t/ (i.e., [k^h] and [t^h]) and a slight decrease (3%) for /p/. This possibly supports the notion of development for a

feature [+spread glottis] generalizing from work on /h/, if the specification of a phonemic feature has relevance for allophonic development. (The decrease on WI /p/ may be a reflection of the work on WF /p/, which, unlike WI singleton /p/, is unaspirated, or it may be spurious.) **

2. The appearance of affricates (with their 'complex' structure) was a new development. This may have been another aspect of the changes in syllable shape, i.e., a structural change -- one fine level of branching. (The Coronal node feature [-anterior] was as yet unspecified for the alveopalatals.) **

Areas of No Change in Feature Specification

1. Laryngeal node: [+voice] was unspecified for WF voiced obstruents except for one token each of /v/ and /d/.

2. Root node: [+continuant] was unspecified for WI Coronal fricatives.

3. Feature spreading (place assimilation) or segment movement (metathesis) continued to accommodate syllabic constraints and underspecification of segments, usually in the stop category.

4. Place node: Dorsal Place was still unspecified for /ŋ/.

5. Coronal node: Coronal node terminal features were not yet established.

Intervention Plan: Block 2

Syllabic Intervention Plan

Since both basic and more complex word shapes were in use at this point, syllable development for Block 2 involved refinement as opposed to radical change. Initial cluster development was one "pure" syllabic goal. The other goals chosen for syllable development involved tier interaction. It was apparent that the CVC word shape was presenting some difficulty in terms of interaction between the syllabic and segmental tiers, as demonstrated by the assimilations and dissimilations between WI and WF stops. A further tier interaction problem was the constraint against [+continuant] in WI position for coronals. The goals, then, were:

1. To establish WI clusters, beginning with /s/-clusters

2. To strengthen the specification of C_1 position by: (1) eliminating the assimilations and dissimilations occurring in CVC word shapes among the stops, and (2) establishing the feature [+continuant] in WI position for coronals.

Moraic Subblock

Targets: 1. Anti-place assimilation/dissimilation: C_1VC_2: C_1 = Dorsal, C_2 = Coronal (two sessions)

2. Specification of [+continuant] in WI position for coronal obstruents -- /#sVV(C)/ words with long vowels or diphthongs and optional WF consonants

3. WI /sp/, /sw/ (two sessions for the second and third goals)

Onset-Rime Subblock

Targets: 1. Anti-place assimilation/dissimilation: C_1VC_2: C_1 = Coronal, C_2 = Dorsal (two sessions)

2. Specification of [+continuant] in WI position for coronal obstruents: /#s-VC/ words with lax vowels and obligatory final consonants

3. WI /st/, /sn/ (two sessions for the second and third goals)

Rationale

Because alternate targets were chosen for the two conditions, the rationale is discussed for both as a unit. The parallels and contrasts which occurred as a result of the targets chosen and the techniques used were as follows:

1. For C_1 strengthening:

Moraic condition stimuli were WI [{k^h,g}V::] followed by WF [t], i.e., [k^hæ :: t^h]. Onset-rime condition stimuli were onsets [{t^{hh},$_v$d}] ([t] with exaggerated aspiration or prevoiced [d], followed by the rime [Vk], i.e., [t^{hh}: ɑk]. In both cases the Dorsal Place consonants were 'attached' to vowels, whereas the (underspecified) coronal stop was presented separately. This parallel between conditions reduced segmental confounding. If one set of C_1VC_2 targets was more successful, either the *syllable position* for the segment or the techniques under observation were

predicted to be responsible. No labial stops were used, in order to test for generalization of this goal.

2. For [+continuant] specification of WI coronals:

As none of the other coronal fricatives were established postvocalically, /s/ was the sibilant of choice for WI position. This choice was made with some trepidation, considering the overgeneralization which had occurred word finally. The directly opposite set of vowels was used from what was used in Block 1 for the two conditions. This was because the object of the task was not to develop morae or branching but to focus on the prevocalic consonant (or onset). In order to do this, the /#sV(V)/ unit had to be able to 'stand alone' easily in the moraic condition, and the VC unit had to 'stand alone' in the onset-rime condition. This led to the use of (long) vowels or diphthongs for moraic targets and lax vowels for onset-rime targets. (It was not completely necessary to choose lax vowels for onset-rime targets since VVC can also 'stand alone', but it did allow for an extra difference between conditions.)

3. For /s/-clusters:

Although /w/-clusters were possible targets, /s/-clusters were chosen in order to compare acquisition of [+continuant] prevocalically versus preconsonantally. The three clusters not chosen were /sl/, /sk/, and /sm/, the former because /l/ was not established, the /sk/ because /k/ was occasionally [t] prevocalically (before high front vowels) and the /sm/, because there were few word choices as training and probe items. Place was consistent within the condition (i.e., Labial C_2 for moraic targets, and Coronal for onset-rime targets). In each condition, one target had an extrametrical /s/ preceding an oral stop, i.e., moraic target /sp/ and onset-rime target /st/. The second /s/-cluster target in each condition had an /s/ within the 'onset' -- moraic target /sw/ and onset-rime target /sn/ (Kiparsky 1979).

Segmental Intervention Plan

Because neither of the targets from Block 1 had sufficiently generalized, they were retargeted in Block 2. Because of the loss of the [w] substitution for /l/, /h/ may not have been the segment with higher level target features at this point. Both required Root node specification for [+consonantal], with the extra specification for /l/ being another Root node feature

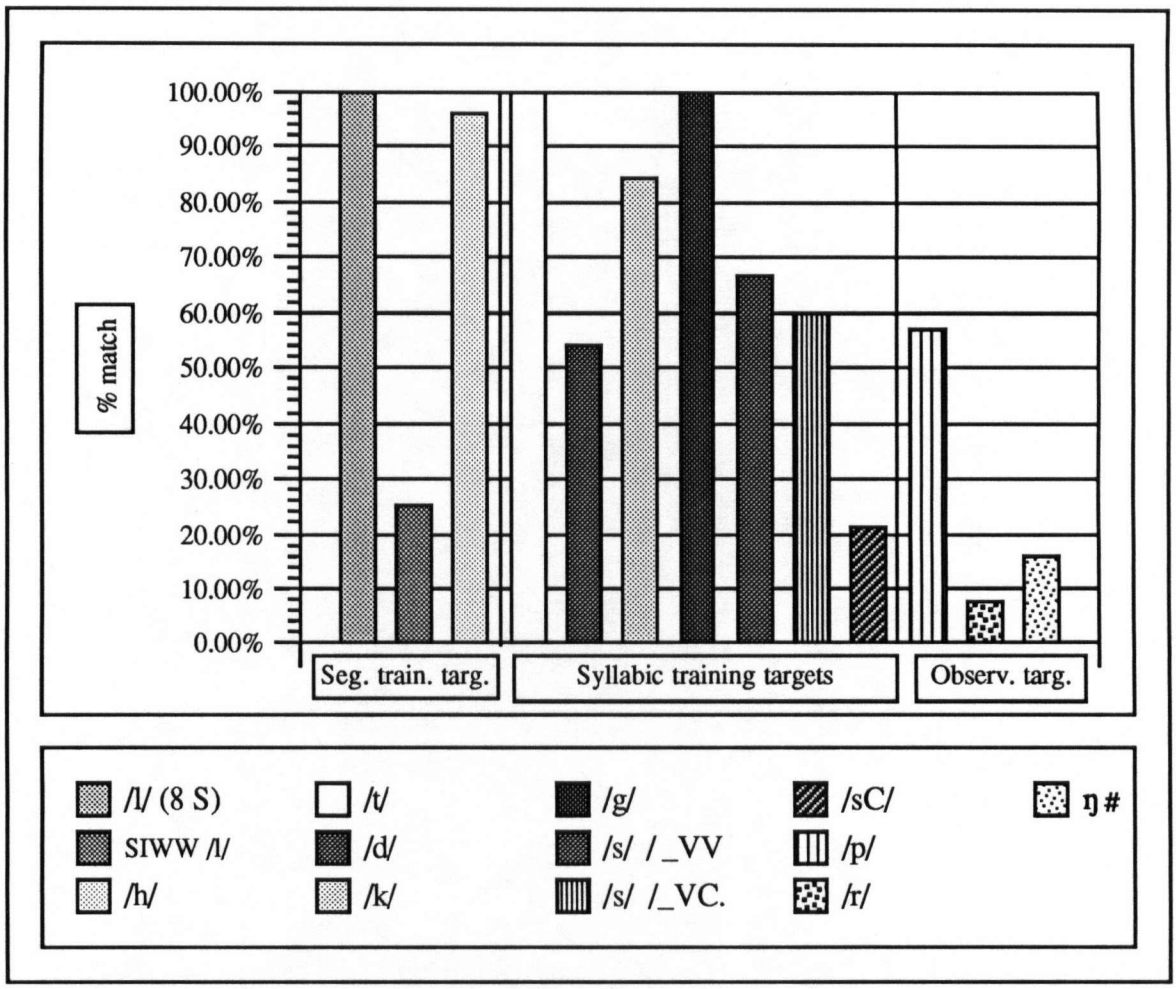
[+sonorant], and the extra specification for /h/ being the lower level [+spread glottis] feature. (As stated at the end of the rationale for targets for Block 1, it is possible that markedness assumptions might take precedence over feature height for prediction of emergence of segmentss, in that the conjunct specification of [+consonantal]/[+sonorant], default Place node could be construed as more marked, and therefore, more likely to be slower in emergence than the specification of a single feature [+consonantal] with the Laryngeal node feature [+spread glottis].) The subcondition order was not changed, however, in order to maintain consistency in order of presentation of segments. Ambiguity with respect to feature height is acknowledged for this subject.

Results of Block 2 Intervention

General Results

In Block 2, S3 gained conversational proficiency with segmental targets SI /l/ and /h/. Although cluster and WI sibiliant use increased and CVC assimilations and dissimilations decreased, syllabic targets did not reach conversational proficiency level (see figures 5.8 and 5.9 and appendix 4, table 3.2).

Average gains for syllabic and segmental targets were equivalent, the trained syllabic targets showing a 37.11% gain (*SD*: 41.03%) and the trained segmental targets, a 36.56% gain (*SD*: 42.81%). For untrained segmental targets, there was no change for alveopalatals, but /r/ and /ŋ/ did appear (one /r/ match, and four /ŋ/ matches). For untrained segmental targets, this represented an average gain of 18.32% (*SD*: 13.67%), alveopalatals being counted as one unit .



Note: There were no other WI matches.

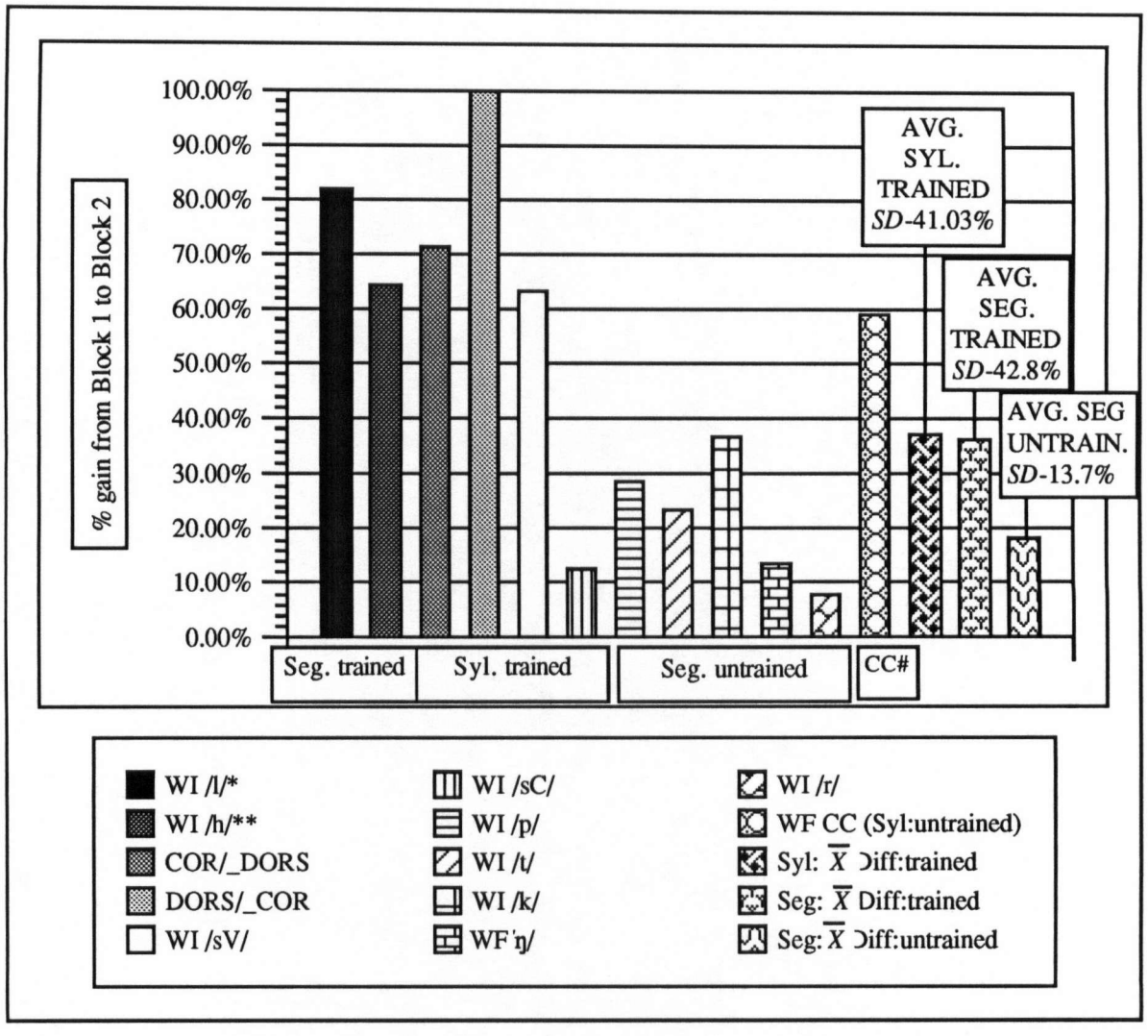
Figure 5.8. S3: Proportional matches for syllabic and segmental targets (WI unless otherwise indicated) in Block 2 major probe

Syllabic Goals

Moraic Subblock

1. Anti-assimilation/dissimilation: C_1VC_2: C_1 = Dorsal, C_2 = Coronal

There were two cases of assimilation to Coronal for /k/ in the Block 2 major probe, but these involved multisyllabic words with regressive reduplication. No cases of C_2 spread to C_1 were noted for CVC. Since the session data showed only 60.61% success for these targets over the two sessions, generalization occurred after the period of initial intervention. (S3 imitated the separate CV and C stimuli accurately on the second day of practice.)



Note: There were no other matches.
*There was no gain in matches for SIWW /l/.
**There were no matches for SIWW /h/.

Figure 5.9. S3: Proportional gain in matches for syllabic and segmental targets between Block 1 and Block 2 major probes

Moraic Subblock (continued)

2. Specification of [+continuant] in WI position for coronal obstruents -- /#sVV(C)/

In the major probe, two of the three tokens matched the adult target. The session data had 10/21 echoic matches for #sVV(C) targets (45.45%). At the beginning of the subblock, S3 had difficulty articulating [sVV]. Whisper (i.e., with voiceless vowels) and breathy onset were used to inhibit the glottal stop insertion. All sessions responses are echoic, since he was unable to produce an unassisted response of that type at the time.

3. WI /sp/, /sw/

These clusters did no appear in the major probe. In the session data, S3 had initial success imitating the [sp] stimuli (28/33 = 84.85%), and difficulty imitating the [sw] stimuli (5/12 = 41.67%). The adjunction of a separate [s] may have been more natural before [p] than before [w], since /s/ is purportedly extrametrical before /p/. However, in the review session (which followed a session of O-R training with /st/ and /sn/), the reverse was true. Only 66.67% of the /sp/ responses matched (two of six matches were spontaneous, however), and both /sw/ responses matched. One of the latter -- swim -- had been particularly difficult the week before, with variable pronunciations including [mɪm]. Since he was swimming every day during that period, he had opportunity to hear and practise that word. This "real-life" fact in combination with the onset-rime training for the other clusters focusing on the onset as a unit separate from the rime, may have facilitated imitation of [sw], with its sonorant second component.

Onset-Rime Subblock

1. Anti-place assimilation/dissimilation: C_1VC_2: C_1 = Coronal, C_2 = Dorsal

There were no instances of Dorsal assimilation for /t/ in the major probe, although there were two instances for /d/. The session data revealed only 33.33% success for C_1VC_2 imitation, with particular difficulty with the voiced cognate. This is not surprising, since it is easier to maintain articulation of [t^{hh}] than [$_{v}$d]. In spite of the low success rate in the sessions, the tendency for assimilation decreased through generalization across the block. In fact, in the week intervening between the major probe and Block 3, he mastered these forms.

2. Specification of [+continuant] in WI position for coronal obstruents -- /#s-VC/ words with lax vowels

In the major probe, three of five tokens (60%) matched the adult targets. This showed some improvement from the sessions, in which five of eleven tokens matched (all matches echoic). There was some overgeneralization of [s], as had been partly expected. The errors for WI /t/ and /d/ were not place assimilations, but reflected overgeneralization of [+continuant] among the coronals, sometimes resulting in a fricative and sometimes in an affricate.

3. WI /st/, /sn/

The only cluster which improved from Block 1 to Block 2 was /sn/. Since it was the only /s/-cluster which had any matches at the end of Block 1, it is unlikely that the training had an effect on the development. The matches that occurred during the sessions occurred spontaneously without prior training. The child found it difficult to pronounce [st] as a unit, although he did learn to do so. Errors in imitation included omission of [t] and omission of [s], the latter more in unelicited imitation. In the major probe, the /st/ was usually realized as [s], which was different from the [t/d] noted at the end of Block 1. There was a general (albeit temporary) confusion between /t/, /s/ and /st/ in WI position. Overlap in production was perhaps a natural consequence of the degree of underspecification of these elements. Unfortunately, they were all targets in the onset-rime condition, possibly resulting in the generally weaker results for this condition. On the other hand, the opportunity to target each of them separately as onsets could have helped to demonstrate their difference more than it seemed to do.

Comparison of Moraic and Onset-Rime Condition Results

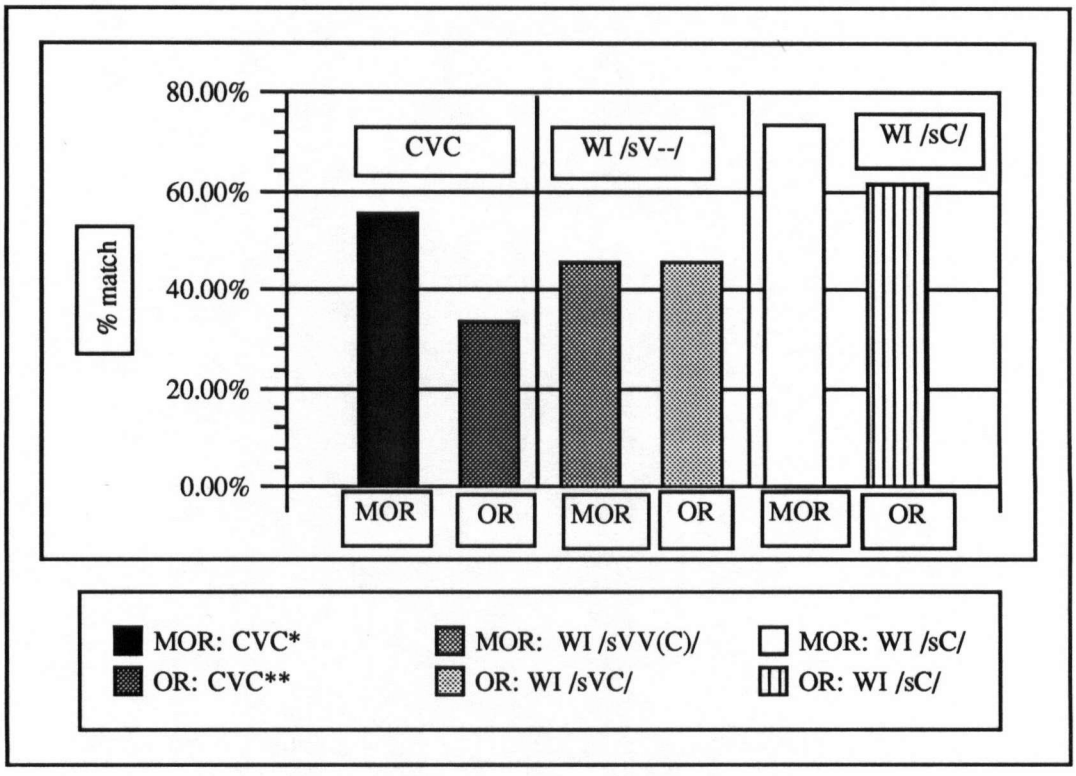
A. Anti-assimilation/dissimilation

According to the major probe and the session data, S3 appeared to acquire moraic CVC targets appeared faster than onset-rime targets (see figure 5.10). As was discussed in the preceding section, overlap among coronals probably contributed to the lower level of success for onset-rime targets. However, as in Block 1, Block 2 session data again suggested that it was easier to add a stop to a CV(V) constituent (as in the moraic condition) than to articulate a stop before a VC constituent.

B. /s/-clusters

For cluster targets, S3 had greater ease articulating an [s] before a stop-vowel unit (as per the moraic condition), than articulating an /s/-stop onset with a V(C) unit (as per the onset-rime condition). However, the initial difficulty with moraic target /sw/, followed by its ease of articulation after training of /st/- and /sn/-clusters as onset-rime targets, may suggest a superiority for onset-rime contsituent training for targets where /s/ is theoretically not extrametrical. It may

be more easily imitated as part of an onset unit. (The glide can be trained as a vocalic constituent, shortened, and converted into a consonantal constituent when followed by a true vowel.)



Note: Does not include data from the last review session of the subblock
*Dorsal__Coronal CVC targets
**Coronal__Dorsal CVC targets

Figure 5.10. S3: Proportional matches for syllabic targets in Block 2 sessions

Comparison (continued)

C. WI [+continuant] for coronal obstruents (WI /s/)

Results for the specification of [+continuant] for WI /s/ were the same (45.45%) for both conditions. This may reflect the fact that S3 needed to learn how to make a smooth phonetic transition of [s] to a following vowel, whatever the condition. It was difficult to train articulation of [sV(V)] without focusing on each constituent separately, although prolongation and whisper were used to encourage smooth transition from the [s] to the vowel in the moraic condition.

Segmental Goals

Both WI /l/ and WI /h/ were produced easily in conversation. A "catchup" effect was noted for WI /l/ (an 81.82% improvement from the Block 1 major probe compared with a 64.42% improvement for /h/). In SIWW position, there was little change for either target. Whether there was any effect from feature hierarchy position is unclear from the results, but this is unsurprising considering the ambiguity of relative height for their distinctive features.

Other Feature Changes for the Overall Segmental Data

Feature changes not discussed above under syllabic or segmental results are listed here in terms of the feature hierarchy. Where training may have influenced the change indirectly, comments to that effect are made. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

Unspecified child forms where adult targets are specified

1. Laryngeal node: More WI voiceless stops were aspirated, reflecting an increase in the number of items specified for [+spread glottis] for this allophonic pattern. *

2. Place node: Dorsal Place was now specified more frequently for /ŋ/. *

Areas of No Change in Feature Specification

1. Place node: Coronal node feature [-anterior] remained unspecified for the alveopalatals.

2. Laryngeal node: [+voice] continued to be unspecified for the majority of WF voiced obstruents.

(3. Place node: Coronal node feature [+distributed] was realized once for /r/, as at Initial Assessment.)

Block 3 and Beyond

In the third block, /s/ and /l/ clusters generalized through training. The coronal "confusion" was sorted out, and initial success with /r/ in imitation began. Six months later,

without phonological therapy, /r/ had generalized except for WI position (in singletons and clusters some of the time), although no development of alveopalatals had taken place. These remained unchanged for one and one-half years at which time they emerged spontaneously. His parents continue to help him with articulation of complex multisyllabic words. Language production skills are improving, although the child remains delayed in syntactic/morphological development.

Discussion

In terms of the research questions the following interpretations are offered.

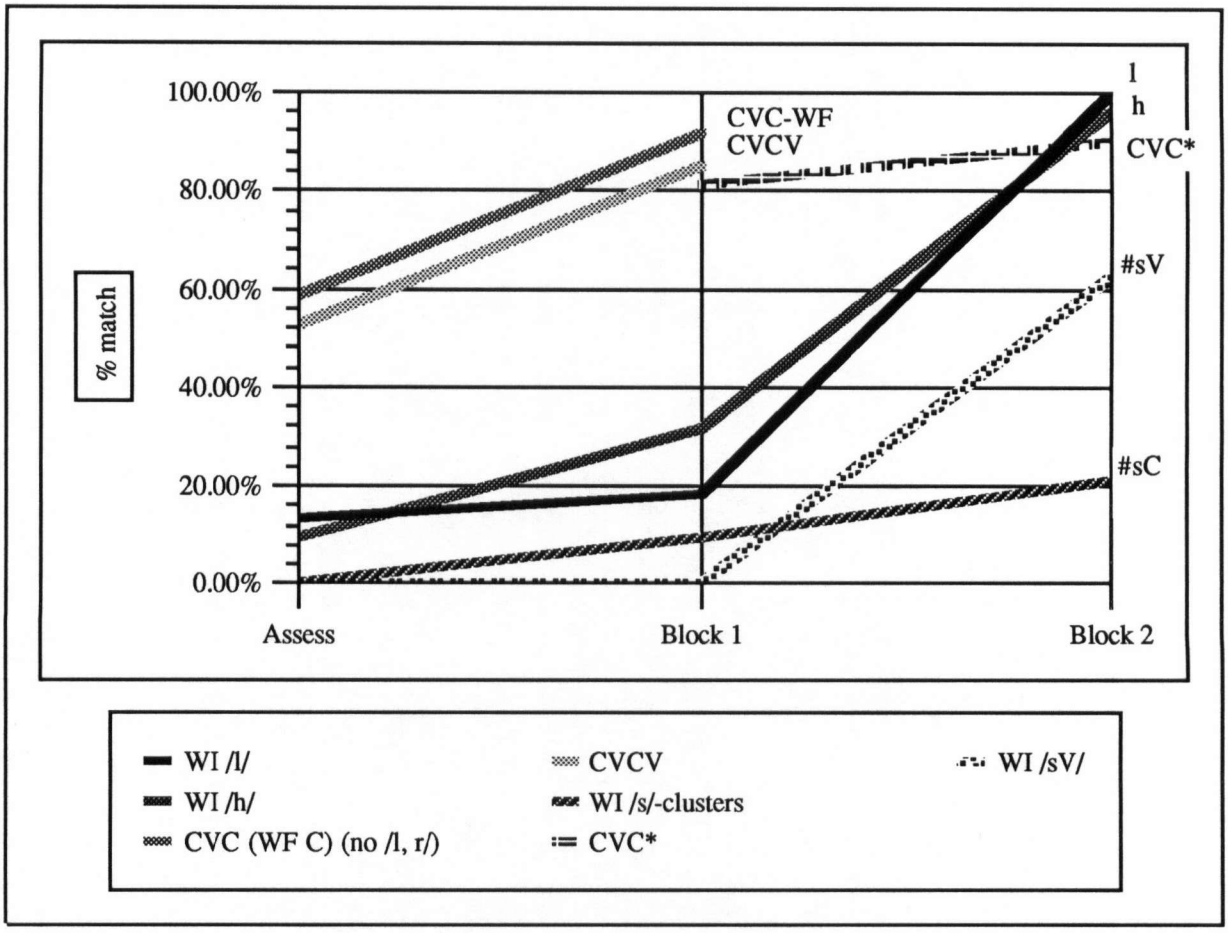
1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

As with the previous subjects, the nonlinear frameworks did lead to reasonable targets for intervention. The intervention project may have been successful for reasons other than the reasonable choice of targets, such as the intensive stimulation and the mutually enhancing effect of a variety of approaches. However, the generalizations noted below are a phonological indication that the chosen targets were relevant for inducing change in the system.

Conversational Intelligibility Gains

There was a rapid improvement in conversational intelligibility due to the attainment of conversational proficiency for a wide range of syllable/word shapes and predicted targets /l/, /h/, WI /s/ and C_1VC_2 (see figures 5.11 and 5.12).

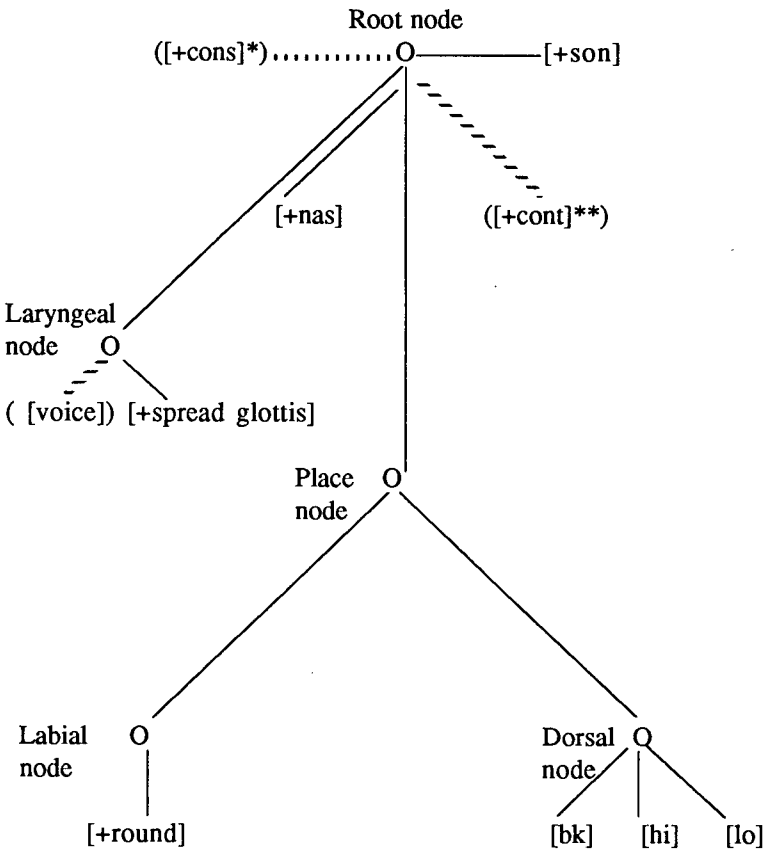
The changes in trained syllabic targets and the generalizations which occurred for other syllabic targets show results of training. In Block 1, untrained word shapes which generalized to conversation from the trained ones were CVC words with WF obstruents other than the trained WF /p/, C_1VC_2V words other than those trained with /n/, /t/, and /d/, and more complex word shapes built up from CVC and CVCV, such as CVCVC. Block 2 observation target -- labial stops-- appeared to benefit from the anti-assimilation/dissimilation training for the other stops, since there was no evidence of these phenomena for labials during the Block 2 major probe.



*Stop data in CVC word shape for anti-assimilation/dissimilation syllabic goal

Figure 5.11. S3: Devleopmental progression in proportional matches for trained phonolgocial targets across the intervention period

A possible generalization from WI /s/-cluster training (or a spontaneous development) in Block 2 was the appearance of WF clusters, particularly nasal-stop and stop-/s/ clusters. (The WF /s/-stop clusters did not appear at this time, suggesting that WF extrametrical stops may be more marked than WF extrametrical [s].)



Note: Parentheses and dotted lines indicate marginal features.
Specified features for Coronal Place were not yet established.
*[+cons] marginally established for /r/, otherwise established
**[+cont] established except for WI /s/ sometimes

Figure 5.11. S3: Feature geometry at end of Block 2

One segmental generalization to an untrained target set may have been a result of training, i.e., aspiration on WI voiceless stops -- [+spread glottis] specification from /h/ training (phonemic to allophonic specification). Development of branching structure for affricates was possibly a result of structural development from Block 1 syllabic training. Emergence of WF /ŋ/ showed interactive development of syllabic and segmental inventories. After establishment of WF /k/ as one of the CVC WF stop generalizations, extension of Dorsal Place to the nasal category, already established in CVC word shapes, resulted in /ŋ/.

In the therapy periods before and after the study, measures showed minimal changes for phonological development, lending support to the perception of the project's effectiveness.

Language Test Results

Changes in linguistic performance evident in language test results demonstrated the effects of phonological intervention. Because language comprehension test scores were within normal limits at the outset, assumptions of intact comprehension were made during treatment planning. At the end of Block 3, age-adjusted comprehension scores were essentially equivalent to the scores forwarded by the previous speech-language pathologist, supporting the original assumptions. S3's age score on the Auditory Comprehension portion of the Preschool Language Scale (1979) increased by seven months, exactly the number of months since the previous test. On the Peabody Picture Vocabulary Test (Form L), S3's standard score equivalent was 105, within the high average range, again equivalent to the slightly better than average age score from the Peabody Picture Vocabulary Test (Form M) previous test (3;11 at 3;3).

In contrast, there was a notable improvement in the Verbal Ability age score of the Preschool Language Scale, from 2;6 at age 3;3 to 3;7.15 at 3;10. The thirteen month gain in seven months in comparison with the even growth in comprehension did not appear to represent a general spurt in language production skills, however. Remaining areas of difficulty on the test were digit recall and sentence repetition, with improvements reflecting vocabulary and articulation development. This was expected considering the nature of phonological therapy, and suggests that the phonological changes were a result of phonological intervention, rather than general language stimulation.

There was a general increase in verb use, which resulted in the production of more simple sentences containing both NP and VP. This was in part of result of general development in language production, but may also be attributed to the phonological intervention, which utilized simple sentence patterning as part of the phonological therapy in the second and third blocks. However, syntactic/morphological development continued to be significantly below average. On the Structured Photographic Expressive Language Test-Preschool , S3's score was below the first percentile.

2. *Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real ?*

Differences between Syllabic and Segmental Conditions

At the end of the two blocks, there were quantitative differences between gains for the syllabic and segmental targets. At the end of Block 1, there was a clear gain in percentage and types of syllable and word shape matches in comparison with segmental targets, the latter of which had not generalized to conversation. The segmental targets introduced in Block 1 were not mastered until the end of Block 2 (which accounts for the noticeable difference between Block 1 and Block 2 for segmental targets). By contrast, rate of change was less for syllabic targets with /s/ than for either of the segmental targets (note slopes of lines in figure 5.11) in Block 2. Mastery of the syllabic targets of WI sibilant continuancy and clusters was achieved only during Block 3. Because of the difficulty noted with the (underspecified) coronals, some regressions were noted at the end of Block 2 for /t/,/d/ and /st/, while S3 gained mastery of WI coronal ([+anterior]) fricatives. As was noted for S1 and S2, syllabic targets took longer to master when segmental learning was required at the level of the coronal node.

With respect to phonological development and the autonomy of tiers, it appears that there is some independent development that can be exploited in intervention. For S3, syllabic changes were more dramatic at the outset and led to improved intelligibility within three weeks of the onset of intervention. The development of CVC and CVCV word shapes began prior to intervention.

Taking advantage of this beginning development led to immediate results. Segmental changes occurred at a slower rate (note the late development of /r/ and the alveoplalatals).

Interaction of the Syllabic and Segmental Tiers

S3's data do not support complete autonomy of tiers. Interaction of the syllabic and segmental tiers was relevant for S3's developmental process, as the following examples show:

1. At the outset, the default segment [*s*] was a 'place-holder' for the final consonant of the CV(V)C word shape, when there was no nasal in the postvocalic slot.

2. Generalization of CVC and other word shapes was according to feature spreading predictions (e.g., from WF /p/ to other unvoiced stops and /f/)

3. Place assimilations and dissimilations were present about 20% of the time after the CVC word shape was acquired, showing a general lack of specification of the consonant positions.

4. Learning to specify continuancy in WI sibilants (a syllabic goal) resulted in some "confusion" among the underspecified coronal obstruents and the /st/-cluster. Where two tiers interact negatively, as for the underspecified coronals, we might then expect a slower rate of change.

5. SF/l/ did not emerge with SI /l/.

6. WF clusters emerged more quickly than WI clusters. If, as moraic theory assumes, consonant adjunction accounts for pre- and postvocalic clusters, then S3's data suggest that postvocalic consonant adjunction may be 'easier' than preconsonantal adjunction. If WF and WI clusters are different in terms of constituency, as onset-rime theory assumes, WI clusters forming a constituent as an onset, and WF clusters being a result of adjunction within a larger constituent, one might predict different rates of emergence for the different structures. The structurally -based onset-rime theory explanation for differences in emergence rate perhaps enhances the theoretical soundness of that theory in this regard.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of intervention methods that contrast the onset and rime versus those that utilize the mora as a constituent?

Quantitative Comparisons of Moraic and Onset-Rime Conditions

Results were somewhat contradictory with respect to this question (see figures 5.6 and 5.10). Using 28 session data points and 11 major probe data points, a Kolmogorov-Smirnov measure was performed for proportional matches across the study to test the following null and alternative hypotheses (see table 5.5):

H_0: There will be no difference between the proportional match scores for all of the moraic (m) and onset-rime (n) measures across the study.

H_1: Moraic targets had proportionately higher proportional match scores across the study.

Table 5.5.--S3: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test

	0-10%	21-25%	31-35%	36-40%	46-50%	51-55%	56-60%	61-65%	66-70%	71-75%	81-85%	86-90%	90-95%	100%
s_m (x)	2/17	2/17	2/17	2/17	3/17	4/17	7/17	8/17	9/17	11/17	11/17	12/17	13/17	17/17
s_n (x)	2/22	4/22	6/22	7/22	8/22	8/22	10/22	11/22	12/22	14/22	15/22	16/22	16/22	22/22

$p > 0.1$

The largest discrepancy is 0.2, yielding a test statistic of (17)(22)(.2)=74.8, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed).[14]

Qualitative Comparisons of Moraic and Onset-Rime Conditions

Failure to reject the null hypothesis implies that conditions were equivalent. However, within the conditions there were some clinically notable occurrences which may bear on the theories in question.

For CVC targets, the moraic condition appeared to be more successful, whereas for CVCV targets, the onset-rime condition appeared to be more successful. With respect to /s/-clusters, success depended on prior acquisition and status of the /s/ with respect to extrametricality. Continuancy establishment for WI sibilants appeared equivalent across conditions, since in both

cases smooth transition between WI [s] and the following vowel was difficult. Discussion of these tendencies follows.

CVC Development

Clinically, the moraic condition appeared to be more successful for CVC development. Consonants were relatively easily adjoined to CV units when the vowel was prolonged (CV::--C). In Block 1, vowel lengthening appeared to assist correct imitation of CVC, since the default [*s*] would only surface in imitation of full CVC with short vowels. Once S3 could produce a CV::[p] without [*s*] insertion, rapid practice of CVC articulations resulted in vowel shortening. In a moraic interpretation of this situation, the [*s*] possibly represented the second mora (except in words with diphthongs, and perhaps tense vowels). By presenting a CV:: unit (with a prolonged vowel) as a stimulus for imitation, the second mora was definitively realized with a vowel. Given this bimoraic word structure (or multimoraic, if hyperlong vowels were used), a WF /p/ could be added by consonant adjunction. With rapid articulation practice, the vowel was shortened, resulting, it is surmised, in incorporation of a specified segment -- /p/ -- into the bimoraic syllable structure, obviating the need for production of the default [*s*]. (It is noteworthy that the last final cluster type to emerge (in Block 3) was the /sC/ type. Even after the [*s*] was no longer the final consonant default for CVC, it appeared to maintain that status as long as it was the first postvocalic consonant.)

Using onset-rime theory, one would have to posit temporary experimentally-induced branching at the level of the nucleus for the vowel lengthening, and then removal of the branching for vowel shortening. The [s] and the [p] would be in the same 'location' as consonants adjoined to the rime node. The moraic interpretation appears to have a greater explanatory power in this case.

Anti-Assimilation/Dissimilation

In Block 2, the moraic condition appeared to be more successful in inhibiting consonant assimilation and dissimilation during the sessions. The presentation of a CV unit followed by a consonant (moraic condition) resulted in ease of production for C_1VC_2 words. The onset-rime

condition results were probably confounded, however, by the use of underspecified coronal targets in that subblock.

C_1VC_2V Development

In Block 1, the onset-rime condition appeared to have better results for $C_1VVC_2V(V)$ words. The presentation of two separate O-R units -- CVV, CV(V) -- appeared to result in faster generalization of C_1VC_2V than the presentation of the moraic stimuli series -- C_1V[n] (PAUSE) C_2[i], C_1V[ni] -- where the first vowel was lax and mora deletion was necessary as a middle step (moraic condition). This may have reflected the primacy of the CV(V) unit, which could be equally designated as the universal O-R unit, or the universal minimal word (core syllable) in moraic terminology.

WI /s/-cluster Development

The session data for /s/-clusters appeared to indicate that the adjunction of [s] to a CV(C) unit (i.e., as in the moraic condition) was favored when the /s/ is theoretically extrametrical (as in /st, sp/), but is less favored when it is not (as for /sw/). This may indicate that various strategies are needed for development of /s/-clusters in intervention, depending on the status of /s/ in syllabic terms.

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

Trained Targets: Block 1

At the end of Block 1, there was a 22.2% proportional gain for WI /h/, whereas there was only a 4.85% improvement for /l/ (and no gain in absolute numbers of matches, i.e., two). It appeared that cooccurring specification of [+consonantal] and [+spread glottis] was easier than cooccurring specification of [+sonorant] and [+consonantal] plus Place node switching (from the "child default" *Labial* to the unspecified Coronal Place node). The Place node switch appeared to

take place during Block 1 for /l/, as no [w] substitutions appeared in that major probe. The feature hierarchy predictions appeared to be confirmed at the end of Block 1.

Trained Targets: Block 2

At the end of Block 2, both WI /l/ and WI /h/ had generalized to conversation, demonstrating an apparent "catch-up" effect for the /l/. If conjoint specification of [+consonantal] and [+sonorant] (along with an unspecified Place node) is more accessible than the cooccurring specification of the Root node feature [+consonantal] along with the Laryngeal node feature [+spread glottis], then the "catch-up" effect for /l/ may be explained with the feature hierarchy prediction of faster development of the higher level features.

The "catch-up" effect may, alternatively, indicate that the assumed difference in levels was false for S3 (as mentioned in the intervention plan sections). The fact that both had [ʔ] substitutions may have made meant that the critical features to establish for both were at the Root node [+consonantal] or [+consonantal]/[+sonorant]. Because of this fundamental specification need at the Root node level, other differences (a Laryngeal feature and a default Place node) may have been irrelevant. The need to specify this identical Root node feature for each (i.e., [+consonantal]) may have provided a mutually enhancing effect, resulting in their near simultaneous mastery, or may have given a "leading edge" to /h/ based on its less marked status of having only one of [consonantal] and [sonorant] as specified features (apparent in Block 1), but no further advantage.

Generalizations and Relevance of Features

The following generalizations for untrained targets related to the training targets support relevance of feature analysis:

1. Use of aspiration on voiceless initial stops became more common as /h/ progressed towards mastery -- possible generalization of [+spread glottis] from the phonemic to allophonic level.

2. After the acquisition of WF /k/, the WF dorsal nasal appeared.

3. There was overgeneralization of the /l/ to a few words with /j/ and /r/ (the other coronal sonorants).

4. From the syllabic condition training, development in the WF position showed predictable generalization from established [s] and trained /p/ to /f/, and from /p/ to other voiceless stops and affricates.

5. Similar feature generalization was noted for SIWW syllabic targets, from /t/ and /d/ to other stops, and from established /m/ and /p/ to /f/.

Summary

S3's phonological development accelerated as a result of the phonological intervention project. In the first three weeks of the study, he gained mastery of the basic word shapes of English. The Block 1 results showed a notably greater gain for syllabic than segmental targets. Even though his disorder had been characterized as more syllabic than segmental, it was not a prediction of that disorder type that proportional gains should have been greater for syllabic targets. (One might have expected the opposite, given the disorder type.)

By the end of the second block, he achieved conversational proficiency for segmental targets /h/ and /l/, use of some syllabic targets -- WI sibilants and WI dorsals, and untargeted WF clusters. By the end of Block 3, he consistently used targeted WI clusters and WI coronal obstruents. Each week, he learned to articulate some previously difficult word or words and used them immediately in conversation. A shy reticent child at the outset, he gradually gained confidence with oral communication, and, one year following the project, maintained a positive attitude towards the learning of complex multisyllabic words and new syntactic forms.

Although there were no significant quantitative differences between the onset-rime and moraic conditions, S3 had greater success with CVC word shapes in the moraic condition, and with CVCV word shapes in the onset-rime condition. There may have been confounding of the CVC onset-rime condition with use of underspecified coronals, and in the CVCV moraic condition with mora deletion, however.

The feature hierarchy prediction of faster acquisition for higher level features appeared to be borne out for development of /h/ versus /l/ in Block 1. The elimination of the [w] substitution for

/l/ at the end of Block 1 and its consistent replacement with [ʔ] was interpreted as a possible learning of the "inappropriateness" of *Labial* Place for /l/. At the end of Block 2, both segments were equally in use. The "catch-up" effect for /l/ may have been a result of it having higher level Root node feature specification requirements than /h/ in Block 2, or a result of simultaneous targeting of two segments with distinctive features above the level of the Place node.

Generalization of the segmental target [+spread glottis] from phonemic to allophonic levels and of CVC and CVCV word shape realizations within sound classes demonstrated general relevance of feature theory.

CHAPTER 6

SUBJECT 4: SUMMARY

[ən dæʔ]?

Case History Information

Subject Characteristics

During the reported period of the study, this boy was 3;6 - 3;10. (See table 6.1.) Associated with the phonological disorder was a general delay in language production. Comprehension appeared to be within normal limits, as did general cognitive and motor skills. At age 1;9 S4 started screaming to communicate anger and excitement. Generally, he did not imitate adults' speech. He became very frustrated by his inability to communicate and was prone to angry outbursts when adults failed to understand his communication attempts. A year and a half after the reported period, he continued to use gesture and drama to help make himself understood.

There were some family characteristics that bear on S4's communication disorder. The older brother (nine years senior) was enrolled in a class for children with learning difficulties, although he apparently had not had a language delay. Neither biological parent completed high school. Two cousins had communication disorders, one a severe language disorder. During S4's second year of life, the parents separated and during the project time, a stepfather was in the home.

S4's health was generally good. The birth record showed a slight delay in onset of breathing at birth (four seconds) as he was born with the cord around his neck. S4's medical and nonlinguistic developmental history otherwise appear normal.

Prior Treatment

S4 was identified at a local health unit as language and speech delayed at age 2;6. He was enrolled in a preschool for the purposes of general developmental stimulation at age 2;10.

Table 6.1.--Subject information for S4

AGE	3;6 - 3;10 for reported period
GENDER	Male
BIRTH ORDER	Second of two boys Older sibling (nine years senior) in class for children with learning difficulties
OTHER FAMILY HISTORY	English-speaking (Canadian-raised parents) Neither biological parent with high school graduation Two cousins with communication disorders (one severe language disorder) Parents separated in second year of S4's life Stepfather in home at time of project
HEARING	Screened within normal limits at 3;4
DEVELOPMENT	Age appropriate for gross motor skills and general cognitive skills Fine motor skills not assessed
MEDICAL HISTORY	Health good Born with cord around neck, breathed after four seconds delay Otherwise unremarkable birth/postnatal history
ORAL MECHANISM	Normal for speech production Stimulable for phones in isolation except /ʧ/ > [s^>], /l/ > [lj], /r/> [ʊ]
LANGUAGE SKILLS	Comprehension Auditory Comprehension Subtest of the Preschool Language Scale -- age score 3;3 at 3;4.15, i.e., average range Production 1. Verbal Ability Subtest of the Preschool Language Scale -- age score ~ 2;6 at 3;4, i.e., moderate-severe delay 2. Language sample: Restricted word, phrasal and sentence use; most common utterances single words ; longest utterance -- 4 morphemes 50% of connected speech utterances had [n̩] as a pivotal filler form at time of assessment ([n̩] still in occasional use at age 5;5) 3. Frequent use of gesture and dramatization to communicate
PREVIOUS THERAPY	Three sessions in the month prior to the study focusing on WF /p/ and /s/ with a different speech-language pathologist

In the month prior to this project, he received three direct speech therapy sessions at a local health unit to stimulate production of WF /p/ and /s/.

Phonological System at Initial Assessment

Phonotactics: Syllables and Words

Overview

Of the 404 words collected, over half (54.21%) were spontaneous utterances. Although monosyllables outnumbered multisyllables by a 2:1 ratio, 59/135 (44.24%) of the multisyllabic words were spontaneous, indicating that multisyllabic words were productive forms for the child.

Established Word Structures

Word structure matches were found for open monosyllables and disyllables in the following order:

1. $CV^{(v)}$: 21/40 (77.5%). The open monosyllable $C^{(c)}V^{(v)}$ accounted for 54.65% of all monosyllables. In a semirandom sample of 83 monosyllabic utterances with tense and lax vowels, 15/17 tense vowels were phonetically long, and 28/30 lax vowels had offglides, i.e., were phonetically long. There appeared to be some ambiguity metrically, since many vowels had onglides and offglides (both within words and at the word boundaries), these glides making the distinction between long and short difficult to ascertain. S4 also tended to lengthen vowels at the ends of words, which may have had a metrical or discourse basis, i.e., for emphasis. (A similar discourse feature was glottal 'fry' -- aperiodic voicing at low pitch and elevated loudness as a result of laryngeal tension -- which S4 used to emphasize his frustration during testing.)

2. CVCV: 18/32 (56.25%) -- 14 (reduplicated) tokens for mommy

3. VC: 6/12 (50%)

(4. VV (as diphthong): 1/2 [50%]. This example is too low in frequency to make a proper judgment.)

Developing Word Structures

Other structures demonstrated a system in the process of change. (For more detailed information about segmental realization within the context of the word structures see appendix 4, table 4.1.)

A. Monosyllabic targets

1. CVV (VV=diphthong): 12/27 (44.44%)
2. CVC (Overall, including [s/ʃ] and [p] as substitutions): 25/103 (24.27%)
3. CVC (Excluding final /l/ or /r/ targets): 25/86 (29.07%)
4. CVC (Including final /l/ and /r/ targets and excluding{[s/ʃ][p]} used for any final C except themselves): 17/103 matches (16.5%)

Of the 83 monosyllabic words in the semirandom sample, 36 were CVCs. Most of these contained lax vowels (32/36), about half of which were extended with offglides (14/32). The four instances of CVC with tense vowels did not have offglides or any obviously marked phonetic lengthening.

B. Multisyllabic targets

Overall, the majority of disyllabic child forms matched adult targets for number of syllables (104/117 = 88.89%). Also, 11/20 multisyllabic words were realized with two syllables. More complex word forms included seven trisyllabic words and one four-syllable mismatch ('banana'>[nædənænə] - Echoic) in the sample.

The predominant disyllabic child form was CVCV, with C_2 often a [z/ʒ] (18/79=22.78%). In spite of the differences in voicing and syllable position between the [z/ʒ] (SIWW) and the [s/ʃ] (WF) substitutions, they were probably related default (underspecified) substitutions in weakly established word positions. As default substitutions they were subject to phonetic tendencies that result in spread of voicing to intervocalic consonants, and devoicing of consonants word finally. There were single examples of more complex disyllabic forms, such as ^{c}CV.CVC ('choochoo' > [^{t}ʃʊʒʊʒ]), CVC.CV^{v}, CVV.CV(V), or CVV.CV^{v}[s]. The most complex trisyllabic form was CV.CV.CVC (musicbox > [mugibak] - Echoic).

Overall, the presence of consonants in realizations of multisyllabic targets demonstrated sufficient competence with SI position and a deficiency in SF position, as follows:

1. WI consonants: Present in all but 12 multisyllabic words (missing in only 10 monosyllabic targets)
2. SIWW consonants: Present in all but three multisyllabic words
3. WF consonants: Present in only 5/78 of the multisyllabic words
4. SFWW consonants: Present in only 5/44 of the items.

C. Diphthong development

As noted above for monosyllables, diphthongs were only partially established in open monosyllables, and tense vowels appeared phonetically short when followed by consonants (CVC, not CV:C). It is not surprising, then, that only 2/17 closed monosyllabic words (CVVC, VV=diphthong)were matches, i.e., bike > [baik] and noise > [nɔɛ^s] or that among multisyllabic words, only six tokens included diphthongs. Only one of the multisyllabic tokens partially matched an adult target -- [naᴵnɑɪ] for nigh'-night.

Undeveloped Structures

In general terms, the following were absent at the time of assessment:

1. Closed syllables in multisyllabic words (five tokens in sample)
2. Consonant clusters postvocalically or prevocalically.

(The single WI /kw/ cluster token -- quarter > [kˣwowɛᵊ] -- was apparently a marginal form, because it disappeared by the end of Block 1 -- [gɑʊwɛᴵ]).

Summary of the Syllabic System Components in Moraic and Onset-Rime Terminology

A. Established structures according to moraic theory

Vowels in open syllables were often lengthened, suggesting that a type of bimoraic word was fundamental in the system, possibly a default 'minimal' word as suggested by McCarthy and Prince (1986), available from UG. Premoraic single consonant adjunction was apparent most of the time, but there were words with no consonantal or glottal onsets (in cases where segments were undeveloped -- see segmental section), suggesting that CV is not an obligatory default.

B. Developing structures according to moraic theory

1. In monosyllabic words, the second mora was realized less often when it was either the second half of a diphthong or a consonant (CVV: $V_2 = M_2$, 44.44%; CVC: $C_2=M_2$, 24.27%, including both tense and lax vowels, since tense vowels appeared to be phonetically short in CVC words). With respect to the consonantal mora, there was a tendency for use of overgeneralized [s] and [p] (recent therapy targets) but also some tokens of [k] and [m] (in mom).

2. A prevocalic consonant could be adjoined to the mora in the second syllable. There were segmental limitations on which consonants appeared: those identical to C_1, dorsals, or a default voiced sibilant substitution ([z/ʒ]). This set patterns with which consonants appeared postvocalically in CVC words and suggests that reduction in complexity at the segmental level (by use of defaults or reduplicated forms) facilitates development at the syllabic level.

3. In the case of most (C)VCV (vowels tense or lax), a single branching foot was licensed (or, in the case of halftime, two degenerate stressed feet). The most common word form was one foot in length (either 'degenerate' or branching), again reflecting a possible UG default (McCarthy and Prince's [1986] 'minimal' bimoraic word). Words of more than one foot were possible (maximum = 2 feet per word), but these constituted only marginal developments. Whether vowels or consonants were counted as morae, the maximum number of morae per word was four. The four maximal exemplars were (C)VV.CVV, CV.CV.CVC , CV.CV.CV.CV, and CVV.CV^{v}s (VV=diphthong).

4. Postmoraic consonant adjunction (after the second mora) occurred only in two CVVC (VV=diphthong) words and was thus only a very marginal development.

C. Undeveloped structures according to moraic theory

The primary absences were final and initial clusters. As for S3, the lack of edge consonants (by adjunction) appeared to be an equivalency in the system and well expressed as such in moraic theory.

A. Established structures according to onset-rime theory

In onset-rime terminology, the basic onset-rime branch had been established with CV$^{(v)}$, again a possible UG default. Branching at the foot level was licensed when there were identical

onsets segmentally, or when the second onset was a dorsal consonant or the default voiced sibilant (not always underlyingly [+voice]).

B. Developing structures according to onset-rime theory

In onset-rime terminology, the following developments were taking place at the time of assessment:

1. Branching at the level of the rime node was developing, licensing single final consonant production (24.27% of the time).

2. Branching at the level of the nucleus was developing, licensing phonemic diphthong realization less than 50% of the time in monosyllables and rarely in multisyllabic words.

3. Although word complexity was limited primarily to the single foot, words of more than one foot were present (21 in total) (e.g., musicbox, banana, each had three O-R units).

4. In either of the O-R units of a foot, a second level of branching was allowed in a few cases, either at the level of the rime node (e.g., V.CV[u]), or of the nucleus (CV V.CV). Only twice was this observed within both O-R units (i.e., a very marginal development).

5. There was marginal "allowance" of two branches within the rime, at the level of the rime node itself, simultaneously with branching at the level of the nucleus (V VC)

C. Undeveloped structures according to onset-rime theory

In onset-rime terminology, there was an absence of:

1. Branching onsets

2. Consonant adjunction to the rime node subsequent to a primary N-C branching of the rime

Segmental Development

Segmental Matches

Table 6.2 and figures 6.1-6.4 show the segmental realizations for the prosodic structure outlined above.

Match data revealed the following:

1. Vowel mismatches were noted to cause some minor intelligibility problems, but were not considered to be as much of a priority as consonants for intervention in Block 1. Hence, they were not analyzed at the time of assessment. (There was some variability between low and front-mid vowels). The lack of diphthongs as noted above (section C of developing word structures) was considered a more serious intelligibility problem. Thus diphthongs were to be reviewed at the next major probe and, if still a concern, analyzed and targeted.

2. Sound class establishment for consonants varied across syllable position. In WI position, reasonably well-established sound classes were (in descending order) nasals > glides > stops (including affricates). The marginal status of the nondistinctive [+spread glottis] feature for initial voiceless stops contributed to the lesser-established position of the stop category with respect to the nasals.

In WF position, the establishment of sound classes was more limited. The descending order of classes was stops (voiceless only) > fricatives (voiceless sibilants only) > nasals (/m/ only).

Specific segments that were adequately (although not completely) established across word positions were /k/ and /w/. The analysis showed some overuse of the recently trained [*p*] and [*s/ʃ*] word finally, and [*z/ʒ*] in SIWW position.

3. The order of Place node establishment (most to least) was Labial > Dorsal (for consonants) > Coronal.

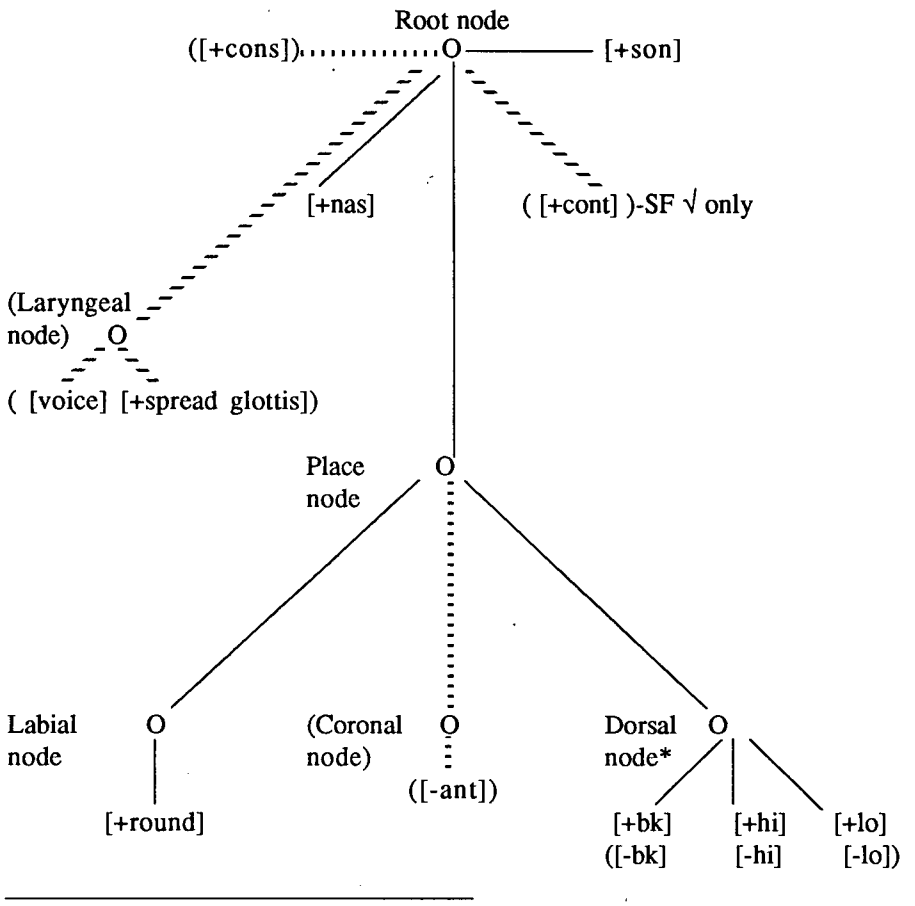
4. The order of match data across word positions (excluding the undeveloped clusters) was WI position (61.46%) > SIWW (36.81%) > WF (18.3%) > SFWW (11.36%).

Table 6.4.--S4: Summary of singleton segmental acquisition at Initial Assessment

Sound class	Word position matches	Word position nonmatches	Main feature differences
Vowels	Singleton vowels	Diphthongs	/VV/ > [V] (VV=diphthong)
Glides -- /w, j/	/w/: WI, (SIWW)[1] /j/: (WI)	/j/: SIWW	SIWW: [z/ʒ] substitution
Nasals	WI /m/: SIWW /n/ : (SIWW)	/m,n,ŋ/: SFWW /m/: (WF) /n,ŋ/: WF	R:Ø
Stops [-voice]	/p/: WF, (SFWW) /t,k/: (WI) /k/ : (SIWW, SFWW, WF)	/p/: (WI), (SIWW) /t/: ((SIWW, WF))	WI: LN: [+spr gl] u or ([+*voice*] **m*)[2] SIWW: /k/:LN: [+*voice*] **m* SIWW /p, t/: R: Ø, [z] WF: R:Ø (WF /k/: Metath. or assim. to coronal onset of σ)
Stops [+voice]	/b,g/: WI /d/: (WI) /g/: SIWW /b/: (SIWW)	/d/: (SIWW) All: WF, SFWW	SIWW: R:ø; [ʒ] WF: /b,d,g/-- LN:[+voice] u or /d/ -- R: Ø or /g/ -- [gi] SFWW: R: Ø
Fric/Affricates	/ʤ/: (WI) /z/: (SIWW) /s/: (WF)	/ʧ/: (WI) /ʃ/: (WF) All others	WI / ð,ʧ, ʤ/: R: [+cont u] Other WI: R: Ø or LN default : [h] or [ʔ] SIWW: R:Ø or [z/ʒ] SFWW: R: Ø WF: R:Ø or [s/ʃ] /ʃ,s/: Imprecise [ant] place
Liquids	None	One token each of SIWW /l/ and WI /r/. Some lateral coloring of [j]	/r/: WI: *Lab* for Cor /l/: WI: R: Ø or LN: default [h] or [ʔ] /l/: SIWW: R: ø /r/: SIWW: R:Ø, [z] SFWW: R: Ø WF: R: [+cons] u or R: ø
/h /		(WI)	LN: [+spr gl] u

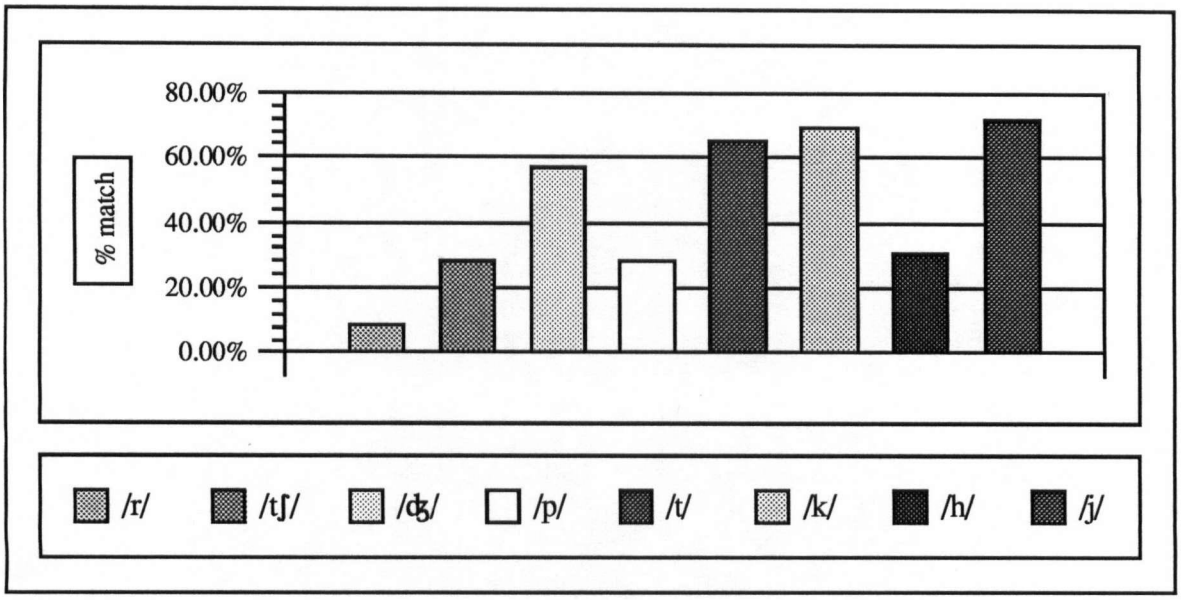
[1]Single parentheses indicate partial establishment: 40% - 80% in the Matches column; 10% - 40% in the Nonmatches column. Double parentheses indicate marginal development -- less than 10%.

[2]u= unspecified; *italics*, **m* = specified inappropriately according to appendix 2



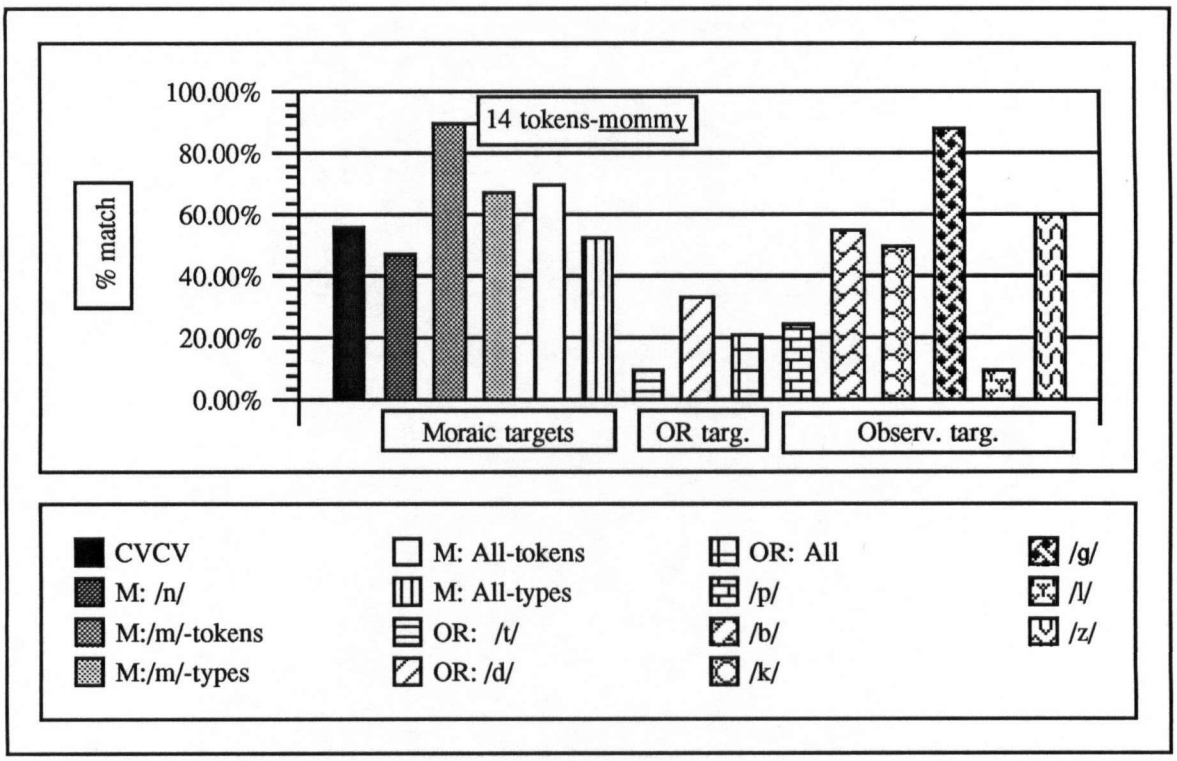
Note: Single brackets and dotted lines indicate partially established nodes or feature
*Some vowel features inconsistently applied, particularly for lax front vowels

Figure 6.1. S4: Feature geometry at Initial Assessment



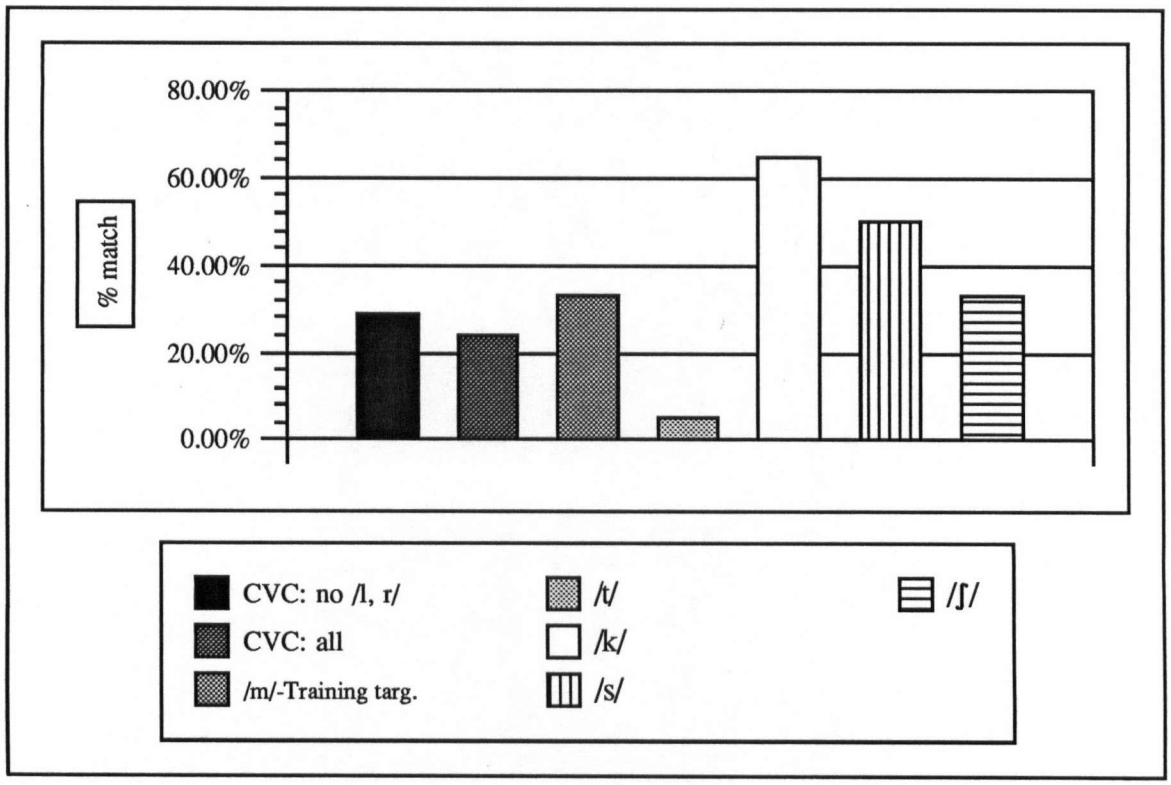
Note: Established segments word initially were /m/, /n/, /b/, /g/ and /w/ and /d/ (some cases of /g/ assimilation). Beyond these, there were no other matches.

Figure 6.3. S4: Proportional WI matches at Initial Assessment for observation targets



Note: SIWW /g/ appeared to be established (7/8 matching tokens, including two high frequency family words). Except for glides /w/ and /j/, there were no other matches.

Figure 6.3. S4: Proportional SIWW matches at Initial assessment for training and observation targets



Note: There were no other matches.

Figure 6.4. S4: Proportional WF matches at Initial Assessment

Developing Segmental Inventory

By sound class, the order (most to least) of emerging phonemes was as follows:

1. Stops: SI /d/ ; WI /t/; SIWW /b/; /p/ (all positions except the established WF one). Nonmatches varied depending on position. The SIWW nonmatches typically had the default [z/ʒ] substitution or missing Root nodes (i.e., nonrealization of any segment). The WI nonmatches for voiceless stops were a result of lack of aspiration -- a redundant [+spread glottis] feature. For /d/, WI nonmatches resulted from spreading from other segments or metathesis.

2. Nasals: SIWW /n/ and WF /m/ (mom in high frequency) (Nonmatches were the result of missing Root Nodes.)

3. WI /h/: Lack of [+spread glottis] specification resulted in a [ʔ] substitution (50% of the cases). There was, as an apparent contradiction in the system, also an overuse of [h] as a substitution (alternating with [ʔ]) for undeveloped segments.

4. In SIWW and WF positions /t/ was marginally established (missing Root node when a mismatch)

Missing Categories by Position

The following categories were missing:

1. SFWW position: All except voiceless stops (/k,p/) and one token of a nasal [ŋ]/ _[g])

2. Glides: SIWW /j/

3. Stops: voiced (WF). For 7/15 nonmatches, only voicing unspecified, otherwise matching

4. Fricatives (WF): Except for /s/, /z/ and /ʃ/ when surfacing as [s] default (1/5 [s] for /s/, 2/7 [s] for /z/, 1/3 [s] for /ʃ/)

5. Fricatives (except for those noted in #4 above): Missing Root nodes or default Laryngeal node substitutions

6. Liquids: Missing Root nodes, or, word finally, Root node feature [+consonantal] unspecified

Summary of Feature Differences

Because the absolute numbers of individual feature differences depend on the particular words elicited in a sample, the following descending order (most exemplars to least) is approximate. (Refer to figure 6.1.)

A. Unspecified child forms where adult forms are specified

1. Root node missing: This occurred both as a result of constraints on syllable structure (lack of development of CVC, CVCV) and as a result of undeveloped segmental inventory. The latter accounts for some missing consonants -- liquids and all fricatives, except the sibilants -- the former, for missing consonants in word positions other than those established by the prosodic structure.

2. Root node: [+consonantal] was unspecified for all fricatives except final sibilants and SIWW /z/, /r/, and some tokens with /h/.

3. Laryngeal node:[+voice] was unspecified for WF voiced obstruents.

4. Laryngeal node: [+spread glottis] was unspecified for 50% of /h/ exemplars and did not appear to be in established use as a redundant feature for WI voiceless stops.

5. Root node: The feature conjunction [+consonantal]/[+sonorant] was undeveloped for /l/.

6. Lack of 'complex' structure was noted for some affricate tokens ([-continuant] aspect missing word finally, i.e., WF [ʃ] substitution in church, itch; cage > [$k^h\varepsilon z_o$] some of the time; [+continuant] aspect missing word initially some of the time, i.e., WI [t^h] substitution in church, cherry; WI [d] in jump, judge, although note judge > [$da^tʃ$])

B. *'Specified'* child forms where adult forms are unspecified or otherwise specified

1. Final [*s*]/[*p*] adjunction and SIWW /*z*/ defaults: Syllable structure constraints on disyllables (lack of development of SIWW and SF consonants in disyllabic words) and closed monosyllables as well as segmental underspecification across categories (liquids and fricatives in particular) led to overuse of one of two recently trained final consonants (/p/, /s/) or, for SIWW consonants, [*z*].

2. *Labial* for Coronal Place was in use for WI /r/.

3. Feature spreading (place assimilation) or segment movement (metathesis) accommodated syllabic constraints and underspecification of segments, usually in the stop category.

Segmental Realization of Clusters

A. Initial clusters

As mentioned in the section on phonotactics, only one initial cluster was realized once with two elements (/kw/). Some optionality for consonant and/or glide realization may have been present with respect to consonant-glide clusters, as the /kw/ item and the following clusters show:

fume > [^{h}jup] -- [j] realization of /Cj/ sequence ([^{h}] onset very faint)

music > [mugi] -- [m] realization of /Cj/ sequence

blue > [bu:] -- [b] realization of /Cl/-cluster

black > [^{u}wæk] -- [w] realization of /Cl/-cluster

Also, one example of broke had a short [w] glide following the [b], indicating that the sharing of labiality may facilitate two-element cluster production at the surface level.

Generally, for initial clusters, a stop or nasal was the element most often realized. The stop produced usually corresponded to the target, except in the case of coronals /t/ (e.g., truck > [gVᵊ]) and /d/ (e.g., dress > [bɔːᵊs]). The coronals in these examples (the underspecified stops) were subject to spreading from a final dorsal (i.e., dorsal assimilation) or labial (spread from the Labial Place: [+round] vowel, itself a possible result of coalescence of [w] from /r/ and the /ɛ/). Some triconsonantal cluster words with /s/ had stop onsets and a WF [*s*]-substitution, e.g. spring > [bɛᵊs]. The [s] may have been a default [*s*] WF substitution or a result of metathesis, or a combination of both.

B. Final clusters

All final clusters with nasals and stops were missing completely or had the default [*s*] substitution. This is consistent with the singleton data.

Final clusters with /s/ had varying realizations. The /ts/ of boots > [p], consistent with overuse of [p] and spread of Labial Place across the word (a left-to-right spreading from onset to rime, unpredicted by direction of government proposed by Kaye et al. [1987]). The /ks/ of musicbox > [k], but the /sk/ of mask > [s]. This suggests that, given equal strength of specification for two segments (as was the case word-finally for /s/ and /k/), syllable position determined which would surface. One postvocalic consonant was licensed (the second mora or the first adjunct of the rime node -- R > N-C), but not additional adjoined consonants.

Intervention Plan: Block 1

In Blocks 1 and 2, conditions for S4 followed the pattern: syllabic/segmental. The syllabic subblock order was onset-rime/moraic; the segmental subblock order was lower level feature/higher level feature. S4's phonological system at time of assessment was similar to S3's, and the contrast provided in the intervention plan is at the subdivision of the subblock order level (for onset-rime/moraic and feature level conditions).

Syllabic Intervention Plan

In general, the goals were:

1. To decrease the use of final [*s*]/[*p*] adjunction, and expand the range of consonants realized in final position (CVC), and

2. To strengthen the disyllabic word shape. The CVCV word shape was in use at the time of assessment, but it appeared to be a default word shape for more complex word shapes, and it frequently had with a voiced sibilant C_2 default segment. A logical progression for phonotactic development seemed to be expansion of the range of permissible consonants in C_2 of C_1VC_2V word shapes.

These goals were the same as for S3, although the motivaton was slightly different, because of differences between the systems.

Onset-Rime Subblock

Targets: 1. SIWW: /t,d/

2. WF: /m/

Moraic Subblock

Targets: 1. SIWW: /m/

2. SIWW: /n/ after lax vowels

3. WF: /n/ after lax vowels

Rationale

Segments available for SIWW consonant training because of a reasonable degree of establishment in WI position were from the stop, nasal, and glide classes. Because of greater generalization scope, stops and nasals were selected over glides. (The glide category had too few words for training, and thus lack of generalization potential in conversation.) Fricatives were not a choice because of (1) the default SIWW sibilant, a target for elimination, and (2) the lack of other fricatives in the system. In order to compare across conditions, different categories were assigned to the two conditions. In order to compare the effect of order of conditions across subjects, SIWW /t/ and /d/ were designated onset-rime condition targets, as they were for S3. In order to maintain consistency and provide a comparison across conditions, two targets from the other major category (nasals) -- /m/ and /n/ -- were chosen for the moraic condition. The /m/ had appeared to be established at the time of assessment (89.47% matches). However, since 14/17 matching tokens

for SIWW /m/ were for one familiar word -- mommy, -- whereas other words had missing SIWW /m/, the /m/ was considered a viable target. For WF targets, only the nasal category was chosen, with /m/ assigned to the onset-rime and /n/ to the moraic condition. The voiceless stop /t/ might have been chosen as an alternative training target, but it appeared that the /t/ was starting to be used without training, and hence it was not as much in need of stimulation as the nasals. (Since one of the goals was to eliminate overuse of the stop [*p*] and fricative [*s/ʃ*], it seemed advisable to choose targets from a category other than stop or nasal.)

In the moraic condition, the /n/ was both a SIWW and a WF target. E assumed that enhancing awareness of the moraic structure of English would promote generalization at the prosodic level. One way to enhance this awareness is to use identical segmental targets, which then makes differences in prosodic stimuli salient. Focusing on the relationship between the moraic status of two word shapes, both verbally and with physical "beats", may assist a child to learn the moraic structure of a language. In this case, the focus was on establishment of moraic status of C_1VC_2 with lax vowels (bimoraic). By deleting the /i/ of C_1VC_2/i/, the mora(e) of /i/ is(are) deleted; C_2 is then obligatorily incorporated into the first syllable as the WF consonant, restructuring its prosodic status as a postvocalic mora. Since the focus was on the relationship between the moraic status of the two word shapes, it was necessary to use words with as many of the same segments as possible in order to eliminate possible interference from segmental difference, e.g., bun, bunny rather than bun, buddy or fin, funny, (see also Block 1 intervention secton for S3).

This produced an inequality between conditions for CVC targets, since WF and SIWW targets in the onset-rime condition were from different sound classes. A confounding factor which may have given an advantage to O-R targets was the use of WF /m/ words trained in the O-R condition as stimuli for the SIWW /m/ words in the moraic condition (again relating CVC and CVCV with same segments, only by moving the mora from the consonant of CVC to the vowel in the second syllable, C_2 adjoined to the following vowel). Thus extra practice was given to those WF /m/ (onset-rime) words (actually already in conversational use at the time of the moraic

condition). However, segmental "biases" should have had minimal effect on the hypothetically autonomous prosodic tier.

Segmental Intervention Plan

Lower Level Feature Subblock

Target: /f/ -- Root node specification of [+consonantal] and [+continuant] in WI position; Place node specification of Labial Place in WI and WF positions

Higher Level Feature Subblock

Target: /l/ -- Root node [+consonantal] in conjunction with [+sonorant] (WI and SIWW)

Rationale

Fricatives and liquids were weakly established or unestablished. Among the fricatives, the most obvious absence was the labial category (some coronals were in use), with /f/ the natural choice as the more common of the /f,v/ cognates for English, since it is more frequent. Between the liquids, the /r/ had a consistent labial substitution, and both the /l/ and /r/ had single target-matching tokens, suggesting that the /r/ was the more "developed" phoneme, and therefore a logical target choice. However, the similarity of substitutions for /l/ and /f/ (either designated with missing Root nodes, or default Laryngeal node specification) made them more equivalent as segmental targets. Hence, the /l/ was chosen over /r/. (Because of the allophonic difference between SI and SF /l/ perhaps requiring additional learning, WF /l/ was not targeted.)
The one matching token of SIWW /l/ (Echoic) in the assessment sample seemed to indicate a slight edge for /l/ over /f/, which had no matches. However, the reasonably well-established coronal fricatives (in SIWW and WF positions) demonstrated that the primary need for /f/ establishment in those positions was the specification of Labial Place node in conjunction with Root node features [+consonantal; +continuant], rather than establishment of the entire set of features for /f/. Thus, the /l/ was considered a segment with higher level distinctive features -- Root node features [+consonantal][+sonorant]. Even though, word initially, /f/ required establishment of all features (including [+consonantal]), the Labial Place node was the lower level feature which distinguished relative hierarchy position for /l/ and /f/. (Even if a feature [+lateral] was a Place node level feature, this would have been higher than the Labial node establishment for /f/.)

The choice of *SIWW* position for /l/ and the *WF* position for /f/ created position overlap between the syllabic and segmental conditions, which could have biased results in favor of the syllabic condition. However, the segmental condition followed the syllabic and, by that time, both therapy and observation SIWW and WF targets were in conversational use. Thus, those positions were considered to be sufficiently established to be used in the segmental condition.

Results of Block 1 Intervention

All segmental and syllabic targets showed an increase in matches. Proportionally, the greatest increases were noted for the syllabic targets and for WF /f/. (See figure 6.5 and appendix 4, table 4.1).

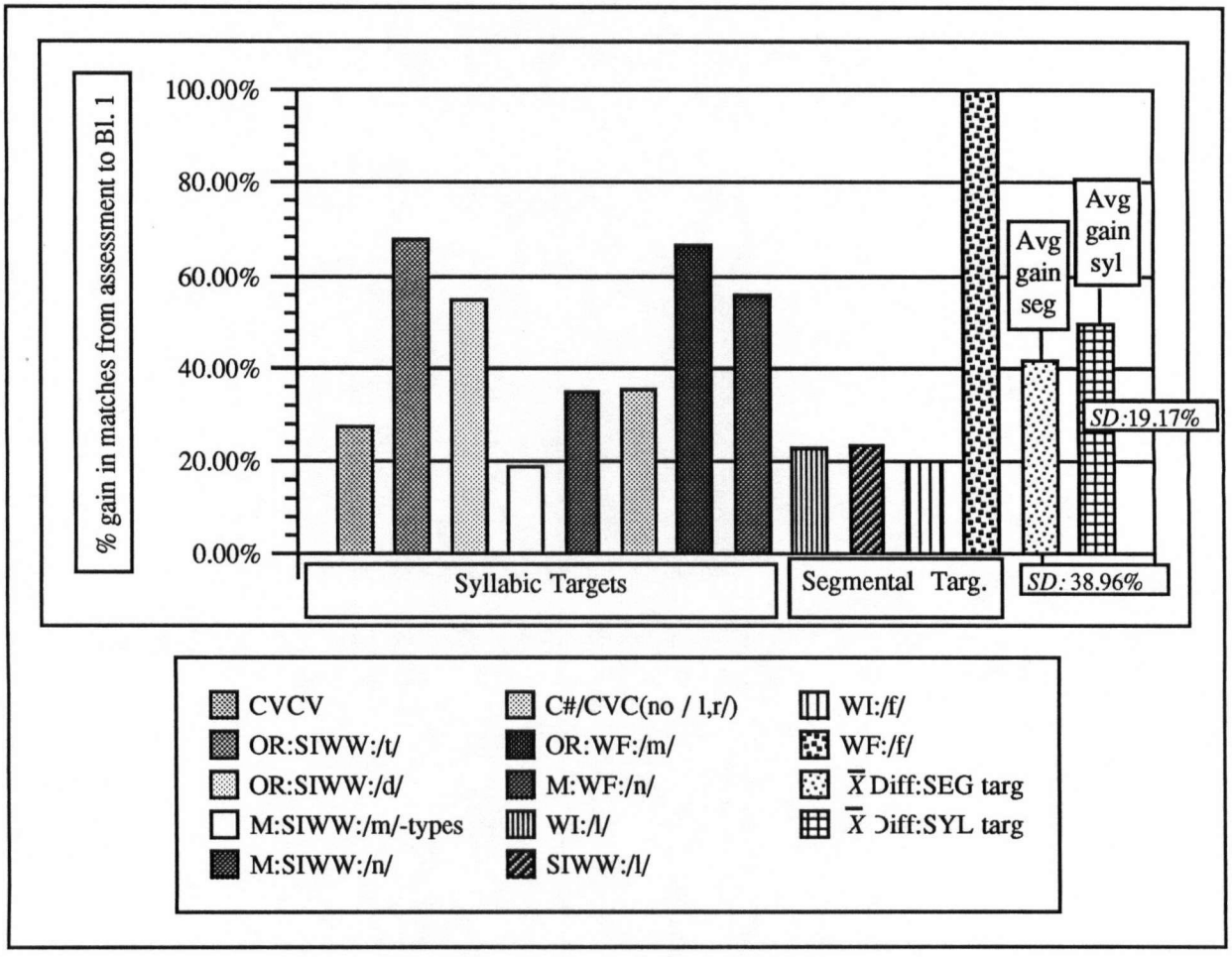


Figure 6.5. S4: Proportional gain in matches for syllabic and segmental targets between Initial Assessment and Block 1 major probes

The WF /f/ target was a crossover target, since the CVC word shape was a syllabic target . The /f/ result was based on only three tokens, however, and declined by Block 2.

Syllabic Goals

1. Final [*s*] and [*p*] adjunction were eliminated in all but one word, and completely for CVC targets. (See figures 6.5 - 6.6.)

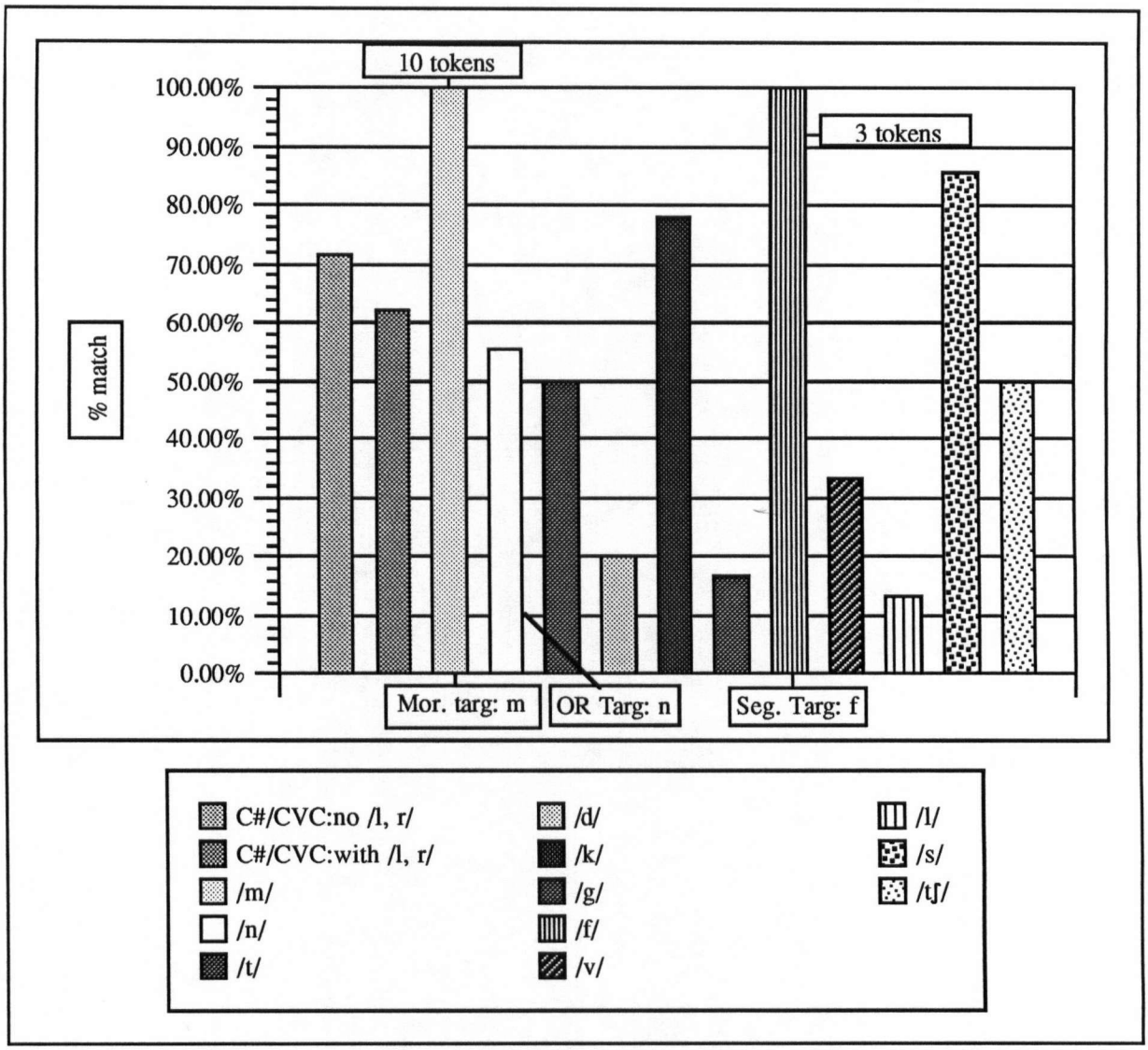
2. Final consonants were produced for CVC targets 58/72 times [80.56%] (excluding WF /l,r/ targets, and using type data for the very frequent word that [dæ^{ə}]). That syllable structure development was occurring, rather than only learning of trained WF segments (namely /m,n,f/) is evident in the increase in matches noted for the majority of observation targets, an overall increase of 31.39%.

3. The CVCV word shape demonstrated a similar gain (27.62%). (See figures 6.5 and 6.7.) Overall, there were 26/31 (83.87%) CVCV matches. Again, the generalization to phonemes other than the trained targets /t/, /d/, /m/, and /n/ indicates that syllable development was occurring. The greatest gain for untrained segments was for the labial obstruents. Gains for labial stops were predictable from the training of the labial nasal and the previous success with WF /p/. The improvement for /f/ and /v/ was predictable as a transfer from the segmental training on /f/ in other positions.

4. Disyllabic targets were realized as such 195/202 (96.53%) times. The most frequently matching disyllabic target was the CVCV word shape, as in the previous probe. Closed syllables remained uncommon in multisyllabic words. Fifteen multisyllabic words had one syllable with a WF consonant, but only two of these were complete matches in terms of vowel and consonant slots (CV.CVC).

5. Trisyllabic targets were realized as disyllabic words five out of seven times, although three trisyllabic tokens (variations of CV.{C/ʔ}V(V).CV(V)) were produced.

6. The SIWW consonant was realized in all but two of the 210 multisyllabic words. The [*z*/ʒ] default appeared in only five words, words which in fact had coronal fricatives or affricates in the adult form.



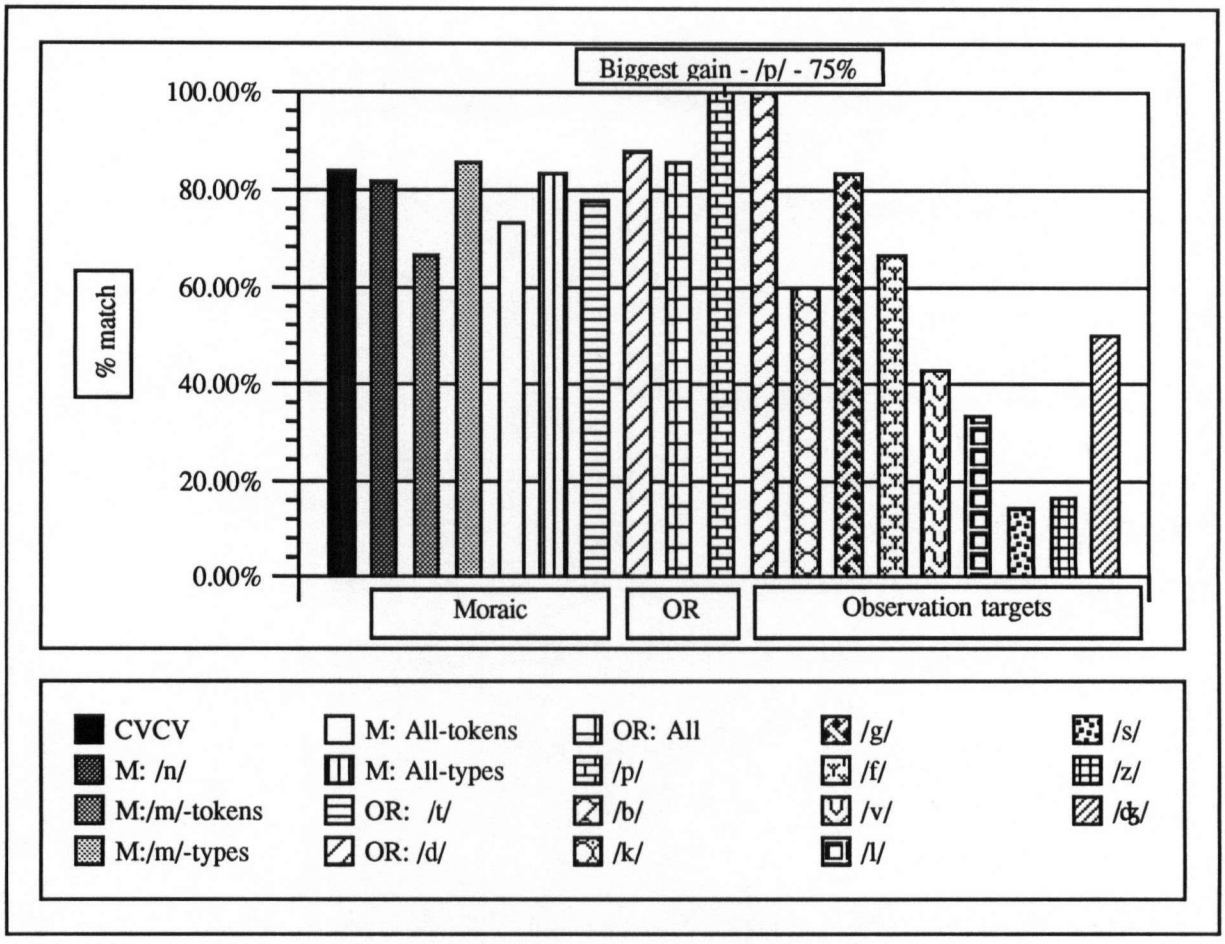
Note: There were no other matches.

Figure 6.6. S4: Proportional WF matches in Block 1 major probe

Syllabic Goals (continued)

7. Diphthongs continued to be slow-developing, with an actual decrease in matches for the all monosyllabic word shapes but VV. Overall, only 13/56 (23.21%) monosyllabic targets and 9/32 multisyllabic targets (15.63%) had diphthongs. Matching diphthongs were /oʊ/ (alternatively labelled a tense, i.e., long vowel) and /ɑɪ/ (40%).

8. Two-element cluster production was incipient, with two /sn/ onset clusters produced and three final liquid-stop clusters produced (two with metathesis of a liquid from initial cluster position to postvocalic position, i.e., glove > [gɔlç], [gɑrp^{f}]).



Note: There were no other matches

Figure 6.7. S4: Proportional SIWW matches in Block 1 major probe

Summary of the Syllabic System Component Changes in Moraic and Onset-Rime Terminology

A. Development in terms of moraic theory

1. Single consonants became more widely licensed as second morae in monosyllables, with no apparent difference between consonant realization after tense or lax vowels. Constraints on final consonant realization continued to be both syllabic and segmental. The syllabic constraint is evident by the lack of variety of WF segments in comparison with the variety noted for other word positions. The segmental constraint accounts for nonmatches for /r/ and the interdentals. While the consonants became more widely licensed as second morae, diphthongs appeared to lose some capacity as second morae, with fewer diphthongs being realized.

2. More prevocalic consonants appeared before the mora in the second syllable. The segmental limitations for C_2's in the assessment sample -- those identical to C_1, dorsals and some

kind of (underspecified) voiced sibilant substitution -- no longer applied. The limitations noted above for final consonants parallels the assessment data for SIWW consonants, suggesting that simplicity at the segmental level facilitated development at the syllabic level in the early phases.

3. At the word level, change was minimal. The single foot word was again the most frequent (branching or degenerate) and, as before, the maximum morae per word were four. The most complex word was CV.CVV.CVʔ (screwdriver > [kʰudɑɪjɪʔ]. Of the trimoraic word forms (ignoring the tense-lax distinction), the most productive word shapes were CV.CVC (10) and CVV.CV (seven tokens: VV =[oʊ] or [ɑɪ]). Although only two of the CV.CVC words matched adult targets, the more frequent appearance of this word shape at the end of Block 1 demonstrated a marginal development in multisyllabic words with consonantal morae.

3. Singleton consonant adjunction was still incomplete prevocalically with missing consonants among the liquids, fricatives and /h/.

4. Pre- and postconsonantal adjunction (equivalent in moraic theory) continued to show parallelism. The two tokens of a second prevocalic consonant (two [s]/_[n]) demonstrated a developing capacity for complexity prevocalically. Postmoraic consonant adjunction (after the second mora) showed similar development with the three examples of final liquid-stop clusters . It is possibly noteworthy that consonant adjunction both pre- and postconsonantally was realized first when sonorants bordered the vowel. Adjunction of [+consonantal/-sonorant] segments to sonorous segments (whether or not they are [+consonantal]) is perhaps easier than adjunction of the same to [-sonorant] segments, as an extension of the default case in CV sequences. Extrametricality does not have to play a role, since the segments can be syllabified.

B. Development in terms of onset-rime theory

1. Branching at the level of the rime node itself became more widely licensed, allowing a greater range and higher proportion of matches for single final consonant production.

2. Branching at the foot level was more widely licensed, allowing a greater range and higher proportion of matches for SIWW (second onset) consonant production.

3. Word complexity changed little, although there was a marginal increase in double branching within one O-R unit of a foot (i.e., ten tokens of CV.CVC: the basic O_2-R_2 branch subdividing again -- R > N-C).

3. Singleton onsets continued to be missing for some fricatives, liquids and /h/. Glottal stops, null or /h/ continued to appear in place of missing initial target phonemes. Onsets, did, however, become licensed for branching, as the two examples of /sn/ initial clusters show. The sharing of coronality within the onset, plus the lack of need for extrametrical constituency possibly facilitated the early appearance of /sn/.

4. The production of three liquid-stop clusters demonstrate consonant adjunction to the rime node subsequent to a primary branching of the rime (for nucleus and single consonant). (The liquid may have been a vowel component, involving nucleus branching to create a diphthong, but considering the general difficulty with diphthongs, this is probably unlikely).

5. Branching at the level of the nucleus showed a decline, with fewer diphthongs realized in the second probe. Branching at the level of the rime was the primary development during this period and perhaps development of branching at this higher level temporarily reduced complexity at a lower level for the entire phonological system.

Onset-Rime Subblock Intervention Targets

1. SIWW /t,d/: In the major probe, 29/34 (85.29%) targets matched. This represented a 64.24% gain from the time of the assessment. Results for /d/ were slightly better (22/25 = 88%) than for /t/ (7/9 = 77.78%).

2. WF /m/: In the major probe, 10/10 final /m/ targets were met. The proportional gain from the assessment was 66.67%, which is similar to that for the SIWW O-R targets. There was overextension of use of [m] once for /n/.

Moraic Subblock Intervention Targets

1. SIWW /m,n/: Proportions for the /m/ tokens both during the assessment and during the Block 1 probe are somewhat misleading. In the assessment sample, 14/17 matches were for the word mommy, and in the the Block 1 sample, the only nonmatches were for the word camel

(which in the adult form is not even CVCV). Therefore, the calculations for /m/ were made both for types and tokens, with the type data reported here. The match proportion was 83.33% for both phonemes, with virtually equivalent proportions for each: for /m/, 85.71% (6/7) and for /n/, 81.82% (9/11). The percentage gain from the assessment was 31.16% over both.

2. WF /n/: In the major probe, 20/36 tokens of WF /n/ appeared (55.56%) (Match data were equal to proportional gain from the initial assessment.) Eleven of the missing WF /n/ tokens were from multisyllabic words. (In other words, the targeted CVC shape was well established with WF /n/.) An overgeneralization of [n] was noted for /ŋ/ (6/28 /ŋ/ mismatches).

Comparison of the Onset-Rime and Moraic Conditions

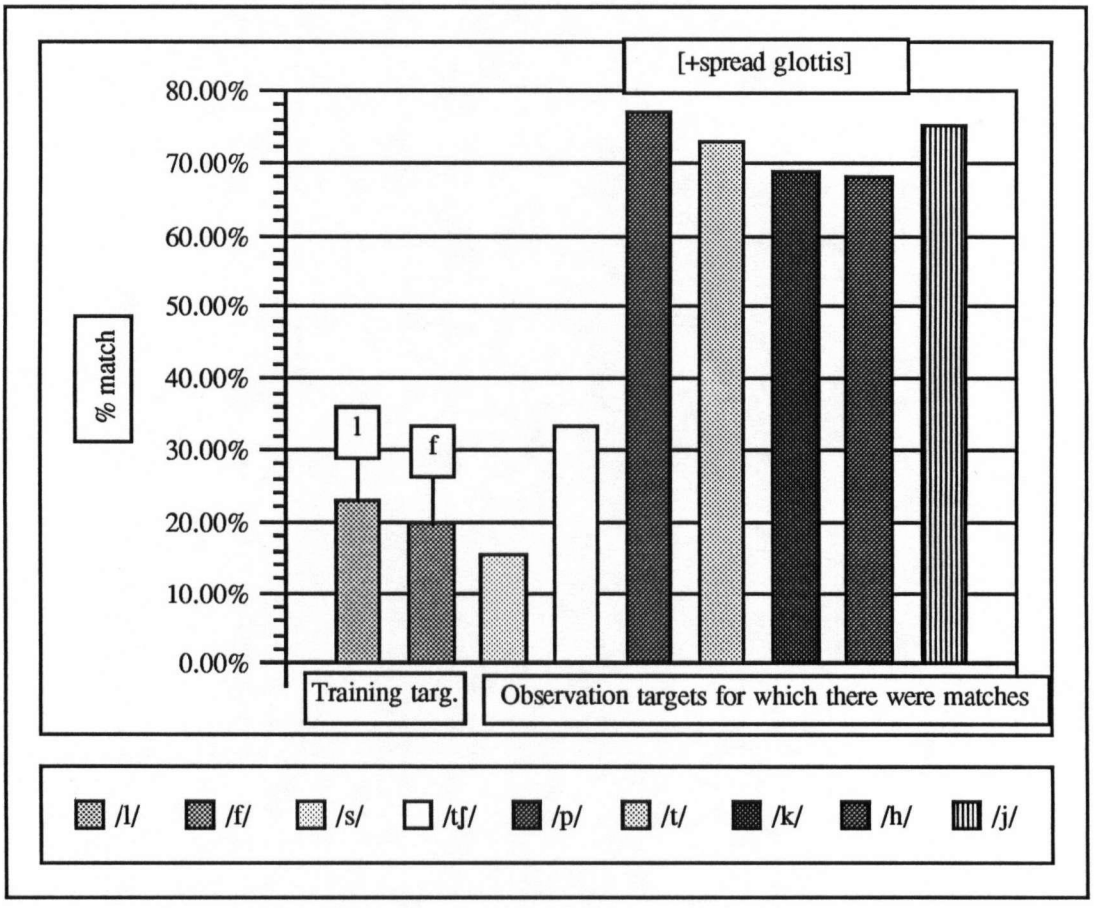
With respect to the absolute proportions for targeted SIWW consonant production, major probe results are ambiguous with respect to the onset-rime versus the moraic methodologies. However, the proportional increase in production of /t, d/ was more than double that for the /m, n/ (64% to 31%). A "catch-up" effect was noted for the /t, d/ targets, which had only half the matches of the nasals at the time of assessment. Because onset-rime targets were introduced first, they may have had the possible benefit of longer practice. However, the absolute score for nasals did not surpass that for stops, considering a possible practice effect in learning to use SIWW consonants, method notwithstanding. (S3 had similar results.) The use of CV(V) units to build up CV.CV words is possibly easier than relating CVC to CVCV with a common second consonant.

The absolute scores for WF /m/ versus WF /n/ also seem to suggest a better effect for the onset-rime training. However, the proportional increases between the assessment and Block 1 probes differ by only 10%, and 11/14 instances of missing WF /n/ were in multisyllabic words. There are two confounding factors: (1) that WF /m/ words were used in the moraic condition for SIWW /m/, and (2) that the child was very excited to be able to pronounce a familiar name which ended in /m/. Altogether, these several facts reduce the probability that the treatment method had any bearing on the differing absolute scores.

Segmental Goals

Lower Level Feature Subblock:

/f/: Root node specification of [+consonantal] and [+continuant] in WI position; specification of Labial Place in WI and WF positions (See figures 6.5 - 6.8.)



Note: There was also a matching token for WI /v/ (1/1).

Figure 6.8. S4: Proportional matches for WI training and observation targets in Block 1major probe

1. WF position: The three realizations of WF /f/ were matches (100%). Furthermore, there was carryover to the /v/, with two matches (33.33%) in six attempts. (See figure 6.6.)

2. WI position: WI /f/ was also beginning to generalize, with 3/15 matches (20%), albeit all echoic responses. Errors showed some feature change, with one [pf] affricate for five and one partial self-correction [hɑ-fɑ] for feather. Carryover was noted for WI /v/ (1/1) and also for

SIWW /f/ (2/3 matches) and SIWW /v/ (6/14 matches). Another generalization effect was [f] for SIWW /θ/. A probable feature carryover effect was the appearance of SI /s/ in a few words and [zj] for WI /ʃ/ once. The training of one WI fricative facilitated the appearance of other WI fricatives, particularly when they were in use in other word positions.

In all cases, the absolute increase in matches represents the proportional increase between the assessment and the Block 1 probe, since there were no labiodentals in the first sample. Extension of /f/ to other word positions demonstrates that a segment, once learned, can be transferred to a well-established syllabic slot. Generalization to /v/ supports the conviction that segmental learning was taking place at a feature level.

Higher Level Feature Subblock:

Target: /l/ -- Root node specification of [+consonantal] in conjunction with [+sonorant]

1. WI position: Generalization of WI /l/ was beginning -- 3/13 matches (23.08%). (The proportional increase was the same, since no WI [l] appeared in the first sample.) Metathesis of the /l/ to postvocalic position in the word glove (see the section above on syllabic goals) shows awareness of /l/ in initial clusters. There was assimilation to [l] of the WI /j/ in the word yellow (continuing to the present -- age 5;9) and the appearance of an [r]-colored [ɰ] as a substitution for /r/, which both show feature class membership for liquids and glides.

2. SIWW position: Two of six tokens matched (33.33%), representing a similar proportional gain to that for WI position (23.33%). Twice, WF /l/ of candle was transposed to the SIWW position, replacing the /d/, i.e., [kʌl̩i?], [kʰæʊl̩ʲʌᵊ?] (both spontaneous utterances).

3. Untargeted postvocalic positions: As mentioned, /l/ appeared postvocalically as a metathesis from the /gl/ cluster model twice. It appeared three other times postvocalically, twice in WF position (in call > [kɑl] and hill>[hʊl) and once for /lz/ in dolls > [dɑlɬ]. The extension of /l/ across positions was an indication that it was being learned as a segmental entity, which could migrate to any consonant slot established at the syllabic level.

Comparison of the Lower and Higher Level Features

It is not possible to determine whether the higher or lower level features developed more quickly in the case of S4. In WI position /l/ was, as predicted, slightly ahead of /f/ in rate of generalization, but in the other word positions, the labiodentals were more prevalent. In WI position, both segments needed specification of two Root node features, so they may have been equivalent for that reason. In comparison, the success of /f/ and /v/ in SIWW and WF positions may be due to the fact that the development of /f/ in those positions meant the amalgamation of the Labial Place node for WF [p] in conjunction with the Root node [+continuant] feature of the default WF [*s*]. It demonstrates, possibly, that the amalgamation of established features from different levels is an easier task than the specification of all features from the Root node down, which was necessary for /f/ and /v/ word initially, as well as /l/. Once again the interaction of the syllabic and segmental tiers is relevant, since establishment of the same segment in different word positions meant establishment of different features or combinations of features.

Other Feature Changes for the Overall Segmental Data

Changes other than those discussed above are noted in terms of the feature hierarchy. The more prevalent changes are noted first, but the order is not absolute. Progressive feature changes for trained segments are denoted with ++ and for untrained segments with **. Regressions are denoted with &.

A. Unspecified child forms where adult forms are specified

1. Laryngeal node -- [+spread glottis]: For initial voiceless stops and /h/, the distribution of matches was from 68-77%, reflecting an increase in words specified for [+spread glottis], whether distinctive or redundant in specification. The greatest changes were for /p/ and /h/, with no change noted for /k/ (considered established at the time of the assessment). **

2. There was a minor and probably spurious regression in number of SFWW tokens, with a solitary token of /k/ realized. &

3. Laryngeal node: There was a marginal development of [+voice] specification of WF voiced obstruents for /d/ and /g/. **

6. Coronal Place node: There was an increase in number of affricates with 'complex' structure (a spontaneous development). **

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

Feature spreading (place assimilation) or segment movement (metathesis) to accommodate syllabic constraints and underspecification of segments was slightly reduced in use in the stop category but showed up for /l/, which was only marginally established, and therefore possibly subject to spreading and movement processes. **, &

Areas of No Change in Feature Specification

1. *Labial* for Coronal Place node substitutions continued for WI /r/; in fact, *Labial* Place was now also noted for the /θ/ in SIWW position (overgeneralization of /f/).

2. Root node remained unspecified for WI /θ/.

The overall progression in the child's phonological development was partially attributable to training, and partially to general development. Generalization from trained targets resulted in some spontaneous changes, either at the syllabic or feature level. Other sponanteous changes, i.e., in use of the Laryngeal node features, increased use of affricates, and the appearance of metathesis among liquids were independent of direct training. The seven-week developmental period was in all probability insufficient to account for these changes in a child with such a severe delay. The focus on specific phonological targets probably accelerated the general rate of phonological development.

Intervention Plan: Block 2

Syllabic Intervention Plan

Onset-Rime Subblock

Targets: 1. Diphthongs /ɑɪ/ and /ɔɪ/ (in CVV and CVVC contexts)

2. CVCVC (WF C = /t/, /ŋ/)

Moraic Subblock

Targets: 1. Diphthongs /ɑʊ/, /ɛɪ/ (CVV and CVVC)

2. CVCVC (WF C = /z/)

Rationale

A. Diphthongs

As stated at the time of assessment, the lack of diphthong development was to be reviewed at the end of Block 1 to check for spontaneous improvement. The Block 1 sample showed a regression in use of diphthongs, possibly as a result of focusing attention on postvocalic consonants. Because the CVC and CVCV word shapes were now considered to be sufficiently robust, E elected to focus on diphthong development. This was considered a syllabic goal, rather than a segmental one, since the individual vowel components making up the diphthongs were generally accurate. Whether the moraic or onset-rime theory was utilized to account for missing diphthongs, the lack of diphthongs could be explained in syllabic terms (see section on assessment above). Both CVV and CVVC wordshapes were targeted, in order to assess the effects of consonant adjunction on diphthong production. The major sample probe indicated that results would probably be better for open syllable words.

As noted in the Block 1 major probe results, the "diphthong" /oʊ/ was often produced correctly and, if not, was produced as [o], arguably an accurate production. The /aɪ/ was sometimes accurate in open syllables ([aɪ] for eyes). For each of the subblocks, two diphthongs were chosen, one with the /a/ and one other. By selecting the /a/-type diphthongs, the raised (/ʌ/) variants (in closed syllables with voiceless final consonants) would be generalization targets. There was an a priori difference in difficulty between conditions favoring the onset-rime condition because (1) /aɪ/ of the onset-rime condition was already in use some of the time, and (2) the /ɛ/ of /ɛɪ/, a moraic target, was itself sometimes produced as [+low] or [+back]. This was to be taken into account at the time of probing. (Some phonologists consider /ɛɪ/ to be underlyingly a tense, i.e., long vowel, rather than a diphthong. In either case, it is bimoraic, and that was the major focus of this particular type of intervention.)

The basic contrasting methodologies were as follows:

1. Onset-Rime condition: The rime was modelled as a unit -- VV(C) -- and then an onset consonant was modelled. Following this, the units were modelled as entire syllables/words, e.g., [ʔɑɪ], then [h]-[ɑɪ], then [hɑɪ]; or [ɔɪn], then [k^h]-[ɔ̃ɪn], then [k^hɔ̃ɪn].

2. Moraic condition: The CV unit was modelled, and then a V added. Following the CVV, a C was added (CVVC), e.g. [dɑ], then [dɑ]+[ʊ], , then [dɑʊ]+[n].

The main difference between the conditions was that the moraic stimuli were additive from left to right, whereas the onset-rime condition focused on the entire rime first, and then introduced the onset (i.e., were additive from right to left).

B. CVCVC

As a marginal development at the end of Block 1, the CVCVC word shape was considered a logical target for enhancement. Its selection offered the opportunity for morphological training, a need observed from language sampling. The present progressive form /ɪŋ/ was a natural onset-rime target as a VC (rime) unit; the plural morpheme /z/ was a segment which could be manipulated phonetically as an independent (weight) unit and therefore was chosen as a moraic target. The other segment -- /t/ -- was added to the onset-rime condition to give a nonmorphological contrast. The design was incomplete because of the absence of a similar nonmorphological segment in the moraic condition. However, the lack of plurals in the Block 1 probe (the only token being icecubes > [ʔɑɪk^{h}ʊ^{ə}s], where the [s] may have been default [*s*] adjunction), and the general lack of voiced WF obstruents indicated that more time would be needed to attempt to establish equivalency between the /z/ plural and /ɪŋ/ morphemes. (The /ɪŋ/ was usually realized as [i] and three times as [n], i.e., the morpheme itself had been established, but the phonological shape was reduced, or, rarely, modified.)

The contrasting methodologies were as such:

1. Onset-Rime condition: The CVCVC word shape was built up from CV (O-R) and CVC (O-R) units. For example, a "king" game was played. With a word such as walking as the target, one of the players acted out the word, and the other had to figure out what kind of "king" word it

was (ba-king, ki-cking, bi-king, etc.). The word was then modelled as [wɑ--k^{h}ɪŋ] (the phonetic syllabification of the word, rather than the morphological).

2. Moraic condition: The CVCVC word shape was built up from the addition of a mora (or consonant adjunction, if the /z/ does not represents a weight unit in this case) to the CVCV word (CVCV+C). For example, a shopping game was played, in which the players took turns buying one or more CVC[i/o^{ʊ}]+[z].

Segmental Intervention Plan

Because neither of the targets from Block 1 had sufficiently generalized, they were retargeted in Block 2.

Results of Block 2 Intervention

In Block 2, the segmental goals were achieved for both /l/ and /f/ at conversational level, although WI /f/ was still less than 70% accurate in conversation. The CVCVC syllabic goal was sufficiently attained for the /ɪŋ/ morpheme but other syllabic goals were not attained at a conversational level. Diphthongs in both open and closed syllables increased in matches by about 25%, but the absolute matches were still only 25/53 (47.17%) and 7/28 (25%) respectively. Plural /z/ in the CVCVC context had not generalized to conversation. (See figure 6.9 and appendix 4, tables 4.2 and 4.3).

Syllabic Goals

A comparison of the CVCVC major and minor probe results demonstrated that learning was taking place between the two probes, during the time of the segmental subblock (see figures 6.9 and 6.10). At the time of the minor probe, only 6/17 (35.29%) of the CVCVC targets matched for consonant slots, compared with 21/30 (70%) at the time of the major probe. Of the six matching tokens in the minor probe, five contained the trained final consonants, all from the onset-rime condition (see below). Although diphthongs were not tallied for the minor probe (because they were available in ample numbers in the major probe), it was apparent that few matched, showing that learning of diphthongs was also continuing during the segmental subblock.

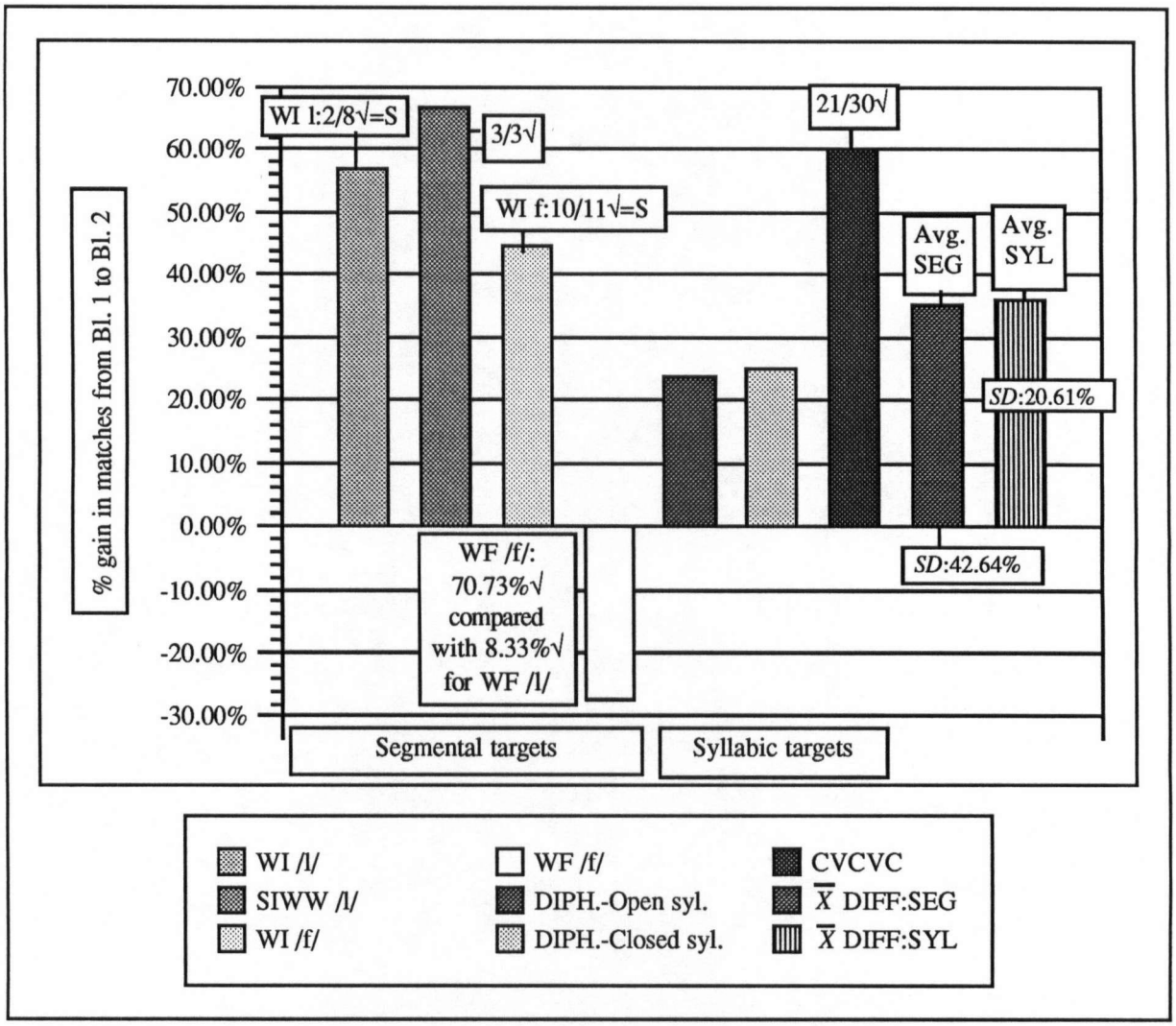


Figure 6.9. S4: Proportional gain in matches for syllabic and segmental targets between Block 1 and Block 2 major probes

Onset-Rime Subblock

Targets: 1. Diphthongs /aɪ/ and /ɔɪ/ (CVV and CVVC)

The /aɪ/ diphthong had been the most well developed diphthong besides /oʊ/ in previous probes. However, training facilitated an increase in matches for /aɪ/ in open syllables by 30.21% to a 73.07% match level in conversation during the major probe. Only one of eight closed syllable words had matching /aɪ/, however, showing that consonant adjunction to bimoraic syllables was still a problem after diphthongs. Of the three words with /ɔɪ/ in the major probe sample, one open syllable exemplar matched the target (boy).

2. CVCVC --WF C = /t/, /ŋ/

The /ŋ/ morpheme was successfully incorporated into the child's morphology (18/21 final nasal matches during the major probe compared with 2/4 at the time of the minor probe). However, a dialectal [In] variant was used for the morpheme [ɪŋ]. Although there were no exemplars of CVCV/t/ in the major probe, three out of the four words with WF /t/ were produced with final [t] in the Block 2 syllabic minor probe, one in spontaneous conversation.

Moraic Subblock

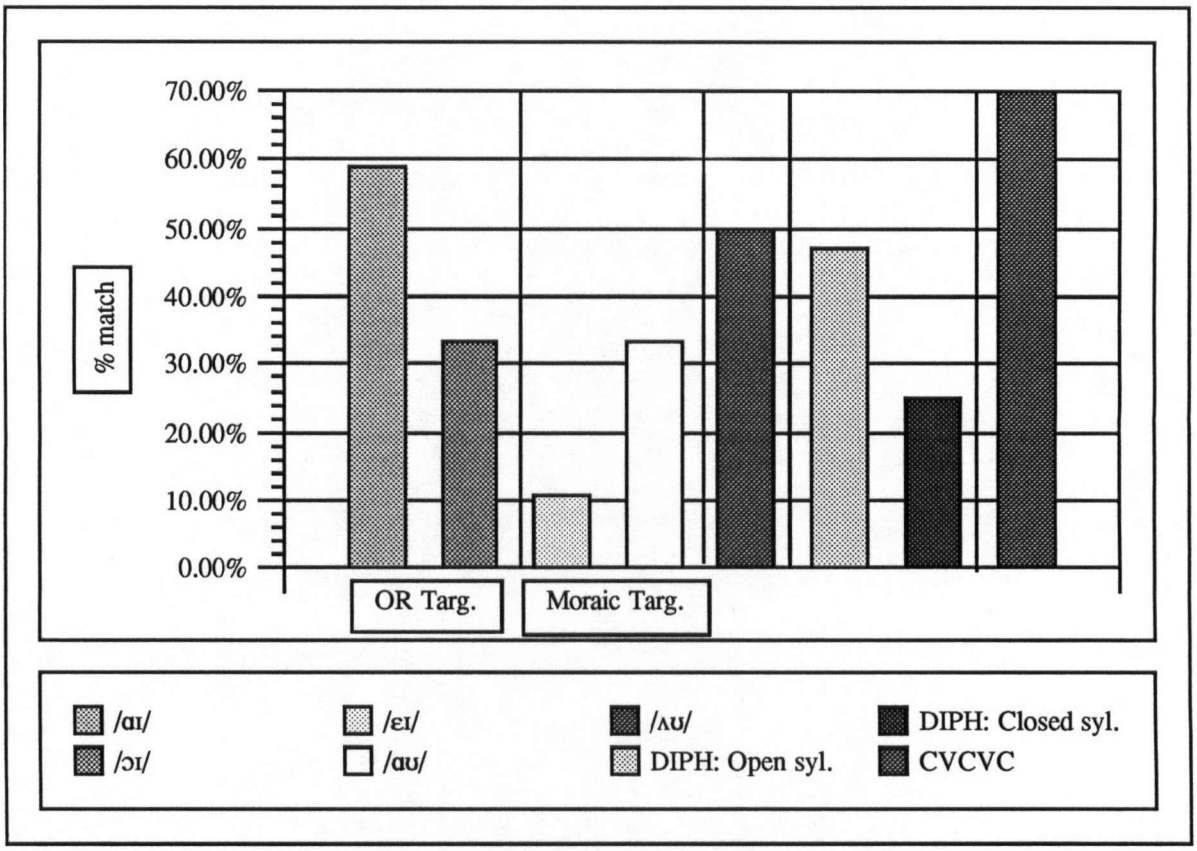
Targets: 1. Diphthongs /ɑʊ/, /ɛɪ/ (CVV and CVVC)

The diphthong /ɑʊ/ was learned during the Block 2 period (7/9 matches = 77.78%, in both closed and open syllables). Since two of the major appeals of this particular diphthong for S4 were activities of "howling at the moon", and jumping "down", it would be unfair to claim that the moraic method of stimuli presentation was uniquely responsible for the successful result.

The /ɛɪ/ had a marginal breakthrough in open stressed syllables (3/17=17.65%) but was slow to change because of the difficulty with the mid tongue position for the /ɛ/ (a segmental rather than syllabic concern). However, one of the child's favorite phrases, that way [dæ wæ], did at least change in terms of vowel slots to [dæt w{æ/ɑ}ɪ], as a result of a six-hour family car trip, during which he identified which way they were travelling at the sight of every road sign!

2. CVCVC (WF C = /z/)

The morpheme /z/ did not generalize to conversation by the time of the major probe. During the minor probe, S4 successfully imitated the phone [z] during two of three attempts, but the [z] surfaced in the SIWW word position, its default position from the outset of therapy (e.g., berries > [bɛzi], Bobby's > [babzi]). One interesting error was the imitation of a final /s/ as [z] in lettuce ([ʔætəz]). Whether this demonstrates a difference between morphological and phonological learning or random responding cannot be determined from the sole example.



Note: There were no matches for /ʌɪ/ in the major probe.

Figure 6.10. S4: Proportional matches for syllabic targets in Block 2 major probe

Comparison of Onset-Rime and Moraic Condition Results

A. CVCVC

CVCVC targets in the onset-rime condition showed a greater increase in matches than the CVCV/z/ plural forms of the moraic condition. A higher match score for the onset-rime targets in absolute numbers was expected at the outset, because of the above-mentioned lack of plural morphology and voiced word-final obstruents. However, a complete lack of generalization of /z/ plurals was not expected. The difference in proportional increase seemed to favor the onset-rime targets.

If the methodology was at least in part responsible for the difference, it appears that it was easier for S4 to gain productive mastery of the CVCVC word shape by building up a word from CV (O-R)+ CVC (O-R) units than from CVCV + C (mora addition or consonant adjunction) units.

The child actually preferred the CVCV+C "shopping" game over the "king" game, so therapy style preference was not the critical factor.

B. Diphthongs

In absolute terms, the diphthong with the highest degree of double vowel slot matches was the moraic target, /aʊ/ (7/9), and the lowest, the moraic target /ɛɪ/ (10/35). (See appendix 4, table 4.3). The difficulty for /ɛɪ/ was possibly segmentally based since S4 seemed to have difficulty approximating a front mid tongue position. (S5 also had greatest difficulty learning /ɛ/ in Block 3 vowel training.) Proportionally, the moraic target matches increased by 38.64% overall, whereas the onset-rime targets increased by 22.47% overall, suggesting that the left-to-right additive stimuli presentation was more facilitative than rime unit presentation in monosyllables. Therapy activity may have played a role in the faster learning rate for /aʊ/ and /ɛɪ/, as "howling at the moon", "jumping down", and calling out travel directions were pastimes favored over repetition of bye and boy. (However, S4 liked the onset-rime word buy, since it involved another favorite object -- money -- with all its associated activities).

Other Untargeted Syllabic Changes

Continued increases in matches for the previously targeted CVC and CVCV word shapes were noted. Although there was no increase in word-initial clusters, /kj/ appeared in SIWW position, which may (1) have represented an increase in within-word consonant slot licensing or (2) have been a result of diphthong training (since /jV/ is sometimes considered a light diphthong). There were seven exemplars of words with SFWW consonants abutting SIWW consonants, representing an increase in word complexity.

Segmental Goals

S4 used both /l/ and /f/ sufficiently in conversation so that they did not need to be retargeted in Block 3 (except in clusters). Major and minor probe results were different for the two segments. The minor probe showed mastery of /f/ in all positions and 17/23 (73.91%) matches for the targeted positions (eleven matches of which were spontaneous utterances). In contrast, S4 produced only 8/17 [l] tokens in target positions (two matches of which were spontaneous

utterances). Just prior to this probe, S4's mother had given /f/ words special attention at home with a "star chart" on the kitchen wall, because generalization to conversation had been slow. During the minor probe, she stated her intention to do the same with /l/ words next. A week later, during the major probe, comparison of the two phonemes shows a better result for /l/ in syllable-initial position and for /f/ in word-final position, as was noted in Block 1. There was a regression in matches for WF /f/, however, making the three tokens from the first block appear insufficient as indicators of productivity. Furthermore, the dorsal and vocalic characteristics of WF /l/ in English makes fair comparison of the feature hierarchy predictions difficult in this word position for the two segments.

It is tempting to state that the prediction of faster access to the higher level features was confirmed at the end of the period by the better syllable-initial results for /l/. However, the /l/-word responses were primarily echoic (perhaps in "therapy mode"), in comparison with a higher proportion of spontaneous responses for the /f/ words, and the minor probe success for /f/ seemed to indicate the opposite. Because of these inconsistencies, no final statement can be made about the segmental predictions for this child.

Other Feature Changes for the Overall Segmental Data

Changes other than those discussed above are noted in terms of the feature hierarchy. The more prevalent changes are noted first, but the order is not absolute. Progressive feature changes on trained segments are denoted with ++, and on untrained segments with **. Regressions are noted with &.

A. Unspecified child forms where adult forms are specified

1. Decrease in number of skeletal slots with missing Root node: The continued development of the WF and SIWW positions resulted in fewer missing segments in general. There was a positive change in SFWW position realization in this block, particularly for /l/ and [s]. (As noted previously, Root nodes were missing both as a result of constraints on syllable structure and because of undeveloped segmental inventory. The latter improved as a result of beginning

competency with labiodentals and /l/ [as discussed above] as well as the use of more SI coronal fricatives.) ++,**

2. Laryngeal node: [+spread glottis]: All WI /k/ and /t/ words were aspirated ([+spread glottis] redundancy rule). There was no change for /h/ and /p/. The changes for the lingual consonants may have been an indirect effect of the syllabic subblock training, in which the words king, kit, and ticket were frequent stimuli words. However, pocket was also a high frequency word, and no carryover was noted to the /p/ in general. (**)

3. Laryngeal node: There was a substantial increase in [+voice] marking of WF voiced obstruents, although there was a strong tendency to overarticulate them with a slight [ə] on release. The syllabic subblock training of WF plural /z/ may have been influential in focusing attention on voicing for WF obstruents. (**)

4. Coronal Place node: There was again an increase in number of affricates with 'complex' structure. **

B. '*Specified*' child forms were adult targets are unspecified or otherwise specified

1. WI /θ/ appeared as a *Labial* [f], a probable transfer from WI /f/ training. **

2. Feature spreading (place assimilation) or segment movement (metathesis) accommodating syllabic constraints and underspecification of segments was less frequent .**

3. Root node: [+consonantal]: There was some overextension of this feature to /j/ and /w/ from /l/ and /f/ training. &

Area of No Change in Feature Specification

No change was noted for the WI /r/ *Labial* for Coronal Place.

Block 3 and Beyond

Diphthongs were retargeted with success in Block 3, both in closed syllables and in multisyllabic words. Final consonant clusters (CVCC) did not develop at the time of CVVC (closed syllables with diphthongs -- except where [s] was a plural morpheme) and in fact had to be targeted six months after the project ended during language therapy.

Another successful repetition from Block 2 was the CVCVC word shape with final [z]. A new set of targets were initial clusters with /l/ and /s/, which S4 began to use in conversation by the end of the block.

In order to encourage the use of WH-question forms instead of the filler form [ŋ], as well as to increase the use of /h/, question words and other words with WI /h/ were targeted toward the end of the block with some success.

After a three-month therapy break, a weekly group language therapy program was conducted for a period of seven months. At age 5;9, language production skills continue to improve, although the child remains delayed in this area. In controlled slow-paced discourse, the filler form is still used for certain conjunctions (e.g., if, when); nominative case pronouns are limited to first person and occasionally third person singular; and question formation shows a lack of Auxiliary movement and do-support. In extended fastpaced discourse, the grammar breaks down to a greater extent. He is intelligible most of the time in conversation, but continues to have Labial substitutions for /r/ and /θ/, and general difficulty with consonant and diphthong production in multisyllabic words.

Discussion

In terms of the stated questions the following interpretations are offered.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

As with the previous subjects, the nonlinear frameworks did lead to reasonable targets for intervention. The intervention project may have been successful for reasons other than the reasonable selection of targets, such as the intensive stimulation and the mutually enhancing effect of a variety of approaches. However, the generalizations noted below are a phonological indication that the chosen targets were relevant for inducing change in the system.

Conversational Intelligibility Gains

There was a rapid improvement in intelligibility due to the attainment of conversational proficiency with a number of trained syllable/word shapes and segmental targets /l/ and /f/ (see figures 6.11 and 6.12).

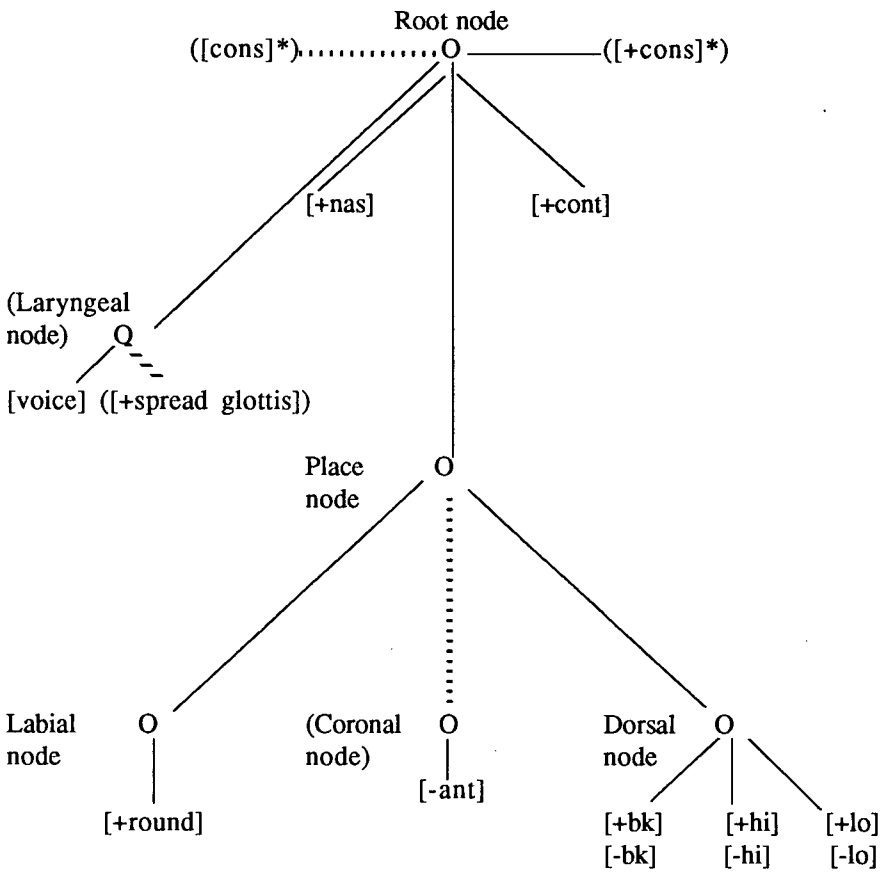
Interdentals and /r/ as well as final clusters, not mastered at the end of the phonological intervention project, were still not in use six months following the project. During language therapy following the project, the /θ/ and final clusters were targeted briefly, the latter generalizing to conversation. At age 5;9, the /r/ and interdentals remain unchanged. Multisyllabic words still present some difficulty (missing consonants or reversed sequences).

That the system was reflecting phonological change as a result of training can be inferred from the changes in trained targets, the generalizations that occurred, and lack of development for certain untrained targets.

In Block 1, untrained syllabic shapes which generalized to conversation from the trained ones were CVC's other than the trained /CV{m/n}/ and CVCV's other than those trained with /{m,n}/ and /{t,d}/. In Block 2, training on the CVCVC word shape may have facilitated the more frequent appearance of CVC.CV(C). Without training, diphthongs did not develop between the assessment and the end of Block 1, and with training, they did develop between Block 1 and Block 2, with mastery by the end of Block 3. The training of the CVVC word shape did not facilitate the untrained CVCC word shape development, where C_3 was not a plural morpheme (see discussion under question 3 below).

Segmental generalization from trained /f/ included appearance of [v], [f] for /θ/, and syllable-initial sibilants. From /l/ training, there was overextension to the /r/ and /j/, which both surfaced as [l] variants in a few words.

Not all changes were attributable to direct training, as the development of the feature [+spread glottis] and the increase in matches for affricates show. Both the focus on phonology and general development were playing a role in the overall improvement, but the major changes did appear to reflect training, especially when measures before and after the study showed minimal change in the phonological system.



Note: Single brackets and dotted lines indicate partially established constituents.
*[+cons] unestablished for /r/ only

Figure 6.1. S4: Feature geometry at end of Block 2

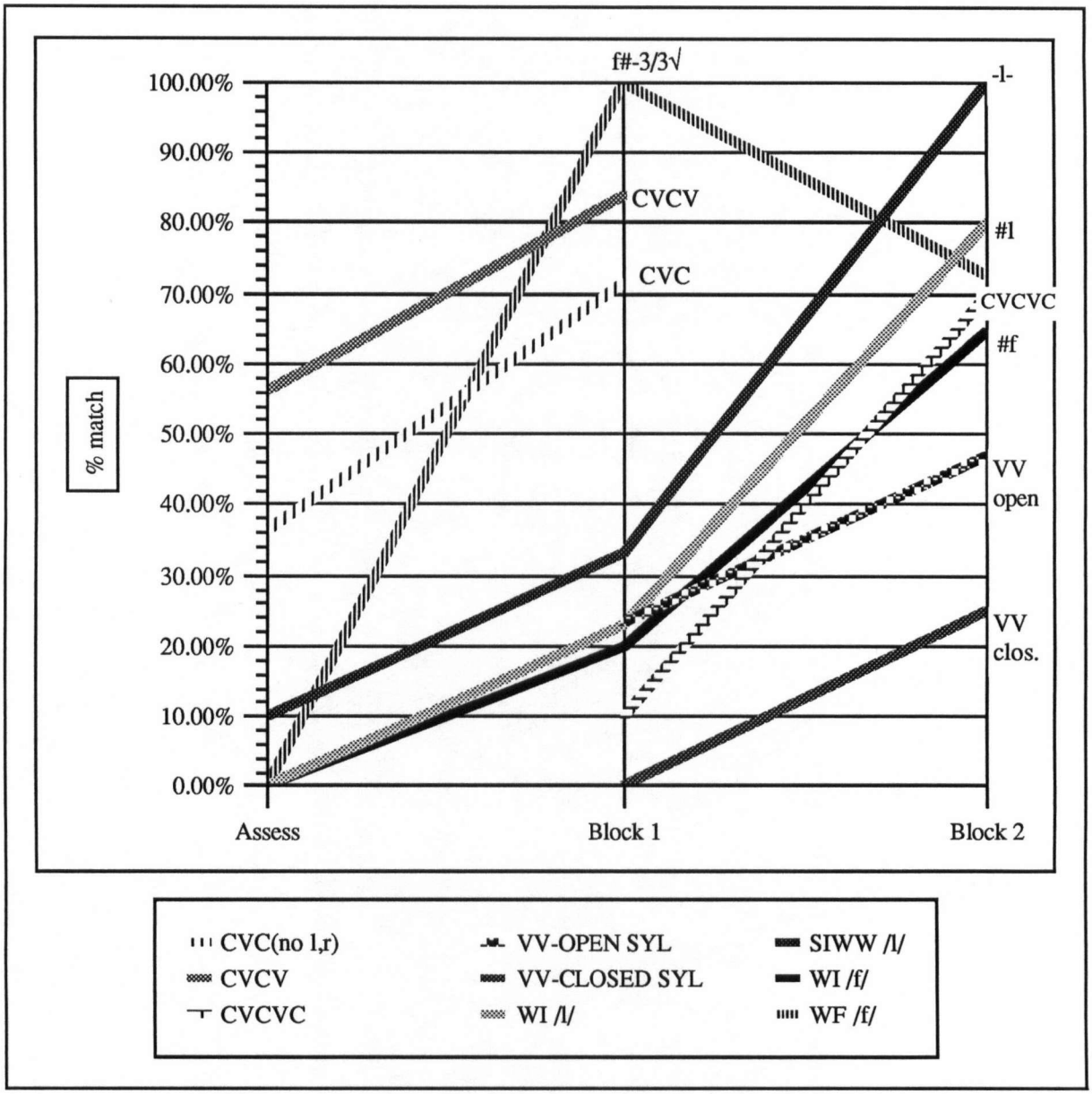


Figure 6.12. S4: Developmental progression in proportional matches for trained phonological targets across the interveniton period

Language Test Results

Language test results demonstrated positive changes in performance, which were in part a result of intensive language/speech stimulation throughout the project and in part a result of increased ability to tolerate testing. Because of the test tolerance variable, it is not possible to sort out the relative contributions of phonological intervention, general language stimulation, general development and behavioral adjustment to increases in scores and the bearing on the null hypothesis above. They are reported for interest and commentary.

Because language comprehension test scores were within normal limits at the outset, assumptions of intact comprehension, and therefore, lack of need of attention, were made during treatment planning. At the end of Block 3, the Auditory Comprehension score of the Preschool Language Scale (1979) was somewhat better than the score forwarded by the previous therapist. In seven months, there was a sixteen month gain (to 4;7 at 3;11.15). That this was probably an average score is suggested by results from the Test of Auditory Comprehension of Language (Revised), on which S4's standard score equivalent (*SS*) was -.25, (the 40th percentile), well within one standard deviation.

More significant in terms of his communication skills was the change in the Verbal Ability age score of the Preschool Language Scale, from an eight-month delay (~2;6 at age 3;4) to a four month delay 3;7.15 at age 3;11.15. The comprehension-production gap remained, in spite of an increase in both areas and an approximation of normal limits for production. Special areas of difficulty on the test (at or below his chronological age level) were sentence use (repetition and formulation) and counting, with improvements reflecting changes on the vocabulary and articulation skills sections. This type of improvement would be expected considering the nature of phonological therapy, and is probably the sole test result which bears directly (and in a positive way) on the question posed above.

There was a general increase in sentence use, which resulted in the production of more simple sentences containing both NP and VP. There was also a notable decrease in use of [n̩] as a filler form (from 50% of the connected speech utterances at the time of assessment to 26% at the end of Block 3). This was in part as a result of general development in language production, but may also be attributed to the phonological intervention, which utilized simple sentence and WH-question patterning as part of the phonological therapy in the second and third blocks. However, syntactic and morphological development continued to be significantly below average. That this was the case, whereas phonology was not a primary concern at the end of the project, contributes in a general way to a positive response to the question regarding the utility of nonlinear frameworks to prediction of logical goals.

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real?

At the end of Block 1, the average proportional increase for syllabic targets was 49.75% (*SD*: 19.17%), higher than the 41.60% average gain for segmental targets (*SD*: 38.96%). With the exception of WF /f/, the proportional increase for individual syllabic targets was greater than that for segmental ones by the end of Block 1. The WF /f/ (a crossover CVC target in any case) result (100%) was based on only three matching tokens, however. The regression observed for this target in Block 2 (to 8/11) probably shows that the Block 1 segmental result was somewhat inflated by lack of sufficient tokens.

The average proportional increase for the second block was about the same for syllabic and segmental targets (35.26% and 36.21% respectively). However, the standard deviation for the segmental targets was double that for the syllabic targets (42.64% versus 20.64%), a reflection of the regression for segmental target WF /f/. The apparent equivalency in Block 2 reflected the mastery noted for the segmental targets and one of the syllabic targets, CVCV/ŋ/, since the other syllabic target -- diphthongs -- had improved by only about 25%. The mastery of CVCVC within one block actually demonstrates a difference between conditions, since mastery of the segmental targets required two blocks.

With respect to phonological development and the autonomy of tiers, it appears that there is some independent development that can be exploited in intervention. For S4, syllabic changes led to improved intelligibility within three weeks of the onset of therapy. Final consonant development and CVCV development had begun prior to intervention. Taking advantage of this beginning development led to immediate results. Building on the final consonant program led to mastery of a more complex word form -- CVCVC. Segmental changes overall occurred at a slower rate (note the late development of /r/ and the interdentals). Targeting the two tiers independently and alternately was synchronous with this slower-changing aspect of the system.

This subject's data, however, does not support complete autonomy of tiers. In addition to autonomous developments in feature hierarchy and syllable structure, S4's developmental pattern

demonstrates that interactions of the syllabic and segmental tiers are also relevant, according to the following:

1. At the beginning of the project, default segments -- [*s/p*] word-finally and [*z/ʒ*] in SIWW position -- enabled the realization of those weakly established consonant slots.

2. The specification of continuancy in syllable-initial fricatives followed the marking of such in WF position; the specification of this feature for one fricative -- /f/ -- facilitated the realization of other fricatives in syllable-initial position.

3. The first WI-cluster was /sn/, suggesting that the sharing of Coronal Place node facilitated the realization of two consonant slots.

4. The specification of voice in WF obstruents was enabled by overarticulation of the segment, which increased the word shape by the addition of an extra vowel.

5. In a few instances when a consonant could not be articulated in a certain context, for phonetic or phonological reasons (e.g., /l/ word-finally or in clusters; an alveolar stop when a velar consonant followed the vowel), metathesis or assimilations resulted.

6. The slow development of diphthongs may have been a reflection of syllabic representational difficulties or a reflection of the difficulty of learning an entity with moving formants, or both. (However, the learning of the CVVC syllable shape, with consonant adjunction to the rime node or mora, can only be seen as a syllabic tier development.)

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of interventions that contrast the onset and rime versus those that utilize the mora as a constituent?

Evidence was not sufficient to answer this question with respect to the onset-rime/moraic intervention methods. A Kolmogorov-Smirnov measure was used to test the null and alternative hypotheses:

H_0: There will be no difference between the proportional match scores for all of the moraic (m) and onset-rime (n) measures across the study.

H_1: Moraic targets had proportionately higher proportional match scores across the study.

Only major probe (10 data points) and minor probe (4 data points) data were used. S4's session data had not been analysed because targets were different in the two conditions, and session data had not revealed any differences for the first three subjects in any case.

Table 6.3.--S4: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test

	<10%	11-15%	31-35%	46-50%	56-60%	76-80%	81-85%	86-90%	100%
s_m (x)	2/7	3/7	3/7	3/7	4/7	5/7	6/7	7/7	7/7
s_n (x)	0/7	0/7	1/7	2/7	3/7	4/7	5/7	6/7	7/7

$p > 0.1$

The largest discrepancy was 3/7, yielding a test statistic of (7)(7)(.429)=21.02, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed). The null hypothesis is thus not rejected, suggesting that the conditions were equivalent.

It may be clinically interesting, although not statistically significant, that all onset-rime targets showed higher proportional increases in each block except for the diphthongs. With the exception of SIWW /m/ and /n/, the moraic targets were at a lower level in absolute matches at the onset of each therapy block. This biasing most likely contributed to a lower level of absolute matches at the end of each block for the moraic targets, but it did not have to result in lower relative gains. Because this child had very strong personal responses to therapy activities (as mentioned above in the Block 2 syllabic condition results), and because his mother put a very creative and time-intensive effort into all home assignments, further confounding of this condition with personality variables is probable. (One would expect the personality variables to have been applied equally to both conditions, but this may not have been so).

One interesting lack in development beyond Block 2 may have bearing on the syllable theories in question. The training of the CVVC word shape did not appear to facilitate the CVCC word shape development. The only final consonant clusters were C[s/z] clusters, either from plurals or from metathesis (e.g., in the Block 3 probe, mask> [mæks], but jump >[ʤʌp] and hand>[ʔæn]). The [s] use probably parallels the default [*s*] adjunction at the onset of CVC

development -- a kind of extrametrical adjunction reinforced by English morphology. This lack of generalization may have a purely phonetic basis (difficulty in coarticulation of consonants as opposed to diphthongs) but may also show the superiority of the onset-rime representation of CVVC over the moraic representation of the same. In the former, CVVC and CVCC differ in representation. The CVVC syllable has a branching nucleus and single consonant adjunction to the rime node; the CVCC has a nonbranching nucleus with two consonants adjoined to the rime node. According to moraic theory, in a 'Weight by Position' language such as English, CVVC and CVCC are virtually equivalent, with two morae and one single consonant postmoraic adjunction. If such were the case (and given the other generalizations noted within the system) both might be expected to develop within the same time period, but CVCC word shapes other than C=[s/z] did not appear until trained seven months later. This may suggest a representational difference between the two. (Contiguous consonant production was possible in WI position and across syllable boundaries, so articulatory difficulty may not have been a strong factor in the late emergence of WF clusters.)

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

As noted in the analysis sections above, the variations in the /l/ and /f/ data make it difficult to determine which segment developed faster. In the first block, the /f/ appeared to be better established in SIWW and WF positions, with /l/ being slightly (and probably insignificantly) better developed in WI position. Just before the end of Block 2, /f/ again appeared to be developing faster according to the minor probe. By the end of Block 2, however, there was a regression for WF /f/, and a higher rate of matches for WI and SIWW /l/. This could lead to a tentative conclusion that the Higher Level Feature segment -- /l/ -- was learned at a more rapid rate. Unfortunately, the major probe data for /l/ was based primarily on echoic responses versus spontaneous ones for /f/ (similarly in the minor probe), weakening any tentative conclusion further.

Generalizations observed for related targets support the relevance of features. For example, /v/ developed alongside /f/, SI coronal fricatives appearedafter /f/ training, and /θ/ became realized as /f/. Thus the Labial Place node in combination with the Root node feature [+continuant] became established "across the board", and the WI training for /f/ resulted in establishment of syllable-initial fricatives ([+continuant]). There was overgeneralization of the /l/ to a few words with /j/ and /r/ (the other coronal sonorants). Training of CVC with /m/ and /n/ increased matches for other inventory segments in the WF position and facilitated WF /f/ establishment. The latter demonstrated predictable amalgamation of the Root node feature [+continuant] from [s] and Labial Place node from /p,m/ to /f/. Feature spread was noted among SIWW targets, from /t/ and /d/ to other stops, from /m/ and /p/ to /f/ and from /f/ to /s/. Training of the plural /z/ may have helped establish WF voiced obstruents.

Summary

Prior to the project, S4's speech was unintelligible most of the time, due to his phonological disorder and general language production disorder. At the end of project, he was intelligible most of the time, although his sentence production continued to be limited. In Block 1 he gained mastery of the trained syllabic word shapes CVC and CVCV; in Block 2 he gained mastery of the trained segmental targets /l/ and /f/ and the trained syllabic target CVCVC, as well as partial mastery of the diphthongs. Most gains in untrained targets were predictable: (1) general CVC and CVCV establishment from training only on SIWW and WF nasals and SIWW coronal stops, (2) CVC.CV(C) from CV.CVC ($VC_2 > VC_1$), (3) /v/ from /f/ (voicing cognates), and (4) WI /s/ from WI /f/ (establishment of Place node for WI [+continuant, +consonantal]). Overgeneralizations from /l/ to /r/ and /j/ and /f/ to /θ/ demonstrate the unity of the sound classes and the effects of new specifications on underspecified units in the system.

Although S4 acquired affricates and /h/, even without indirect intervention through predictable generalization, he did not master CVCC until training six months after the project period, and two years later still did not produce /r/ and the interdentals, suggesting that intervention directly affected learning rate. The small gains in syntax in comparison with the phonological gains demonstrate that the intervention was more than general developmental acceleration.

In the first block rate of gain was greater for syllabic targets than segmental, the latter reaching mastery level only by the end of the second block. The second block average gain was equivalent for the two conditions, because of the slower rate of acquisition for diphthongs compared with other targets in that block. Considering that the segmental targets did not reach the 25% level of conversational use of the latter after one block of treatment, rate of acquisition was still accelerated more for syllabic than segmental targets overall.

Tier autonomy was evident in the independent learning for each block. However, interactions of the tiers also impacted on development in terms of, for example: (1) the default segments in WF ([*p*], [*s*]) and SIWW ([z/ʒ]) positions at the onset of treatment, (2) acquisition of WF before WI fricatives, (3) acquisition of /sn/ before other /s/-clusters, and (4) the slower rate of change for diphthongs, which, although considered syllabic targets, may have involved segmental learning as well (particularly for /ɛɪ/).

Syllable shape mastery did not seem to depend crucially on the learning of one type of constituent stimulus versus another, as targets under both moraic and onset-rime conditions showed gains. However, for this subject, all onset-rime targets progressed at a faster rate. Order of presentation may have been important for him, with first-learned material having the greater impact, simply because it was first, and secondly, because a longer period was available for consolidation of the targets. The onset-rime representation of diphthongs as distinct from the moraic may have some relevance for the failure of CVCC to emerge after the training of CVVC. In the moraic theory, the two formulations are similar, whereas in onset-rime theory they are quite different. In the case of S4, the CVCC word shape did not emerge after training of diphthongs, with the exception of those words with plural morphemes (which involve a different type of adjunction).

Feature hierarchy level appeared to be only marginally relevant for order of emergence of /l/ and /f/.

CHAPTER 7

SUBJECT 5: SUMMARY

[ʔɑɪ tᵘɰɑɪ]

Case History Information

Subject Characteristics

During the reported period of the study, this boy was 6;2 - 6;6. His phonological disorder was associated with the following (see tables 7.1 and 7.2):

1. A general one to one-and-a-half year developmental delay
2. A moderate to severe delay in language development, particularly in production
3. An intention tremor affecting fine motor manual skills
4. Some suggestion of oral neuromotor involvement, indicated by a slight deviation of the tongue to the left on protrusion, a delay in imitation of tongue movements and slow rate of syllable repetition. Other possible (but inconsistent) oral mechanism influences on speech production were the tendencies to clench teeth when making effortful articulation and to protrude the mandible when approximating upper and lower teeth. The quiet and sometimes tremulous quality of his voice could have had a neurological basis or a psychosocial one (see the comments re response mode below).
5. The Test of Language Development (Primary) Auditory Discrimination Subtest suggested a marginal weakness in phonemic discrimination.

His medical history indicated a post mature Caesarean birth to a mother suffering from hypothyroidism. Medical testing of S5 two years prior to the study was negative for thyroid involvement.

Table 7.1.--Subject information for S5

AGE	6;2 - 6;6 for reported period
GENDER	Male
BIRTH ORDER	First of 2 children; younger sister with normal development
OTHER FAMILY HISTORY	English-speaking (Canadian-raised parents). Father Grade 12 education; mother Grade 10 Father's brother 'dyslexic' Mother and children spent one year in urban area to obtain SLP services
HEARING	Screened within normal limits at beginning of project
GENERAL DEVELOPMENT	Cognitive development -- mild delay (per testing during project period at local hospital)* Gross motor skills -- mild delay in some areas (per testing during project period at local hospital)* Fine motor skills: Intention tremor and mild-moderate delay in several areas (per testing during project period at local hospital)* Feeding history Bottle-fed; difficult to feed in first few weeks Used pacifier until about 9 months.
MEDICAL HISTORY	Born post mature with Caesarean section. Mother had hypothyroidism during pregnancy but similar testing yielded negative results for S5. Frequent viral infections.
ORAL MECHANISM	Babbling: Minimal amount, per mother's report Tongue: Slight deviation to left on protrusion : Delay in approximating tongue movements Teeth: Tendency to jut mandible forward on occlusion : Tendency to clench teeth when producing phones not in inventory : Teeth grinder at night, per mother's report : Acquiring lower central incisors at time of assessment Syllable repetition: Slow but accurate repetition of [pʌtʌkʌ] sequences Phone repetition: Stimulable for all but [ʤ] and WI [r] Voice: Quiet, sometimes tremulous voice
PREVIOUS THERAPY	Three months at age 4, one month at age 5 for language stimulation Urban school system speech therapy prior to project: 6 months twice/wk.: Dorsal stops acquired; increase in use of prepositions, is, articles; no change on briefly targeted WI /l/, /st/

*Scores are not reported for reasons of confidentiality.

Table 7.2.--S5: Language test results at Initial Assessment and end of Block 3

TEST	PRETEST SCORE	POSTTEST SCORE
Peabody Picture Vocabulary Test (Form L)	*S.S.** : 86	*S.S.* : 94
Test of Auditory Comprehension of Language (Rev.): Total Score	*S.S.* (*z*): -2.05 (marked delay)	*S.S.* (*z*): -.52 (low average)
Test of Auditory Comprehension of Language (Rev.): Word Classes and Relations	*S.S.* (*z*): -1.56 (below average)	*S.S.* (*z*): -.39 (low average)
Test of Auditory Comprehension of Language (Rev.): Grammatical Morphemes	*S.S.* (*z*): -3.5 (very marked delay)	*S.S.* (*z*): -1.00 (borderline average)
Test of Auditory Comprehension of Language (Rev.): Elaborated Sentences	*S.S.* (*z*): - .61 (low average)	*S.S.* (*z*): -.05 (average)
Test of Language Development (Primary Revised): Auditory Discrimination Subtest	Raw score: 10/20 (borderline average)	Raw score: 20/20 (above average)
Expressive One-Word Picture Vocabulary Test	19th percentile (per hospital testing during Block 1)	53rd percentile (average)
Sentence use (General comments)	Language sample: Single words or 3-4 word sentences Minimal use of unbound grammatical morphemes	Language sample: Decrease in one-word utterances; increase in use of sentences Some self-correction for gramm.morph. More initiation of questions and sentences beginning with conjunctions

**S.S.*=Scaled Score

S5 was susceptible to viruses and often absent from kindergarten as a result. (He did attend all sessions of the intervention project, but there were two or three days per month when ill health interfered with active participation). His basic strategy in testing and conversation was minimalist. It appeared that slow response time, lack of energy to engage in the efforts required for language production or academic activity, as well as lack of confidence, contributed to the low scores and reduced language output. During the six-month therapy period in the school system immediately prior to this study, he acquired use of dorsal stops and some use of spatial relations prepositions, question forms, articles, and is. Although WI /l/ and /st/ had been targeted briefly, no changes had occurred in conversation.

Phonogical System at Initial Assessment

Phonotactics: Syllables and Words

Overview

S5 used basic English word and syllable shapes. Exceptions included (1) words containing syllable-initial clusters and (2) occasional word reductions and/or metatheses in production of complex multisyllabic words, e.g., rhinoceros > [nowɑɪnwɔðɪ], dinosaur > [dɑɪnˈθɔɚ]. Nasal clusters were usually intact word finally and medially, although /nd/ > [n] on five of six occasions. Data is reported here only for the syllable-initial clusters, which were reduced or simplified in comparison with the adult target. As the length of the word increased, the frequency of reduced clusters increased.

WI Clusters

The following was observed in terms of cluster matches for WI skeletal slots (not necessarily segments). Matches are reported for clusters with and without short epenthesis, assumed to be a minor timing mismatch (see appendix 4, table 5.1).

1. Overall: 25/93 (26.88%) matches. With short epenthesis ignored as a mismatch, there were 35/93 (37.63%) matches.

2. Monosyllabic words: 18/57 (35.58%) matches for diconsonantal clusters, with nonmatches being singletons (ignoring short epenthesis -- 27/57 [47.37%] matches). Neither diphthongs nor postvocalic consonants appeared to influence realization of initial cluster elements, indicating that output limitations for monosyllables were not based on number of skeletal slots.

3. Disyllabic words: 7/33 (21.21%) matches for diconsonantal clusters (for /br/, /gl/, /sp/, /kr/ [2], /sn/ [2]), with nonmatches being singletons (ignoring short epenthesis -- 8/33 [24.24%]).

4. Words of three or more syllables: 0/3 matches for diconsonantal clusters (singleton realizations).

5. Triconsonantal clusters: No matches on four attempts. For three of the target words, two consonant slots were filled: /skw/ >[θ^·k], /spr/ > [θ^p], /str/ > [θʊw] and for the fourth, only one: /str/ > [θ]. The latter cluster initiated a compound word-- Strawberry Shortcake, whereas the others were monosyllabic.

According to points #4 and #5 above, words of three or more syllables, i.e., words of more than one foot, had only singleton realizations of clusters, suggesting an interaction between the word tier and skeletal tier at that level of word complexity.

Syllable-Initial Clusters Within Words

There were no matches for SIWW clusters (0/12).

Segmental Realization of Cluster Elements

The segmental data further demonstrates the delay in cluster development (see tables 7.3 and 7.4 and figure 7.1). With the exception of /sk/ in one of three items (sky), no consonant clusters matched adult targets for *both* segments. The first segment of the cluster matched the adult target 50% of the time and the second element only 18.42% of the time, as a result of minimal development among the liquids. There were further differences in realization of the two consonantal-type elements depending on their segmental composition.

Table 7.3.--S5: WI consonant slot matches by cluster category and match type at Initial Assessment and at the ends of Blocks 1 and 2

Cluster type	Match[a] type	Assessment #CC matches	Block 1 #CC matches	Block 2 #CC matches
#CC + segmental match	#CC	1/101	3/78	5/101
	Including epenthesis[b]	2/101	10/78 (12.8%)	14/101 (13.9%)
/s/ - clusters	#CC	11/26	12/25	15/47
#CC match	Including epenthesis	Same	14/25	21/47
/r/ - clusters	#CC	7/45	3/31	3/26
#CC match	Including epenthesis	12/45	18/31	15/26
/l/ - clusters	#CC	4/21	1/16	0/21
#CC match	Including epenthesis	5/21	10/16	14/21
/j/ - clusters	#CC	0/7	0/1	No tokens
#CC match	Including epenthesis	0/7	0/1	
/w/ - clusters	#CC	0/2	1/5	4/9
#CC match	Including epenthesis	1/2	2/5	6/9

[a]Unless otherwise indicated, matches are in terms of consonant slots, not segments.

[b]Epenthesis designates a reduced vowel, shorter in duration than a full vowel.

Table 7.4.--S5: WI /s/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2

Substitution type	Assessment	Block 1	Block 2
SYL[a]: CC match	*TOTAL: 9/25*	*TOTAL: 11/25*	*TOTAL: 11/31*
SEG[a]: /s/ > [+*dstr*] *m^b	/sm (2/2), sn (3/4), sp (1/1), sk (1/3), sl (2/4)/	/sm (2/2), sn (2/3), sp (4/4), st (2/10), sl (1/3 - /l/ >[w])/ With epenthesis: /sn/ (*3/3*)	/sm (2/3), sn (1/7), sp (3/4), st (3/8), sk (2/5)/ C_1 > 'complex' *m^b: /sn (3/7), sk (1/5)/
SYL: CC match SEG: /s/ > [-ant]			*TOTAL: 3/31* /sn (1/7), st (2/8)/
SYL: C_2 present; : C_1: RN > Ø	*TOTAL: 3/25* /sn (1/4), st (1/11), sk (1/2)/	*TOTAL: 3/25* /sk/ (2/2) /st/ (1/10) ([+vd])	*TOTAL: 3/31* /sm (1/3), sp (1/4), st (1/8)/
SYL: C_1 present; : C_2: RN > Ø, SEG:/s/>[+*dstr*] *m	*TOTAL: 11/25* /st (9/11), sl (2/4)/	*TOTAL: 8/25* /st (6/10), sl (1/3)/ (5/8 >'*complex*' *m &1 /st/ > [tʃ])	*TOTAL: 2/31* /sn - (1/7: C_1 > '*complex*' *m), st (1/8)/
SYL: C_1 present; : C_2: RN > Ø SEG: C_1: /s/ >[-ant]			*TOTAL: 2/31* /st (1/8), sl (1/5)/
SYL: CC with epenthesis SEG:/s/>[+*dstr*] *m			*TOTAL: 5/31* /sk (1/5), sl (4/5)/ /l/ > [w] (2/4) /l/ > [l̰] (1/4)
SYL: CC with epenthesis SEG: /s/ > [-ant] m		*TOTAL: 2/25* /sw/ (1/1 - /w/>[r]; C_1 '*complex*' *m) /sl/ (1/3 - [w])	
SYL: CC with ep. SEG: [$k^{ɨ}$ - k ^{ə}l j̇]			*TOTAL: 1/31* /sk/ (1/5)

[a]SYL = syllabic level realization, SEG = segmental level realization

[b]*Italics*, *m = specified inappropriately with reference to appendix 2

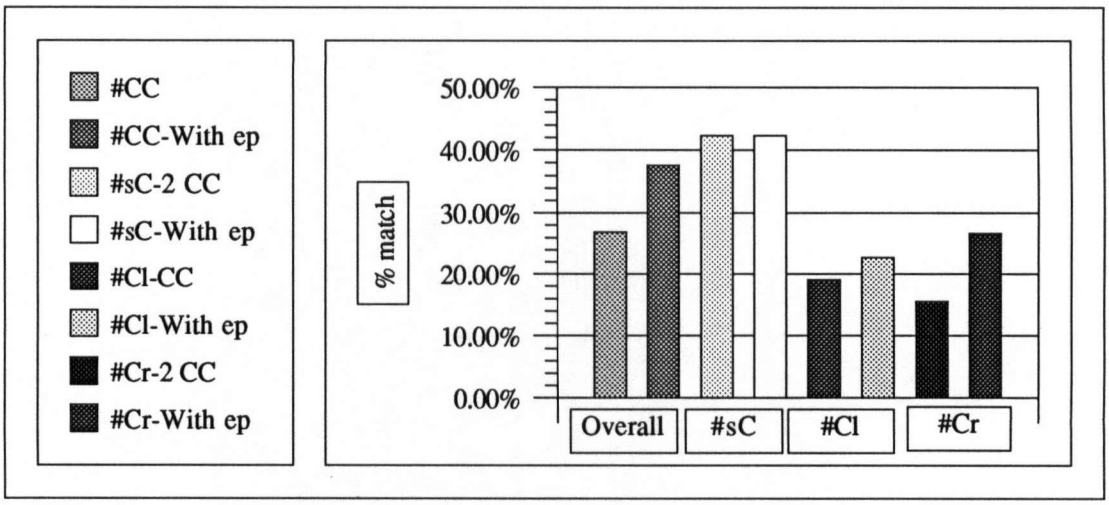


Figure 7.1. S5: Proportional matches for two element (CC) clusters with and without short epenthesis, overall and by cluster type, at Initial Assessment

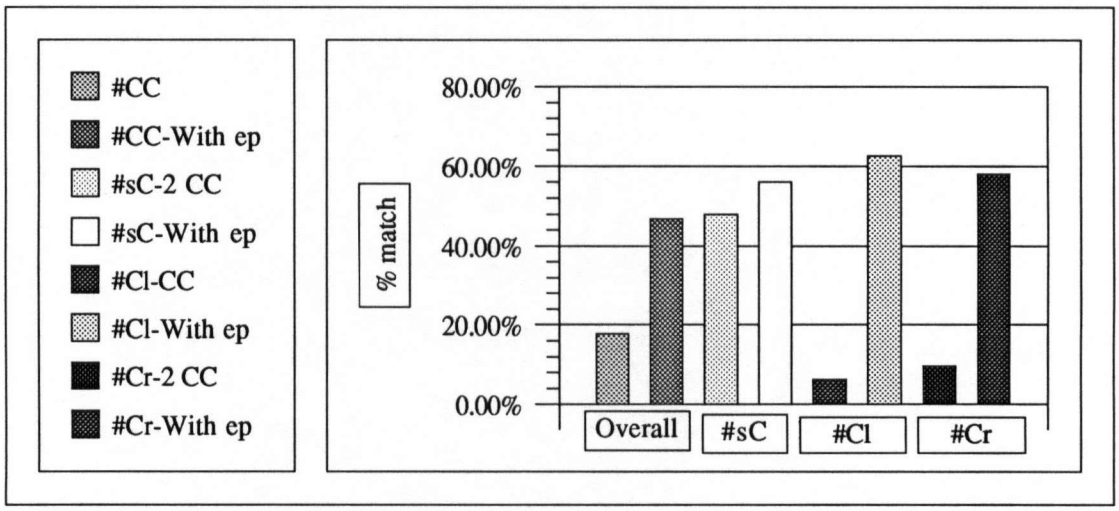


Figure 7.2. S5: Proportional matches for two element (CC) clusters with and without short epenthesis, overall and by cluster type, in Block 1 major probe

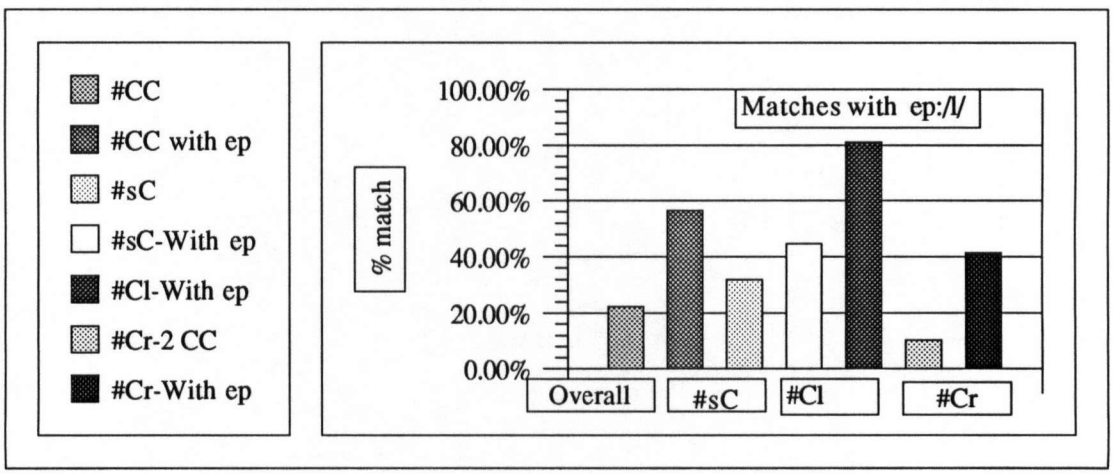


Figure 7.3. S5: Proportional matches for two element (CC) clusters with and without short epenthesis, overall and by cluster type, in Block 2 major probe

WI /s/-clusters

In terms of skeletal slot realization, 11/26 (42.31%) /s/-clusters had two elements. Variability in skeletal slot realization was noted for /s/-clusters within and across cluster types, although /s/-nasal clusters and /sp/ clusters were realized with both elements more often than other clusters (see tables 7.3 and 7.4).

1. Cluster with both elements realized (in descending order): /sm, sp, sn, sk, sl, st/. In other words, some of the time there was a surface realization of /s/ > [θ] over all categories. The least developed was /st/, with only 1/12 tokens having two consonants.

2. Clusters with missing Root nodes: /st, sl, sk / and one of four /sn/ tokens. In the case of /sk/ and /sn/, the noncontinuant was realized, possibly because the omission of an extrametrical consonant (/s/) is a type of phonotactic default at the syllabic level. The surfacing of /s/ (as [θ]) for /sl/ (two out of four cases) seems to support the extrametrical hypothesis, since /s/ is purportedly not extrametrical before /l/. It is also possible that the specified features for /k/ (Dorsal node) and /n/ ([+nasal]) take precedence over the [+continuant] marked feature of /s/. That usually only the supposedly extrametrical /s/ was realized for /st/ seems to indicate that segmental attributes of the cluster play a role at least equal to syllabic constituency in determining which of two elements will surface when phonotactic constraints oblige activation of only one. In appendix 2, both /s/ and /t/ are among the least specified consonants with /s/ relatively more marked than /t/ by having [+continuant] as its extra specification. According to that designation, it appears that the more marked of two minimally different adjacent consonants may surface when syllabic constituency is constrained. Although /sn/ also consists of adjacent coronal consonants, [θn] or [n] surfaces rather than a [θ]. One might speculate that /n/ surfaces since syllabification can take place (from right to left) on the most sonorous first prevocalic consonant which has marked specification, in this case, [+nasal].

3. Triconsonantal clusters with /s/ (/skw, skr, spr/, /str/): Again clusters with and without /t/ differed in segmental realization. Even though the /s/ is purportedly extrametrical in all of the #CCC clusters, it was the approximant that did not surface for the clusters without /st/, (i.e., the third element) and either only the /t/ or the /t/ and the approximant that did not surface for the /str/ clusters.

Stop-Initial Clusters

A. Stop-glide clusters

For clusters with /j/ and /w/, the stop alone appeared, although in one of two cases, both elements of /kw/ appeared, with an intervening long epenthetic vowel (see table 7.5).

B. Stop-liquid clusters

Both /l/- and /r/-clusters had two elements less than 20% of the time. Two elements appeared slightly more often for /l/-clusters than /r/-clusters (see tables 7.3 and 7.5), although when clusters with epenthesis the reverse was true. In general, the dorsal stop clusters appeared more advanced at the syllabic level, possibly because of some phonetic (and perhaps phonological) affinity of dorsals and [w].

1. For the /l/-clusters, there was a difference between dorsal and labial stop clusters (see tables 7.3 and 7.5). The latter only surfaced with two elements when epenthetic vowels were also present. For the dorsal stop-/l/ clusters, both elements surfaced without epenthesis (some of the time). This was in contrast to (admittedly limited) data for /kw/ clusters. As [w] is often considered to have both labial ([+round]) and dorsal ([+back]) components, it is noteworthy that the [w] did in fact appear with both labials, e.g., brother > [bwʌDoᵘ], and dorsals, e.g., crash > [kwaðₒ]). Whether the epenthesis was a random phonetic artifact or had some significant phonological basis (such as distancing of two like elements, one of which could be subject to deletion because of some Obligatory Contour Principle [McCarthy 1986]) cannot be determined.

2. For the /r/-clusters, the data was more variable (see tables 7.3 and 7.6). All but /gr/-clusters appeared as single elements, and all but /pr/ clusters appeared as diconsonantal clusters. Only the dorsal stop clusters appeared with epenthesis (reminiscent of /kw/ and in opposition to /kl/), and only the coronal-/r/ and /br/-clusters appeared with complex segments in place of stops, e.g., dress > [ᵈðɑᵊθ], brushing > [bᵛrʌfɪn]. The coronals were unique in appearing often as [+continuant], e.g., drink > [ðɪŋk]. In this way the /tr/- and /dr/-clusters were similar in output to the /st/-clusters. Perhaps some trace of [+continuant], a redundant feature from the [+sonorant] /r/, was being realized through the underspecified coronal stops, in some kind of system analogy between the more advanced /s/-clusters and the later-developing /r/-clusters.

Table 7.5.--S5: SI /l/-, /w/- and /j/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2

Substitution type	Assessment	Block 1	Block 2
/l/ - clusters	*TOTAL: 4/21*	*TOTAL: 1/11*	
SYL: CC match SEG: C_2: *Lab*[a] for Cor	/kl (3/8), gl (1/1)	/fl/ (1/1)	
/l/ - clusters	*TOTAL: 3/21*	*TOTAL: 7/11*	*TOTAL: 8/15*
SYL: CC with epen[b] SEG: C_2: *Lab* for Cor	/pl, bl, fl / - 1 each	/pl (3/3), kl (1/1), gl (3/3)/	/pl (2/4), kl (1/1), fl (1/5), gl (4/5[v]/[w])/
/l/ - clusters		*TOTAL: 1/11*	*TOTAL: 1/15*
SYL: CC with epen SEG: [r] coloring		/bl/ (1/3)	/pl/ > [p^{ə}ɻ] - 1/4
/l/ - clusters			*TOTAL: 3/15*
SYL: CC+long epen SEG: Match			/gl/ - 1/5; /fl/ (2/5)
/l/ - clusters	*TOTAL: 13/21*	*TOTAL:2/11*	*TOTAL: 3/15*
SYL: C_1 present; : C_2:RN > Ø	/pl (6/7), bl (2/3), kl (5/8)/	bl/ (2/3)	/pl/ - 1/4 /fl/ - 2/5
/l/ - clusters	*TOTAL: 1/21*	*TOTAL: 0/11*	
SYL: C_2: RN> Ø SEG: C_1:*'complex' *m*	/fl/ (1/2)		
/w/ - clusters	*TOTAL: 1/2*	*TOTAL: 2/5*	
SYL: C_1 present; : C_2: RN > Ø	/kw/ (1/2)	/tw/ (2/3)	
/w/ - clusters			*TOTAL: 2/3*
SYL: CC+ long epen SEG: Match			/kw (1/2), tw (1/1 - false start [f])/
/j/ - clusters	*TOTAL: 7/7*	*TOTAL: 1/1*	
SYL: C_1 present; : C_2: RN > Ø	/mj (3/3), fj (1/1), kj (3/3)/	/mj/	

[a]Italics = inappropriate specification according to appendix 2

[b]Unless noted, any epenthetic vowel is considered a nonmatch.

Table 7.6.--S5: SI /r/-cluster realizations at Initial Assessment and at the ends of Blocks 1 and 2

Substitution type	Assessment	Block 1	Block 2
SYL: CC match	*TOTAL: 7/45*	*TOTAL: 1/25*	*TOTAL: 3/25*
SEG: C_2 > *Lab** for Cor	/br (1/8), tr (2/10), kr (2/4), gr (1/3), θr (1/3)/	/θr/ (1/3)	/br (1/9), kr (2/5)
SYL: CC match SEG: C_1>[+*dstr*, +*cont*] : C_2:*Lab* for Cor	*TOTAL: 2/45* /tr - 2/10/	*TOTAL: 0/25* With epenthesis: /tr/ (2/4)	
SYL/SEG: C_1:'*complex*' **m* SEG:C_2:*Lab* for Cor	*TOTAL:5/45* /br (1/8), tr (1/10), dr (3/12: [-vd] 2/3)/	*TOTAL: 1/25* /dr/ (1/4) [ʤ] but also [ɰ]	
SYL: C_1 present; : C_2: RN > Ø	*TOTAL: 14/45* /pr (1/1), br (6/8), tr (1/10), dr (1/12), kr (2/6), fr (2/2), θr (2/3)/	*TOTAL: 4/25* /pr (1/2), br (1/8), θr (2/3)/	
SYL: C_1 present; : C_2: R N > Ø SEG: C_1>[+*dstr*] **m*	*TOTAL: 7/45* /tr (3/10), dr (4/12)/		
SYL: C_1 present; : C_2: RN > Ø SYL/SEG: '*complex*' **m*	*TOTAL: 6/45* /tr (2/10), dr (4/12)/		
SYL: CC with epenthesis (short or long epenthesis) SEG:C_2:*Lab* for Cor	*TOTAL: 4/45* /kr (2/4), gr (2/3)	*TOTAL: 11/25* /br (1/8), dr (1/4), kr (7/7 - 1 /k/ > [+vd]), gr (2/3)/	*TOTAL: 6/25* /pr (1/1), br (1/9), tr (1/3), kr (1/5), fr (1/2), θr (1/1) - (θ >[f])/
SYL: CC with epenthesis SEG: C_2> [l]		*TOTAL: 1/25* /br/ (1/8)	*TOTAL: 6/25* /br (4/9 + 1 [bʏ l]), kr (1/5), gr (1/3 + 1 [rl])/
SYL: CC with epenthesis SEG: C_2> [ɰ]		*TOTAL: 5/25* /pr (1/2), br (2/8), tr (1/4), gr (1/3)/	*TOTAL: 8/25* /br (1/9), tr (2/3), dr (2/2), kr (1/5), gr (1/3), fr (1/2)/

**Italics* = inappropriate specification according to appendix 2

Segmental Development

Segmental Matches

In general, the segmental system was not as well-developed as the prosodic structure for this child. The order of match data across word positions (excluding the undeveloped clusters) was SIWW position (60.82%) > WI (60.27%) > SFWW (52.11%) > WF (43.64%) . For all consonants and cluster segments, 48.85% of the child forms matched adult targets. Match data revealed the following (see table 7.7 and figure 7.4):

1. Vowel mismatches reduced intelligibility but vowels were not considered to be as much a priority as consonants for intervention in Blocks 1 and 2. Hence, they were not analyzed until the beginning of Block 3, and are not included for description in this paper. There was apparent random variability between front mid and high vowels and a lack of use of /u/ and /ɛ/. Diphthongs were generally adequate.

2. The order of sound class establishment was (in descending order): glides > nasals > voiced stops > voiceless stops > fricatives > liquids. Nasals were well established except for /ŋ/. Stops were established for place, but varied in Laryngeal node specification depending on syllable position. WI stops matched only 59.66% of the time, usually because of lack of [+spread glottis] (aspiration). WF stops matched slightly more often (65.79%) because of devoicing (complete or partial). Coronal stops were the least well developed with occasional marking of [+continuant] (with or without 'complex' marking) and some dentalization, particularly word initially and for the voiceless /t/. The labial fricative /f/ was well established except in SIWW position and its voiced counterpart was developing. Coronal fricatives and affricates were produced randomly as defaults [θ] or [^{t}θ] (or the voiced counterparts). Both liquids were marginally within the system, the /ɹ/ being advanced over the /l/ by its appearance word finally after /ɑ/ and /ɔ/, and once in SIWW position (after /ɑ/ and before /i/ in a derived /ar/-word -- starry). Only one token of [l] (out of 18 attempts) appeared (in WI position).

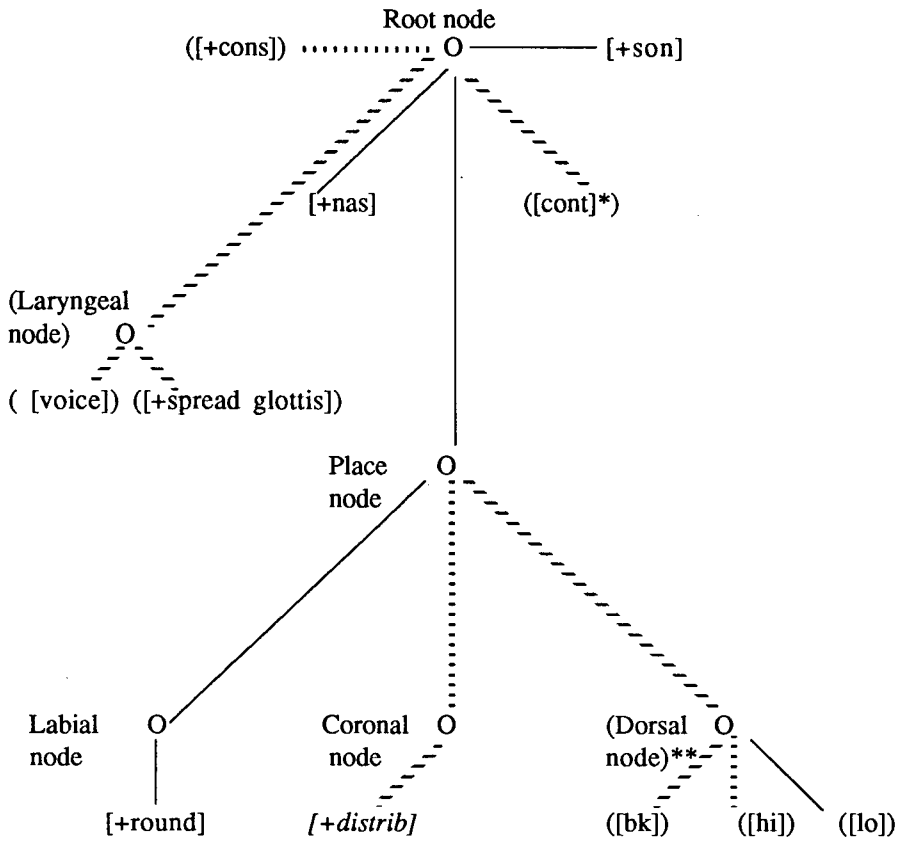
3. The order of Place node establishment was Labial > Dorsal > Coronal. There were no Place node mismatches for labials in the consonant system. However, the lack of the /u/ is unusual in terms of V-Place features. Usually /u/ is the vowel specified for Labial [+round], but for S5, /u/ > [ou], suggesting that height was the critical factor for distinction of /u/, rather than Labial.

Table 7.7.-- S5: Summary of singleton segmental acquisition at Initial Assessment

Sound class	Word position matches	Word position nonmatches	Main feature differences
Vowels	Low vowels, central vowels, mid back vowels, most diphthongs	Inconsistency in mid and high front vowels including diphthong /ɛɪ/; /u/, /ɚ/ unestablished	Rhotacization u for /ɚ/ [hi] u[1] for /u/ Variability in height specification for mid & high front vowels [-ts] u for most mid and high front lax vowels
Glides -- /w, j/	/w/ - All /j/ - WI, (SIWW)[2]		
Nasals	/m/ - All but (SFWW) /n/ - All /ŋ/ - (SFWW)/_.k, g	((/ŋ/ - WF))	/ŋ/: Dorsal u
Stops [-voice]	WF, (WI) SFWW - /t/, /k/ SIWW - /p/, /k/, (/t/)	SFWW - /p/	WI: [+spread glottis] u /t/: Above or [+*distrib*] *m** or '*complex*' **m*[1] SIWW /t/: R:Ø
Stops [+voice]	WI, (WF) - All SIWW - /b,g/, (/d/) SFWW - /g/	SFWW - /d/	/d/: (SFWW, SIWW) Cor: [+*dstr*] **m* or R:Ø WF: Partial devoicing
Fricatives -- Labial	/f/ - WI, SFWW /f/, v/ - (SIWW) /f/, /v/ - WF	/v/ - WI (1 token only)	/v/ - Partial devoicing Minor infrequent errors
Fric/Affricates -- Coronal	None	All	[+dstr] **m* or u (for /ð/) ('Complex' **m* or u) /θ/: *Lab* for Cor **m* R:Ø: A few SFWW, WF
Liquids	/r/ - (WF)	/l/ - ((WI)) - 1/18 /r/ - ((SIWW)) - 1/24 All others	Both: [+cons] u /r/: [+dstr] u; 2 [w̩] (WI, SIWW) or R:Ø:SF (a few) /l/: *Lab* for Cor **m* or R:Ø SFWW (a few)
/h/	All		

[1]u= unspecified; **m, italics* = specified inappropriately with reference to appendix 2

[2]Single parentheses indicate partial establishment: 40% - 80% in the Matches column; 10% - 40% in the Nonmatches column. Double parentheses indicate marginal development -- less than 10%.



Note: Parentheses and dotted lines indicate marginal features or nodes in system development. Italics indicate inappropriate feature.

*'Complex' branching structure for affricates specified some of the time, also sometimes inappropriately for coronal stops

**Dorsal unspecified for nasals, and sometimes [+hi] or [-hi,-lo] unspecified for vowels

Figure 7.4. S5: Feature geometry at Initial Assessment

In terms of Dorsal C-Place, /ŋ/ was not yet established. In terms of the Dorsal V-Place, there was variability in specification of height (including for /u/ as noted above and for front high and mid vowels) and tenseness. For Coronal Place, there were mismatches in all consonant classes, with default segments [θ]/[^{t}θ] appearing for fricatives and sometimes /t/.

Segmental Nonmatches for Consonants

Nonmatch feature differences were as follows (in an approximate descending order determined partly by word and consonant frequency and partly by feature difference salience):

A. Unspecified child forms where adult targets are specified

1. Root node: [+consonantal] was unspecified for liquids (except for /r/ after /ɑ/ and /ɔ/, and WI /l/ once).

2. Root node: The Root node was unspecified (i.e., there was a missing element) in clusters, and occasionally for SIWW /t/ and /d/, SFWW /d/, /m/, /s/ and liquids, and WF /r/, /t/, and /z/.

3. Place node: Dorsal Place was not specified for /ŋ/ except some of the time before dorsal stops.

4. Laryngeal node: Voiceless WI stops were unaspirated most of the time (lack of redundant feature [+spread glottis] although [+spread glottis] was specified for /h/).

5. Laryngeal node: [+voice] was unspecified for obstruents, primarily stops.

6. Root node: [+continuant] was unspecified for /ð/.

7. Branching (complex) structure of affricates was in place syllable initially 7/17 times. Coronal fricatives and stops sometimes had inappropriate branching structure, i.e., they were not identifiable as definite stops or fricatives, but had stop or fricative onsets or offsets.

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Place node: Coronal Place: [+*distributed*] dental or interdental place was observed for sibilants and some coronal stops. As for S1, the default coronal segment for S5 was not merely

[+anterior] but [+*distributed*]. Coronal Place node was underspecified in the extreme, as the lack of clearly distinguishable stops, fricatives and affricates demonstrates.

2. *Place Node: *Labial* for Coronal Place node was observed for liquids and /θ/. (See further discussion below under segmental intervention plan as well as the same section in chapter 5 -- Block 1.)

3. *WI Coronal fricatives and stops were sometimes realized as affricates, i.e., as complex segments.

Intervention Plan: Block 1

In Blocks 1 and 2, conditions for S5 followed the pattern: syllabic/segmental. The syllabic subblock order was onset-rime/moraic; the segmental subblock order was higher level feature/lower level feature. S5's phonological system (and age) at time of assessment was similar to S1's, and the contrast provided in the intervention plan is counterbalanced at the levels of both syllabic and segmental conditions as well as at the subblock order level (for onset-rime/moraic and level of feature conditions).

Syllabic Intervention Plan

In general, the goals were:

1. To increase the proportion of initial clusters realized with two elements
2. To introduce /r/ into initial clusters

The first of these goals was the same as for S1, although the actual training targets (/Cr/ versus /Cw, Cj/) were different. Because [r] was present in the inventory, and because dorsal stop-[w] sequences were already developing, /r/ was chosen as the cluster target in preference to the /Cw/ clusters. No data appeared to indicate that the /Cj/ sequence was functioning as a cluster instead of a consonant followed by a light diphthong (CjV) for S5 as had been the case for S1; hence the /Cj/ cluster was not chosen as a target.

Onset-Rime Subblock

Targets: /dr, pr/

Moraic Subblock

Targets: /tr, br/

Rationale

For each condition, one labial and one coronal cluster (counterbalanced for voicing across conditions) were chosen. The /tr/- and /dr/-clusters were selected because of the need to change the [+*continuant*] "specification" for the stop. The labial clusters were an arbitrary choice. Other /r/-clusters remained as generalization targets.

Specific Presentation/Elicitation Techniques

A. Onset-Rime condition

E presented the cluster as an onset unit ([Cr]) independent from a rime unit (V(C)). The [r], as a lengthened segment becomes [ɚ], but S5 could not easily imitate [dəː] or [pəː]. Since he could pronounce [dɑr] or [pɑr], they were permitted as an intermediate step to [dəː]/[pəː], and finally [dr] or [pr] joined to the rime units.

B. Moraic condition

Although S5 had not been able to produce WI [r] at the time of assessment, after the onset-rime training period it was possible to elicit WI [r] for the moraic-type presentation of the stop separately from the /rV(C)/ stimulus, e.g., [t^h] + [rɪk] (trick).

Segmental Intervention Plan

Higher Level Feature Subblock

Target: /l/ -- Root node [+consonantal]/[+sonorant] (WI, SIWW, /bl/ [part of one session]), defualt Place node

Lower Level Feature Subblock

Targets: /ʃ, ʤ/ -- Coronal node [-anterior] (WI, SIWW, WF)

Rationale

A primary rationale for the above plan was to counterbalance the order of treatments for S1. Fortunately, the lack of established coronal fricatives, affricates and liquids made the choice of targets reasonable for S5 as well. In the assessment sample, there was one self-corrected match

for /l/, showing capacity for correct specification. The most common SI substitution for /l/ and /r/ was [w] (showing neutralization of the two in that context). Although Labial Place may be a redundant feature at some point in the derivation for liquids, they are articulated with the blade and tip of the tongue, as other coronals. Development for /l/, then, for S5, necessitated the specification of [+consonantal] for the Root node and intermediate Place node specification (resulting in the default C-Place -- Coronal). (Refer to this similar section for S3 for further discussion of liquid specification.) Because the /r/-clusters were generalizing at the end of the syllabic subblock, the training of /l/ in /bl/-clusters as well as as a singleton was considered a justifiable test of the cluster development in interaction with segmental development. The /bl/ was chosen on the basis of a probe in session 12, showing consistent production of two consonant slots for this target.

Results of Block 1 Intervention

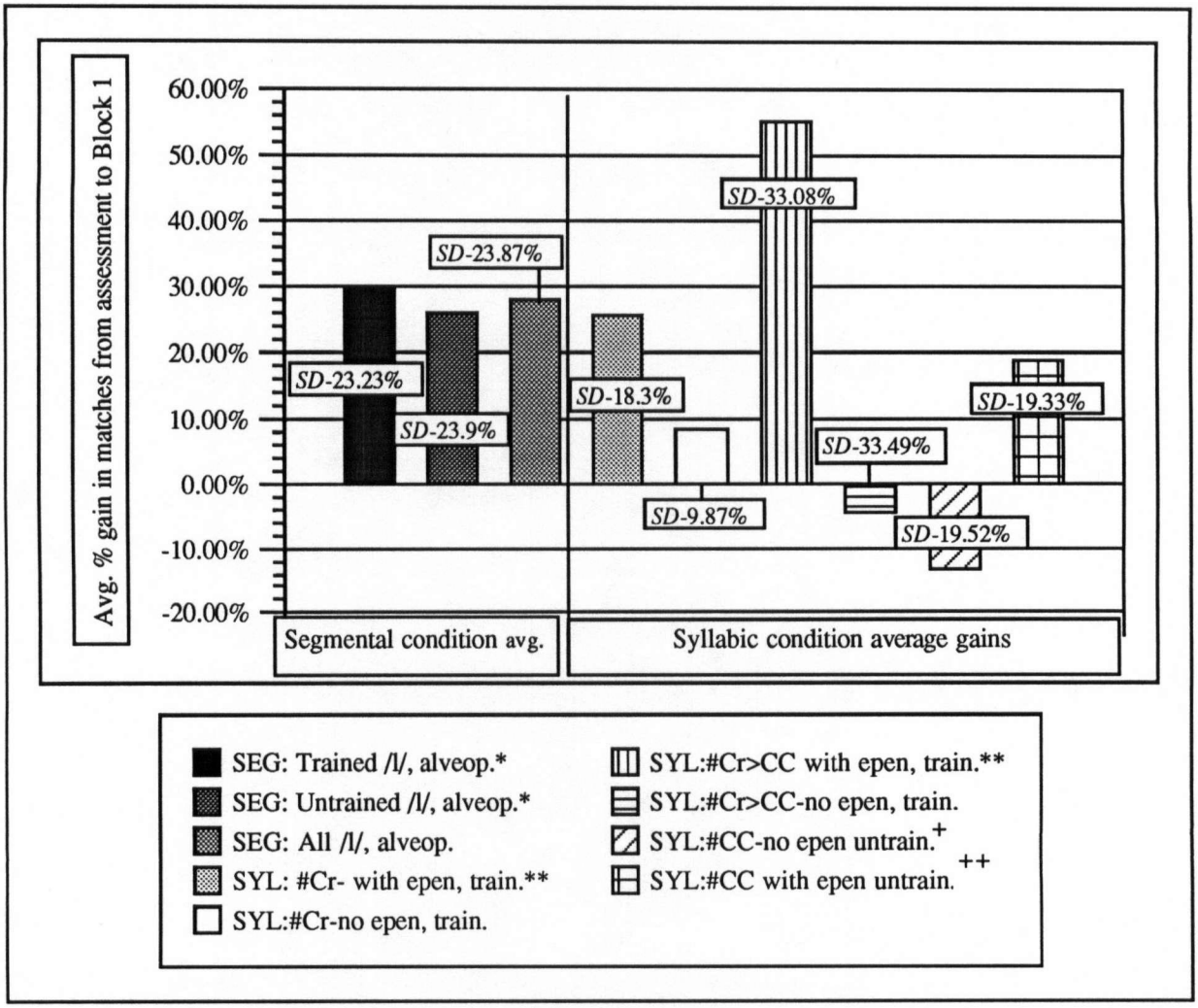
Block 1 major probe results demonstrated an increase in matches for all segmental and syllabic targets with the exception of initial cluster skeletal slots without epenthesis (see appendix 4, table 5.1, and figures 7.5 and 7.6).

Average proportional gains were similar for segmental targets and actual /r/-cluster targets. The choice of /r/-clusters for syllabic training at a time when /r/ was not well established as a singleton probably accounts for the similar results for /Cr/-cluster targets and segmental targets, since segmental learning was involved for both. The crossovers noted for bread - [$b^{ʊ}$ $læd_{o}$] - and black - [$b^{ɣ}$ $læ^{ə}k^{h}$] - indicated a lack of established specification within the liquid class. The training of /bl/ clusters in the segmental condition following the training of /br/ clusters in the syllabic condition probably increased the potential for crossover.

However, the greatest gain was in cluster slot establishment *with epenthesis* at the syllabic level for trained targets. Epenthesis, a process enabling two-element cluster realization, was emphasized as a result of the onset-rime subblock elicitation. Use of epenthesis caused a "regression" in some cluster productions, which were now not produced less frequently as [CC], and more often as [$C^{ə}C$] (see tables 7.3 and 7.6 and figure 7.2).

Skeletal Slot Changes

As mentioned above, overall results conflicted in the major probe for syllable-initial cluster development (both WI and SIWW) in terms of skeletal slot realization (see table 7.3 and figures 7.2 and 7.5).



*Trained targets = WI and SIWW /l/,WI /bl/, /ʃ/ and /ʤ/; untrained targets in same segmental categories = SF /l/ and other /l/-clusters,/tʃ/, /ʒ/

**/pr/, /br/, /tr/, /dr/ = trained targets; epen = epenthesis

+CC = skeletal slots for cluster elements

++Average of totals for /s/-clusters, /l/-clusters, and /r/-clusters in terms of skeletal slot realization

Figure 7.5. S5: Average proportional gain in matches for syllabic and segmental targets between Initial Assessment and Block 1 major probes

S5 produced fewer CC cluster matches without epenthesis than in the initial assessment. However, short duration epenthesis began to appear in greater strength as a mechanism by which to effect realization of two skeletal slots. When clusters with short duration epenthesis were considered matches, there was a 9.2% gain in CC slot realization. Including items with epenthesis as matches, the *minor* probes administered at sessions 1 and 9 also demonstrated a 9% improvement in two element realization. (This improvement reflected gains for all clusters tested except /fr/).

Skeletal Slot Changes by Cluster Type

A. /s/-clusters

There was a minimal change in number of /s/-clusters with two elements (5.69%). There were two additional two-element /s/-clusters produced with short epenthesis (/sw/ and /sn/, both with sonorants), producing an overall 13.69% increase in skeletal slot realization. (See tables 7.3 and 7.4.)

B. /r/-clusters

There was a 5.88% *decrease* in /r/-clusters produced with two skeletal slots without epenthesis, and a 31.4% *increase* in /r/-clusters with two skeletal slots with short epenthesis. (See tables 7.3 and 7.6.)

C. /l/-clusters

Without epenthesis there was a 12.8% *decrease* in syllabic slot realizations. With short epenthesis, there was a 33.52% *increase* in syllabic slot realizations. Increases for /l/- and /r/-clusters were similar, suggesting that both were being learned as segments and as cluster elements. (See tables 7.3 and 7.5.)

Exact Match Changes

Examination of matches for cluster types revealed a slight increase in exact matches for *both* skeletal slots and segments for clusters with /r/, /l/ and /w/ (see table 7.3). The only /s/-

cluster match noted during assessment (/sk/) did not appear at the end of Block 1, and no changes were noted for /Cj/ words.

More /r/-clusters than /l/-clusters showed exact matches, with only trained /br/- and /dr/-clusters and untrained /w/-clusters showing matches without epenthesis. When items with short epenthesis were included as matches , all /l/-cluster types except /fl/ were represented. This was not the case for /r/-clusters for which only trained clusters /br/, /tr/ and /dr/ showed matches with epenthesis. Thus, while the more intensive training with /r/-clusters appeared to lead to more exact matches for trained targets, generalization to untrained targets was more prevalent for the /l/, which had been targeted as a singleton more than in a cluster. There may have been a recency effect in testing, however, since the (segmental) /l/ training was in the second subblock, just prior to the major probe, while the (syllabic) /r/ training was in the first subblock.

Nonmatch Changes

A. /s/-clusters

S5 produced more *types* of /s/-clusters with both elements (see table 7.4). Only /st/ (six of ten attempts) and /sl/ (two of three attempts) were missing the second segment, as they had at beginning of Block 1. Only /sk/ (two of two attempts) and /st/ (one of ten) were missing the first segment, in a quantity similar to that of the assessment probe. A further change was noted in the appearance of [-anterior] affricated ('complex') substitutions for the /s/ of /sw/ and /sl/ clusters. The segmental coronal targets (alveopalatal affricates) had possibly overgeneralized to the underspecified /s/. Epenthesis was a minimally used strategy for /s/-clusters but did appear for /sn/ and /sw/ (two of the sonorant /s/-clusters, where epenthesis would facilitate the appearance of the sonorant).

B. /r/-clusters

The major differences for /r/-clusters were: (1) the above noted use of epenthesis, (2) gains in exact matches, (3) the retroflexion of [ɰ] as a second element 5/31 times, (4) the near

elimination of the coronal [θ] substitution for /t/ (1 token), and (5) one instance of [-anterior] coronal marking (see /s/-clusters above) for /dr/. The overgeneralization of [-anterior] again shows the interaction of segmental and syllabic tiers. The most successful /r/-clusters were trained targets /br/, /dr/ and /tr/ clusters. (See table 7.6.)

C. /l/-clusters

The major difference for /l/-clusters was the above noted use of epenthesis creating matches (both exact and for skeletal slot marking). Despite session 12 probe results indicating that S5 produced /bl/ consistently with two consonants, two Block 1 major probe /bl/ realizations had was only one consonant. For another /bl/ item, the [l] had [r]-coloring. Overall only one /bl/-cluster was an exact match for number of consonants and actual segments (albeit with short epenthesis). (See table 7.5.)

Onset-Rime Subblock Intervention Targets

1. /dr/ : S5 produced one exact match for a /dr/ cluster (out of four attempts), and two with epenthesis. All /dr/ clusters showed two elements, and the interdental default segment did not appear in the major probe data. This was a progression from the minor probe at the end of the syllabic subcondition. At that time, although nine of ten /dr/ targets had two elements, none had [r], and two had interdental defaults for /d/.

2. /pr/: Of the two tokens for /pr/ in the major probe data, one had two elements with long epenthesis and retroflexion on the [ɰ], an improvement from the assessment probe. The other had only one consonant --[b]. The minor probe data showed two elements for four of eight tokens (the same 50% ratio as on the major probe), with no retroflexion.

Moraic Subblock Intervention Targets

1. /tr/: Of the four tokens in the major probe, one was a match with epenthesis. The other three tokens had two nonmatching segments and an epenthetic vowel. In two cases, the /t/ was [+continuant] and the /r/ a [w]. In the third case, the /t/ matched and the sonorant was [ɰ]. In the minor probe, nine of ten tokens had two elements, with one exact match. Long epenthesis

facilitated realization of two elements for three tokens, and in six tokens, the /t/ was an interdental affricate.

2. /br/: One exact match for /br/ occurred in the major probe. Including items with short epenthesis, two further matches were counted. Mismatches included only a single item with one cluster element. Other mismatches had a segmental basis, i.e., the /r/ was realized as [w], [ɰ] , or [l] (one of each). On the minor probe, five of ten tokens had two elements, showing an improvement at the prosodic level from the minor to major probes.

Comparison of the Onset-Rime and Moraic Conditions

According to the major probe, it was unclear which condition resulted in faster acquisition of /r/-clusters. The moraic targets /br/ and /tr/ as a pair appeared to be better-established than the onset-rime pair /dr/ and /pr/. However, the voiced pair /br/ and /dr/ appeared to be better established than the unvoiced pair, suggesting that the voicing may have contributed to easier articulation of the sonorant and the stop, regardless of the condition (feature-sharing within an onset constituent facilitating realization of skeletal slots?).

Minor probe results were also basically equivalent. There was improvement in specification of skeletal slots for /pr/ (two of three cases), /tr/ (four of six cases), and /dr/ (all three cases) on words probed before and after the syllabic subblock. This yielded a total of five out of six improved tokens for the onset-rime condition and four out of six for the moraic condition.

The clinical impression during the sessions was that S5 gave equal effort to both types of imitations and that neither seemed more difficult nor more facilitative.

Segmental Goals

Higher Level Feature Subblock

The /l/ in WI position ([+consonantal/s+sonorant]) matched the target eight out of ten times in the major probe (see appendix 4, table 5.1, and figure 7.6). In SIWW position, there was less generalization (three matches out of eight attempts), and for the /bl/ cluster, there was one match with epenthesis as noted above. No changes were noted for syllable-final /l/, although there were matches with epenthesis for all clusters except /fl/. Summing data across trained /l/ targets, the

percentage match was 54.55%, representing an improvement of 51.1% from the assessment, and individually for /l/, a greater gain than for the syllabic targets individually.

Lower Level Feature Subblock

A. Targeted segments for [-anterior]

1. /ʃ/: The use of /ʃ/ in the major probe varied according to word position, with one match out of one attempt word initially, none in SIWW position, and two out of six matches word finally. Summing the /ʃ/ data, the percentage match (and gain) was 27.27%, much less than for /l/.

2. /ʤ/: The use of /ʤ/ also varied according to word position. There were three out of twelve and one out of four matches for WI and SIWW positions respectively, with none for WF position. Overall the percentage match (and gain) was 16.67%, less than for /ʃ/ and /l/.

The lesser gains for trained alveopalatals contributed to a lower average gain for the segmental condition in comparison with skeletal slot establishment for trained targets in the syllabic condition.

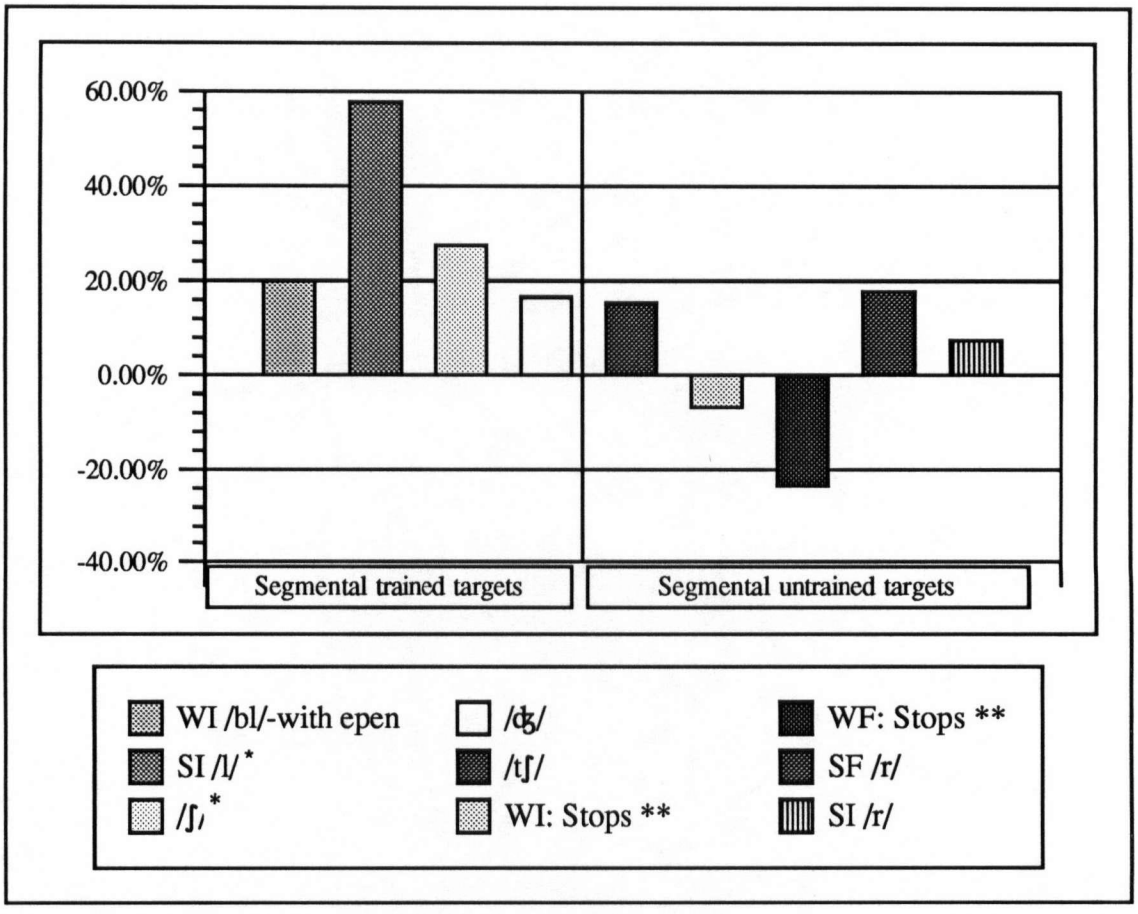
B. Untargeted alveopalatal /ʧ/

As the 15.38% match (and gain) in WI position shows, S5 generalized training from the other alveopalatals to the voiceless affricate.

C. All alveopalatals

Generally, the alveopalatals appeared to be generalizing more rapidly in WI position, with the fricative improving more quickly than the affricates. The training on /ʤ/ appeared to be facilitating the development of the voiceless cognate.

Mismatches primarily resulted from the use of the default interdental (32/39 mismatches) and lack of 'complex' structure. The 'complex' structure of affricates was specified most of the time for /ʤ/ (14/19 matches for 'complex' structure) but proportionately not as often for the untrained /ʧ/ (6/11 matches for 'complex' structure). Only one inappropriate 'complex' specification was observed for /ʃ/. Six voicing errors appeared in total.



*Proportional differences based on sums (not averages) of matches across word positions for each sample, e.g. (WI /l/ + SIWW /l/ matches/100) at time 2 minus the same for time 1 or (sum of all matches/100 for each of the alveopalatals) at time 2 minus the same for time 1.
**Aspiration for WI stops, voicing for WF stops

Figure 7.6. S5: Proportional gain in matches for trained and untrained segmental targets between Initial Assessment and Block 1 major probes

Comparison of the Lower and Higher Level Features

As predicted, there appeared to be a more rapid gain in matches for the higher level feature ([+consonantal] conjoined with [+sonorant]) for /l/ production, in comparison with the lower level feature ([-anterior]) for the alveopalatals.

Other Feature Changes

Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

A. Unspecified child forms where adult forms are specified

1. Root node: There were fewer missing consonant realizations, particularly for cluster elements, SIWW /t/ and WF /z/. +,*

2. Laryngeal node: A decrease in use of aspiration for /k/ and /t/ (27% decrease) was observed (redundant feature [+spread glottis]). This was unexpected, considering the focus on individual unvoiced stops during cluster training. &

3. Laryngeal node: A higher proportion of voiced stops were unspecified for [+voice] (23%). This may have been a spurious finding or, along with the regression noted for aspiration, indicative of some variability in the child's laryngeal valving control. The tremulous voice quality may have been related to this finding as well. &

4. Root node: There was an increase in number of SI (7.14% gain) and WF [r] (17.62% gain) tokens with specifications of [+consonantal] in conjunction with [+sonorant] and [+distributed]. This was expected as a result of training of /r/-clusters. +

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

Place Node -- Coronal Place: Use of the [*+distributed*] dental or interdental place decreased for stops (although not for sibilants). **

Intervention Plan: Block 2

Syllabic Intervention Plan

Onset-Rime Subblock

Targets: 1. /st/

2. /fr/ versus /fl/

Moraic Subblock

Targets: 1. /tw/

2. /kr/ versus /kl/

Rationale for /Cr/-/Cl/ contrasts

As demonstrated by the results from Block 1, the segmental instability of liquids was affecting the development of liquid clusters. In order to stabilize the specifications of /l/ and /r/

within clusters, a minimal contrast training approach was planned. Rather than utilize previously trained clusters from Block 1 (and hence previous biases), two new pairs were targeted, one for each subcondition.

Rationale for /st/ and /tw/ choice

S5's treatments were as much as possible counterbalanced with those of S1, for whom /st/ and /tw/ were Block 2 targets. They were useful targets for consolidation of two skeletal slots for initial clusters for S5: (1) because they were from different cluster groups (stop + approximant versus /s/+stop) and (2) because they were realized as singletons in S5's speech (/tw/ two out of three times and /st/ eight out of ten times). Targeting them in the opposing subblocks allowed comparison of clusters with the maximally underspecified consonant /t/.

Segmental Intervention Plan

In spite of gains made, neither of the targets from Block 1 had sufficiently generalized to conversation, and as a result, they were retargeted in Block 2. The /l/ was targeted only in WI and SIWW positions, because it was targeted directly in clusters during the syllabic subblock.

Results of Block 2 Intervention

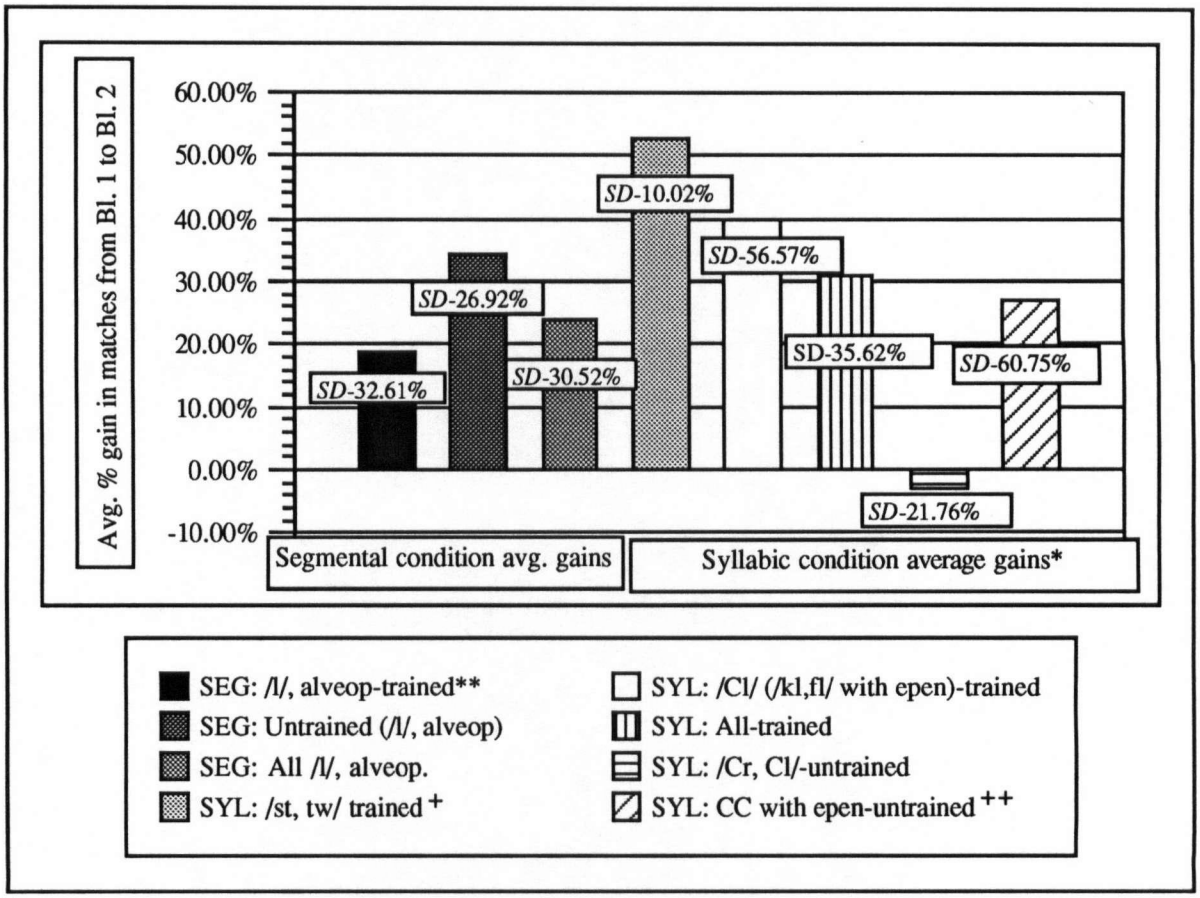
Block 2 average proportional gains were greatest for syllabic targets /st/ and /tw/ (the average also had the lowest standard deviation) with other results being within the same average, but demonstrating widely varying standard deviations. (See figure 7.7.)

Syllabic Goals

Skeletal Slot Changes

At the end of Block 2, S5 produced more clusters with two consonants than previously, both with (9.64%) and *without* (4.63%) short epenthesis (see table 7.3 and figure 7.3). Short duration epenthesis continued to be a mechanism by which to effect realization of two skeletal slots, but was not essential for their production. The overgeneralization of epenthesis noted at the end of Block 1 was lessening. However, when the actual cluster types were examined, regresssions in matches were noted for /s/ and /r/ clusters. Small gains in segmental matches for cluster elements were attributable to developments in /l/-clusters (matches all occurring with

epenthesis). The greatest gains were for /w/-clusters. It is noteworthy that all cluster types were targeted in this block, but that gains only occurred for /w/ and /l/-clusters.



*There were no matches for trained syllabic targets #/kr/ and #/fr/.
**Includes WI, SIWW /l/, /ʃ/ and /ʤ/ whereas untrained segmental targets include SF /l/ and /ʧ/
+All clusters word-initial
++Refers to skeletal slot realizations for untrained WI clusters with /s/, /l/ and /r/

Figure 7.7. S5: Average proportional gain in matches for trained and untrained syllabic and segmental targets between Block 1 and Block 2 major probes

Skeletal Slot Changes by Cluster Type

A. /s/-clusters

There was an unexpected regression in number of /s/-clusters with two elements (-16.1% without epenthesis and -11.32% with it). This occurred in spite of (because of ?) the training on /st/, which showed a 45.83% gain in realization of both elements.

B. /r/-clusters

There was equivalence for /r/-clusters produced with two skeletal slots without epenthesis(.16% gain) between the two major block probes, but an unexpected 16.69% *decrease* in two-element /r/-clusters with short epenthesis.

C. /l/-clusters

For clusters without epenthesis, there was a 6.25% *decrease* in syllabic slot realizations. For those with short epenthesis, there was a 4.17% *increase* in syllabic slot realizations. Again, greater progress occurred for /l/ than for /s/ and /r/, presumably because /l/ had been both a segmental and syllabic target.

D. /w/-clusters

The greatest proportional change during this subblock was for /w/-clusters, which demonstrated a 24.44% gain in matches without epenthesis, and 26.67% including clusters with short epenthesis as matches. Epenthesis was not as important a mechanism for the realization of two consonants for /w/-clusters from the outset, since there were many tokens of [Cw] substitutions for the other approximant clusters at the assessment.

Exact Match Changes

Examination of matches for cluster types revealed a 1% increase in exact matches for both skeletal slots and segments for cluster with /r/, /l/ and /w/ (see table 7.3). The cluster types demonstrating exact matches were different, however. Although /w/-clusters increased in exact matches, an /sn/ cluster was the other matching cluster type, not the /r/-clusters as in the previous major probe. Another change from Block 1 major probe was observed for the exact matches with short epenthesis. More /l/-clusters than /r/-clusters showed exact matches, with only previously trained /br/ represented among the match group in the Block 2 probe. As had happened at the end of Block 1, all /l/-cluster types were represented in terms of exact matches except /fl/ (which had matching segments, but full epenthetic vowels). Contrary to expectations, the contrast training had not equalized results for the liquid clusters by the end of Block 2.

Nonmatch Changes

A. /s/-clusters

In contrast to the Block 1 major probe, the number of *types* of /s/-clusters with missing elements unexpectedly increased (see table 7.4). The Block 2 major probe added /sn/ (one of seven tokens) to /st/ (two of eight tokens) and /sl/ (one of five tokens) for missing second consonant. Whereas /sk/ was not among the types with missing /s/, /sm/ and /sp/ each added one token to the total, along with one from /st/. Epenthesis was used more often, expectedly for /sl/ but unexpectedly before the nonsoronant /sk/ in the word skating.

As on the previous probe, [-anterior]/('complex') substitutions occurred for /s/, this time for /st/ and /sl/ clusters. This was a continuing sign of overgeneralization of the segmental coronal targets (alveopalatal affricates) to the underspecified /s/. Another (unpredicted) overgeneralization was [kɬ--kəl j ɑʊ f] for scarf, previously [kɑrf]. Although the two consonant slots were realized, this was accomplished with the use of one of the more accessible clusters /kl/, probably triggered by the /r/ in the root.

B. /r/-clusters

The major differences for /r/-clusters, besides the loss of exact matches, was an increase in the retroflexion of [ɣ] as a second element fivet imes and the use of overgeneralization of [l] to /r/ slots (6/25 times). The targeted /fr/ and /kr/ clusters demonstrated the [ɣ] once each, and for /kr/ a [kl] substitution appeared once. The elimination of the coronal [θ] substitution for /t/ in /tr/ was accomplished. (See table 7.6.)

C. /l/-clusters

The major difference for /l/-clusters was the above noted increased use of epenthesis creating matches (both exact and at the prosodic level). There was [r]-coloring on only one /pl/ cluster in comparison with the number of [l] substitutions for /r/. (See table 7.5.)

Onset-Rime Subblock

1. /st/: As stated above, there was an increase in the realization of /st/ with two consonants, which can be attributed to the training in Block 2 (45.83% gain).

2. /fr/ versus /fl/: The two tokens of fruit showed use of CC with epenthesis, one with retroflexion. The /fl/ tokens showed use of CC three out of five times (the word flower had /l/ metathesis to the /w/ slot) with an /l/ match twice out of five attempts (with long epenthesis).

Moraic Subblock

1. /tw/: The greatest proportional gain for Block 2 was for /tw/ (60%). When short epenthesis was considered a match, four of the five /tw/ targets matched. (The fifth had a [f] onset which may have been a false start).

2. /kr/ versus /kl/: Major probe data showed a clear gain for /kl/ (two out of three exact matches including those with epenthesis) over /kr/, which showed interference from /kl/ as well as articulatory difficulty in [kr] production. In terms of CC matches, all had two consonants, with epenthesis in five out of six cases.

Comparison of the Onset-Rime and Moraic Conditions

Major probe results were similar for both conditions. The /t/ clusters fared best, with the Moraic target /tw/ having the most matches. It had been predicted at the outset that the /st/ would be more difficult because of the /s/, so the better result for /tw/ probably reflects the segmental ease for that cluster. The /l/-/r/ contrast training appeared to help consolidate two skeletal slots for the targets although the /l/-clusters fared better in both conditions. Again the segmental difficulties impacted on the outcome more than the training methods did. As for Block 1, the clinical impression during the sessions was that S5 gave equal effort to both types of imitations, and that neither type seemed more difficult nor more facilitative. Because of the apparent equivalence and the strong influence of the segmental constraints, no further analysis was done to compare moraic and onset-rime treatments for this subject.

Syllabic Changes for Targets Other than WI Clusters

One unexpected progressive development was the appearance of #CCC cluster slots (albeit with epenthesis) for /skr/ (screwdriver > [θkʊlouðɑɪvɔ^ɘʔ]) and /spr/ (spring > [θpʊwi˘n]). There was also a marginal gain for SIWW clusters (less than 10% proportional increase in matches).

Segmental Goals

Both /l/ and alveopalatals increased in use by the end of Block 2, to the point that they only need to be reviewed briefly toward the end of Block 3 (see appendix 4, table 5.2, and figures 7.7 and 7.8).

Higher Level Feature Subblock

Target: /l/ -- Root node [+consonantal]/[+sonorant], default Place node

As was the case for Block 1, the /l/ continued to show faster development than the alveopalatals. Syllable-initial /l/ was mastered (100% matches), with marginal development postvocalically.

Lower Level Feature Subblock

Targets: /ʃ/ and /ʤ/ -- Coronal node [-anterior]

S5 produced more matching affricates than in Block 1, even though the /ʧ/ was an untrained target, with best results as follows:

1. SIWW /ʤ/: 100% matches
2. WI /ʧ/: 2/3 matches
3. SIWW /ʧ/: 15/21 matches.

Match levels for the other targets were in the 25%-36% range, except for SIWW /ʃ/ and WF /ʤ/, which had no matches (the latter because of slight devoicing). This contrasts with Block 1 results, which show /ʃ/ with the "most" matches (one WI match out of a possible two, and two WF matches out of a possible six).

Nonmatches for /ʃ/ were primarily a result of the default [θ] use in WF position, and of the '*specification*' of 'complex' structure syllable-initially (with or without [-anterior] marking). In contrast, the nonmatches for WI /ʧ/ showed lack of [-anterior] marking, and the WF nonmatches lack of 'complex' structure (with or without [-anterior]). Word initially, /ʤ/ was unspecified for 'complex' three out of seven times, whereas word finally, /ʤ/ showed slight devoicing. In general, however, more matching voice specifications appeared among the alveopalatal targets than in the prior major probe.

Other Feature Changes for the Overall Segmental Data (unordered)

Increases in matches are noted with + and * for trained and untrained segments respectively. Progressive feature changes (without matches) on trained segments are denoted with ++, and on untrained segments with **. Regressive changes are denoted with &.

A. Unspecified child forms where adult targets are specified

1. Root node: Again there were fewer missing consonants, particularly for cluster elements, SIWW /t/ and /d/, WF /z/ and /r/ and SFWW /s/. +, *,**

2. Laryngeal node: Redundant feature [+spread glottis] appeared to be in use for more unvoiced stops (14.29% gain), with the lowest number of matches for /t/ (at 50%), and the highest for /k/ (77.77% matches). These gains exceeded the regression noted on the Block 1 probe, producing an overall gain from the assessment of about 10%. *

3. Laryngeal node: More WF obstruents showed [+voice] specification (32.89% gain for stops), particularly /b/ and /d/ (mastery levels). The WF /g/ and /ʤ/ remained the least marked obstruents for [+voice]. Gains for /b/ and /d/ surpassed the regression in Block 1, resulting in an overall gain from Block 1 of 60% for /b/ and about 11% for /d/. The /g/ continued to regress. *, &

4. Root node: Specification of [+consonantal] in conjunction with [+sonorant] and Coronal feature [+distributed] was less frequent for WI /r/, partly as a result of overgeneralization of the /l/ and /ʤ/ (lack of [+distributed] marking for /r/). There were slight gains for SIWW and SF /r/ (less than 3%). Other failure to mark [+distributed] for /r/ resulted in a four /l/ substitutions (out of eight attempts) in SIWW position. **,&

5. Place Node: [+distributed] was specified once for WF /θ/ *

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Place Node -- Coronal Place: There was a decrease in [+*distributed*] dental or interdental place for sibilants and some coronal stops. There were also a few overgeneralizations of [-anterior] among the sibilants. **,&

2. Root node: Specification of [+*consonantal*] in conjunction with [+sonorant] resulted in overgeneralizations of /l/ in SIWW position for /w/ and /j/ and in WI position for /j/. &

3. Place Node: Coronal Place: [*-anterior*] was specified inappropriately twice (out of a possible four times) for /θ/ as an overgeneralization of /ʃ/, and twice for /r/. &

Block 3 and Beyond

As stated at the outset, nonmatching vowel productions reduced conversational intelligibility at the time of Initial Assessment, but at that time consonant intervention was a greater priority. Because of the progress made in consonantal development, in comparison with the lack of spontaneous change noted for vowels by the beginning of Block 3, vowels became priority training targets in the last block. The high back round vowels /u/ and /ʊ/ as well as the lax front mid and high vowels were targets. S5 developed facility with /u/ in conversation but not with the lax vowels.

The Block 3 syllabic target was SI /r/, which also did not generalize to conversation in the time allotted.

Because of this subject's needs in language production, improved sentence production and 'whole language' foundations for prereading were general goals outside of the phonological intervention.

After a three-month therapy break, E visited this child in his school system in rural British Columbia (where he received no speech-language intervention). There was no apparent phonological development in the interim, with some minor regression noted for alveopalatals in conversation.

Discussion

In terms of the research questions the following interpretations are offered.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

The nonlinear frameworks led to reasonable targets for intervention for S5. As is true for all subjects, other factors may have contributed to the success, such as the intensive stimulation and the mutually enhancing effect of a variety of approaches.

The variability in S5's data (progressions and regressions) was considered to reflect his general learning difficulty as well as a specific phonological encoding difficulty, with some confusion added by the utilization of two same-class segments -- /r/ and /l/ -- in the opposing conditions (/r/ as a syllabic target and /l/ as a segmental and syllabic target). However, the changes pictured in figure 7.8 below are a *phonological* indication that the chosen targets were relevant for system development.

Conversational Intelligibility Gains

S5's conversational intelligibility improved due to the attainment of proficiency in using a number of initial clusters plus segmental targets /l/ and alveopalatals (see figures 7.8 and 7.9).

Those phonemes not mastered at the end of the phonological intervention project were still not in use three months following the project, with a slight regression for the trained alveopalatals, suggesting that the intervention was responsible for change.

The effects of intervention are also evident in (1) the changes for trained targets, (2) the within-class generalizations which occurred (such as from /ʃ/ and /ʤ/ to /ʧ/, and the skeletal slot marking across clusters) and, (3) lack of development for certain untrained targets: /s/-clusters other than /st/, interdentals, alveolar sibilants and SI /r/.

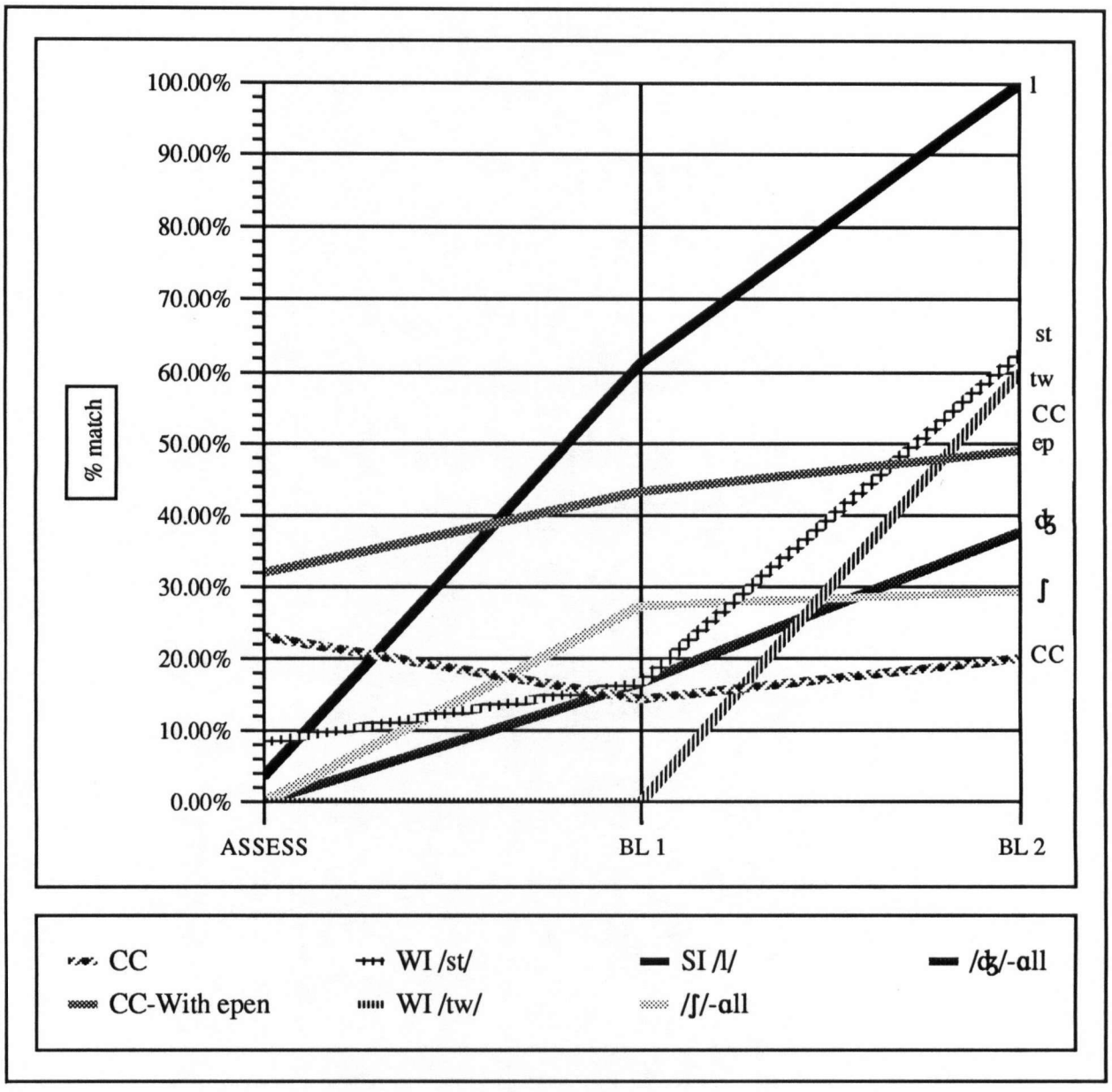
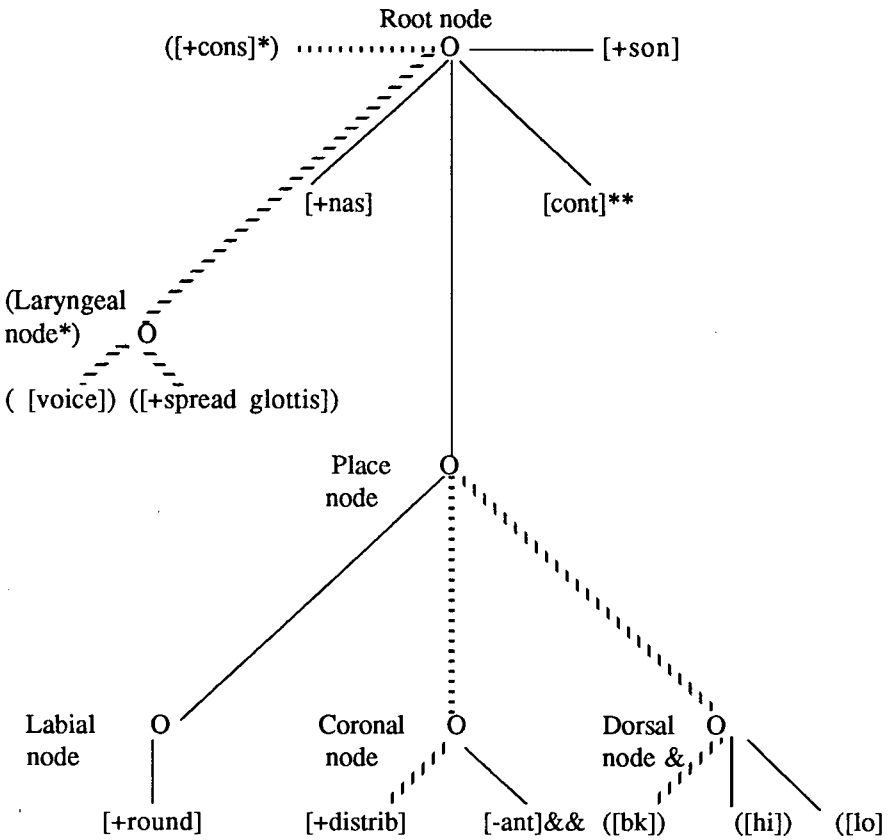


Figure 7.8. S5: Developmental progression in proportional matches for trained phonological targets across the intervention period

Language Test Results

All language test results showed positive changes in performance (see table 7.2). With the exception of sentence production, the posttests given placed the child in the low average range for language skills. Recalling the child's minimalist test response style in the early phases of the study, some of the improvement in scores undoubtedly reflects acquaintance with and trust in E, as well the motivational program for "best" performance carried on throughout the project.



Note: Parentheses and dotted lines indicate marginal constituents in system development. Italics indicate inappropriate feature.
*Increase in matches for Laryngeal and Root node features
**'Complex' branching structure in place for affricates most of the time
&Dorsal unmarked for nasals, and sometimes [+hi] or [-hi,-lo] unmarked for vowels, or [-hi,-lo]
&&[-anterior] marked most of the time for affricates, some of the time for /ʃ/

Figure 7.9. S5: Feature geometry at end of Block 2

Language Test Results (continued)

The 100% score on the Test of Language Development Auditory Discrimination Subtest suggested a sharpened focus on phonemic distinctions. Although sentence production remained delayed, there was a general increase in sentence types and tokens both in response to questions and in initiation of conversation. Sentence types at the final assessment included those beginning with conjunctions such as if, because, and when, questions and statements, in comparison with a predominance of single-word utterances and three-to-four word statements at the onset of the project. In the posttest, he demonstrated developing self-monitoring skill, enabling self-correction for grammatical morphemes, which were in part a result of intensive language/speech stimulation throughout the project and in part a result of motivation to produce more than a minimal response. These changes are in part a result of the general language stimulation and encouragement to speak in sentences. They probably also reflect the sentence patterning utilized in the phonological therapy in the first and second blocks, and the direct targeting of sentences in story retell in Block 3. That sentence production was the least improved skill is indicative of the severity of the expressive language disorder. It is probably also a result of intervention which focused on phonology, accelerating phonological and vocabulary development at a greater rate than syntax, a desirable result of the project.

2. *Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real ?*

S5's data generally demonstrates a difference in learning rate for syllabic and segmental targets. Considering matches for syllabic targets as matches for skeletal slots, the greatest average gains were for syllabic targets in both blocks, the predicted outcome. Considering exact target matches (skeletal slot plus segmental matches for cluster elements) for Block 2, the /st/ and /tw/ syllabic targets showed the greatest average gains. However, for other exact target matches, the segmental targets showed faster development. This reflects the marginal status of the syllabic target /r/ in the segmental inventory, producing a negative prosodic/segmental interaction for

prosodic development. The /l/-clusters showed greater gains than the syllabic target /r/-clusters, when /l/ became both a cluster and singleton target. The greater proportional differences for syllabic targets /st/ and /tw/ targets between Block 1 and Block 2 in comparison with segmental targets demonstrates, as predicted, that syllabic development can outdistance segmental development if there are minimal negative interactions between syllabic and segmental tiers.

As was mentioned previously, the interaction of the syllabic and segmental tiers was relevant for S5's phonological development, most noticeably for /r/-cluster development in comparison with /l/-cluster development, but also in comparing his greater success with /tw/ than /st/. The difficulty with /st/-, /tr/-, and /dr/-clusters was hypothesized to reflect the degree of underspecification inherent in coronal obstruents, rather than a strictly syllabic constraint.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of intervention methods that contrast the onset and rime versus those that utilize the mora as a constituent?

Major probe data from Block 1 and Block 2 and minor probe data from Block 1 did not reveal any notable difference between the moraic and onset-rime subconditions. The articulatory difficulty with /r/ made comparison difficult in any case. With skeletal slot matches as the basis for comparison, a Kolmogorov-Smirnov measure based on twelve data points (ten from major probes and two from the first minor probe) was used to test the following null and alternative hypotheses:

H_0: There will be no difference between the proportional match scores for all of the moraic (m) and onset-rime (n) measures across the study.

H_1: Moraic targets had proportionately higher proportional match scores across the study.

The largest discrepancy was 1/6, yielding a test statistic of (6)(6)(.16)=5.76, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed). (See table 7.8.) The clinical impression of equivalence of methods for S5 is not disconfirmed by the statistical test.

Table 7.8.--S5: Proportional matches across the study for onset-rime and moraic trained skeletal slots cast for Kolmogorov-Smirnov test

	46-50%	56-60%	61-65%	66-70%	81-85%	86-90%	100%
s_m (x)	0/6	1/6	1/6	2/6	3/6	4/6	6/6
s_n (x)	*1/6*	1/6	*2/6*	*3/6*	3/6	*3/6*	6/6

$p > 0.1$

A clinical finding which may have linguistic relevance, however, is the general increased use of epenthesis to facilitate cluster realization. The onset-rime subblock methods may have been enhanced epenthesis use, since E presented cluster onsets with epenthetic vowels during that condition.

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

In both blocks, the higher level feature [+consonantal] conjoined with [+sonorant] for /l/ (default Place node) was mastered more rapidly than the lower level terminal feature Coronal [-anterior] for the alveopalatals. Both features overgeneralized, usually within the same sound class (i.e., /l/ to /r/ or glides, [-anterior] to coronal fricatives), but occasionally to other sound classes, such as two [ʤ] substitutions for /r/, and [kᵊl] for /sk/. The feature hierarchy did appear to have relevance for S5's phonological intervention program, both in a general way to predict reasonable goals, and also in terms of specific feature positions in the hierarchy. The higher level features were acquired before lower level features as predicted.

Summary

The intervention project was effective in accelerating S5's language development, particularly his phonological development. He gained conversational proficiency for segmental trained targets /l/ and the alveopalatals and trained prosodic cluster targets /st/, /tw/, /Cl/ as well as

skeletal slot marking for clusters in general, with only marginal gains for most untrained targets. Average gains were greatest for trained prosodic tier targets. As the hypothesized supporting tier for segmental realizations, the prosodic framework needs to be in place before segments can be assigned to slots created by its structure. In facilitating syllabic tier development, there was no notable advantage for this subject in training according to moraic versus onset-rime constituency, although the onset-rime treatment may have fostered the development of epenthesis as a facilitating mechanism for cluster realization.

Segmental constraints against consistent /r/ production interacted negatively with the syllabic targets containing /r/, once skeletal slots were established. The faster rate of acquisition for /l/, with its higher level feature conjunction [+consonantal]/[+sonorant], compared with /r/ and alveopalatals, with their lower level features [+distributed] and [-anterior] respectively demonstrates the relevance of the feature hierarchy for S5's development.

CHAPTER 8

SUBJECT 6: SUMMARY

[ju ʔɑ maɪ ˈsɐ̃nˈʃaɪn]

Case History Information

During the reported period of the study, this girl was 2;11 - 3;3. Nonspeech factors with some possible bearing on the phonological disorder were (1) a medical history of frequent colds and tonsillitis (possible ear infections) and (2) birth order position, as the third of four children under 7, the older two of whom anticipated her needs. E observed S6 's speech development from age 2;6 to age 2;11 at one month intervals in order to monitor spontaneous change. Between age 2;9 and 2;11, there was minimal change. Consequently, S6 became a subject for the intervention project at age 2;11. (See table 8.1.)

Phonological System at the Time of Initial Assessment

Phonotactics: Syllables and Words

General Word/Syllable Structure

At the word level, S6 showed a productive capacity for words up to four syllables (a single item -- helicopter), although the sample consisted mainly of monosyllabic words (140/168 = 83.33%). Among the multisyllabic words, there were 22/28 matches (78.57%) for number of syllables per word.

Singletons within the Syllable Structure

Even though syllable/word congruency was high, the realization of skeletal slot positions for consonants was severely limited, particularly for WF consonants. In general CV terminology, the relative order of establishment of syllable structure was (C)V > (C)VCV > (C)VC.

Table 8.1.--Subject information for S6

AGE	2;11 - 3;3 for reported period
GENDER	Female
BIRTH ORDER	Third of four children 7 years and under
OTHER FAMILY HISTORY	English-speaking (Canadian-raised parents) Mother homemaker, father architect Mother's brother died at age 19 from muscular dystrophy Mother's cousin has hearing loss, wears aid
HEARING	Screened within normal limits at 2;9
GENERAL DEVELOPMENT	Appeared age appropriate for all skills except speech Five sets of casts worn for inturned feet
MEDICAL HISTORY	Frequent colds and tonsillitis (possible ear infections) Induced labor, otherwise no significant birth history
ORAL MECHANISM	Normal for speech production Stimulable for all phones in age range Sucks index finger and blanket at night
LANGUAGE SKILLS	Comprehension 1. Sequenced Inventory of Communication Development (Revised) -- R.C.A. 36 mo. at 32 mo., i.e., avg. range 2. Peabody Picture Vocabulary Test (Form L) -- *S.S.* 97, i.e., avg. range Production Language skills appeared to be within average range except for morphemes affected by phonological delay
PREVIOUS THERAPY	None Development observed for four months prior to enrolling her in project

Looking at development of singleton consonants in the various word positions, syllable-initial position was advanced in relation to syllable-final position as indicated by skeletal slot matches: WI (63.49%) > SIWW (20.43%) > WF (6.48%) > SFWW (10% but only 1 item -- [p] in helicopter).

Nonmatches resulted from undeveloped syllable structure and segments (see table 8.2).

Table 8.2.--S6: Number of substitutions over total nonmatches (and percentage) for singleton consonants by substitution type, in WI, SIWW and WF positions at Initial Assessment

Substitution	WI	SIWW	WF	TOTAL
[ʔ]	17/46 (36.96%)	6/32 (18.75%)	47/80 (58.75%)	70/158 (44.3%)
[h]/([ç])[a]	9/46 (19.56%)	9/32 (28.13%)	4/80 (5%)	22/158 (12.66%)
[ʔ] + [h]	26/46 (56.52%)	15/32 (46.88%)	51/80 (63.75%)	92/158 (58.23%)
Glide	1/46[b]	5/32 (15.63%)		6/158 (3.8%)
Consonant	18/46 (17.39%)	4/32 (12.5%)		22/158 (12.66%)
[V:]/[Ṽ]			8/80 (10%)	8/158 (5.06%)
R:Ø		8/32[c] (25%)	21/80 (26.25%)	29/158 (18.35%)

Note: Proportions are calculated over total substitutions within word positions, and in the final column over total number of substitutions.

[a]Occasionally, in the context of high front vowels, the [h] had a general Place shaping as [ç].

[b]/r/ > [w] - one item only

[c]Only in cases of word reduction

Syllabic constraints accounted for the lack of closed syllables and clusters. Undeveloped segmental inventory resulted in nonmatches in all word positions, with default (minimally specified) "substitutions" -- [ʔ] or [h] -- accounting for 58.23% of the total nonmatches. (See table 8.2.) For singletons, rank order of glottal use (most to least) for word positions was WF >

WI > SIWW, whereas for [h] use, the rank order was SIWW > WI > WF. These orders may reflect the transitional quality of [h] between vowels, and the bounding quality of [ʔ] for word edge demarcation.[15]

The status of the default [ʔ] and [h] substitutions is discussed further below. Because the laryngeals seemed to serve a role as syllable structure place-holders as well as segmental "substitutions," details about segmental development as it impacts on skeletal slot realization for major word positions are included in this section. (See tables 8.2 - 8.7.)

[ʔ] and [h] Substitutions

A. WI singletons

As was stated above, WI position was the best developed, with CV a basic system unit realized for most sonorants (glides, /l/, nasals). However, [ʔ] or [h] replaced all initial obstruents except /p/ and /d/ some of the time (see table 8.3). Because segmental specification was still incomplete, particularly below the level of the Root and Laryngeal nodes (see the section on segmental development), realization of the underlying consonant slot was accomplished with a minimally specified laryngeal substitution. The [h] appeared often for fricatives and the [ʔ] for stops, although [ʔ] also appeared sometimes for fricatives. This suggested some awareness of the appropriate obstruent values for [continuant]. Although [continuant] only refers to supraglottal obstructions (McCarthy 1988, 92), the Laryngeal feature [spread glottis] serves a similar function in terms of the speech stream. In S6's substitutions, the values for [spread glottis] often matched adult target values for [continuant].

The inconsistent appearance of [h] for fricatives plus general phonetic tendencies to insert glottals in the absence of other consonants prevocalically led to contrasting explanations for the WI [ʔ] "substitutions." The glottal may be a phonemic substitution, specified for the Root node feature [+consonantal] and Laryngeal node (unmarked value [-spread glottis]). Alternatively, the glottal may be a *phonetic* onset to a vowel-initial word with a missing prevocalic consonant. It is particularly difficult to attribute consonantal status to glottals in WI position when words are utterance-initial, since most utterance-initial, vowel-initial words in English begin with a phonetic glottal stop.

Table 8.3.--S6: WI singleton matches and substitutions at Initial Assessment

Child forms >	Matches	Substitutions				
		[ʔ]	[h]/[ç]	Glide	Consonant	R.N.: Ø
	/m, n, p, d w, j, h/ - All 100% /b/ - 8/10 /g/ - 3/6* /t/ - 1/6 /f/ - 8/10	/b/ - 1/10 /t/ - 1/6 /k/ - 4/4 /g/ - 3/6 /ð/ - 1/11 /s/ - 1/3 /z/ - 1/2 /ʃ/ - 1/5 /ʧ/ - 4/4	/f/ - 2/10 /s/ - 2/3 /z/ - 1/2 /ʃ/ - 2/5 /ʤ/ - 1/1	/r/ - 1/1	/t/ - 4/6 /ð/ - 10/11	/b/ - 1/10 (Wd. reduc.)

*One word -- gum -- a high frequency, high interest word

Within-utterance words afford a better opportunity than utterance-initial words to observe the status of the WI glottals. In this case, smooth transition from one word to the next vowel-initial one is often effected with consonant 'liaison' (the final consonant of the first word linking to the first syllable of the following vowel-initial word, creating an onset) or gliding from the final vowel of the first word to the initial vowel of the second (the glide filling an 'empty' prevocalic slot). In S6's sample, glottals appeared before all of the vowels of words with underlying initial consonants, but also in eight of eleven words with underlying initial vowels.

The consistent glottal appearance for the *consonant*-initial targets, when compared with the inconsistency for the *vowel*-initial words, may suggest phonemic status for the former. However, the results are not sufficiently distinct to make strong claims about [ʔ].

For the [h] and [ç] substitutions, Root node specification might have been more likely. The optional [ç] substitution for sibilants suggests a general oral cavity shaping (hence, default Place node), and if so, a necessary Root node specification of [+continuant] and [+consonantal]. However, as this substitution only appeared before high front vowels, it may have been a glide receiving all of its features from the vowel, rather than a 'true' consonant. As a glide, neither of the features [continuant] nor [consonantal] would be underlyingly specified, but would receive default values for glides -- [+continuant] and [+consonantal] -- by word position. By extension,

the [h] substitution may also have had redundant specification of [+consonantal] by word position, i.e., was a Laryngeal glide, rather than a 'true' consonant. The [+spread glottis] feature may have been a random default realization alternating with [-spread glottis], since the optional [h]/[ʔ] substitutions for sibilants demonstrate lack of distinctive underlying specification for the ("equivalent") target word feature [continuant].

Whether or not the WI Laryngeal substitutions had underlying specification, their appearance suggests the existence of an onset word position requiring segmental realization.

Table 8.4.--S6: Proportion of glottal and [h]([ç]) onsets in vowel-initial child forms at Initial Assessment

Adult words	[ʔ]: Utterance - initial	[ʔ]: Utterance-internal	[h]
Vowel-initial words	11/11	8/11[a]	
Consonant-initial words	16/23[b]	8/8	5/23[b]

[a]Three transitional glides appeared.

[b]The other seven tokens included [h] five times for sibilants and [f] twice for /ʃ/ in My shoe fell off > [maɪ fʊ ʔʌʊ-fʌʊ {ʔ/h}ɑ͡ɔʔ] (twice). The [f] was a probable result of between-word processes.

B. WI clusters

With the limitations on word/syllable types and singletons noted above, singletons appeared in place of clusters. The [bᵛ] affricate for /br/, in the absence of any such affricate productions for the singleton /b/, may indicate a possible developing awareness of two underlying elements.

Contrasting the [h] realization for /sl/- and /θr/-clusters with the stop realizations for clusters with stops demonstrates the importance of the sonority hierarchy for S6's cluster development. The least sonorous element was realized, either as a phonetic match, or as one of the default laryngeal substitutions: stop > fricative > liquid (never). Where segmental specification was incomplete, glottal stops appeared for dorsal and (optionally) coronal stops, and [h] appeared for /s/. In this way, the clusters followed the pattern for WI singletons. (See table 8.5.)

Table 8.5.--S6: WI cluster realizations at Initial Assessment

Child form >	Consonant	Glottal stop	[h]
Liquid clusters	/bl/ > [b] (1) /br/ > [b^{v}] (2), [b] (1)	/tr/ (1) /gr/ (2) /gl/ (2)	/θr/ (1)
/s/-clusters	/sp/ > [p^{h}] (1) /st/ > [T] (1), [d] (1)	/str/ (1)	/sl/ (1)

C. SIWW position for singletons

As noted above, CVCV was a developing word shape. However, matches for SIWW consonants (C_2) were less than half that for WI position. As noted in tables 8.2 and 8.6, consonants were missing only in cases of word reduction, i.e., when entire syllables were missing in comparison with the adult target.

The following general types of realizations were noted:

1. For stops: Matches or glottal stop substitutions
2. For sonorants: Matches or glide substitutions
3. For fricatives: [h] substitutions

Child forms matched the adult targets in terms of Root node features or their equivalents (i.e., [continuant]/[spread glottis]). However, as noted above for WI position, this tendency was not completely consistent. The [h] also appeared in place of the [-continuant] stops /d/, /k/, and /g/, while the noncontinuant [ʔ] appeared in place of the [+continuant] /s/. (See table 8.6 below.)

Table 8.6.--S6: Substitutions for SIWW singleton consonants at Initial Assessment

Child forms>	Matches	Substitutions				
		[ʔ]	[h]/[ç]	Glide	Consonant	R.N.: Ø
	/m/ - 2/4 /n/ - 1/2 /p/ - 1/4 /b/ - 1/1 /t/ - 1/4	/p/ - 3/4 /k/ - 2/3 /s/ - 1/5	/d/ - 2/2 /k/ - 1/3[a] /g/ - 1/3 /s/ - 4/5 /r/ - 1/5[a]	/m/ - 2/4 /br/ - 1/1 /l/ - 2/3 /r/- 1/5[b] /ð/ - 1/1[c]	/t/ - 3/4[d]	Only in cases of word reduction for /n, g, f, r, l, j/

[a]Reduplication from σ_1 onset: helicopter > [haijo^hapTɔ$^{U}_{o}$]; giraffe > [hʊhæʔ]

[b]S6's typical /r/ substitution of [w]

[c]A combination glide/glottal substitution (feather > [ʔɛʔjʊ^{ə}])

[d]Dental or lateral flap variant of /t/

D. WF position

The least developed syllable shape was CVC. In contrast with WI position, there was a distinct difference between realization of the WF segment in adult word targets ending in vowels versus those ending in consonants. For those adult targets ending in consonants, 53.26% of the child forms (excluding WF /r/ and /l/ adult targets) ended in glottals, compared with 10.53% for target words ending in vowels. This supports the designation of a consonantal slot position, filled by a [ʔ]. It is not possible to compare the [h] substitution across the two sets of adult targets, since the child's pronunciation of WF vowels sometimes had a fading or devoicing quality, similar to the [h] substitution. (This may have been a source of the glide-like [h] substitution, phonetic tendencies leading to phonemic substitutions, as was suggested above.)

As table 8.7 shows, more glottal stop substitutions appeared for unvoiced stop targets than for other segments. In terms of underlying representation of the child forms, this implies specification of [+consonantal]; ([-continuant] redundantly), with the unmarked negative value for [voice] resulting in the affinity of the voiceless stops and [ʔ]. By contrast, voiced and/or continuant adult target phonemes were more likely to be missing altogether in child forms.

Table 8.7.--S6: Substitutions for WF singletons at Initial Assessment

Child forms >	Matches	Substitutions					
		[ʔ]	[h]/([ç])	[V]	[V:]	[Ṽ]	R.N.: Ø
	/m/ - 3/5 /n/ - 4/12	/m/ - 1/5 /p/ - 4/4 /t/ - 18/18 /d/ - 3/7 /k/ - 12/12 /g/ - 1/3 /f/ - 3/4 /v/ - 3/7 /ʃ/ - 2/3 /ʧ/ - 1/1 /l/ - 1/11* /r/ - 2/7*	/d/ - 1/7 /f/ - 1/4 /s/ - 2/5	/l/ - 9/11 /r/ - 4/7	/ŋ/ - 1/1 /d/ - 1/7 /θ/ - 1/1 /l/ - 1/11 /r/ - 1/7	/n/ - 4/8	/m/ - 1/5 /n/ - 4/8 /d/ - 3/7 /g/ - 2/3 /v/ - 4/7 /s/ - 3/5 /z/ - 2/2 /ʃ/ - 1/3

*Because /l/ and /r/ were generally realized as vocalic segments, the glottal may be phonetic rather than phonemic in these cases.

The general distributional difference between unvoiced stops and the others suggests that relative sonority of the target postvocalic consonant is relevant for underlying specification in the child forms. The voiceless stops -- the least sonorous consonants -- were specified as [+consonantal] and Laryngeal, whereas many voiced stops and continuants -- more sonorous segments -- were completely unspecified. The contrast between the vowel and the unvoiced stops was maximal, which may have been both a phonological and acoustic explanation for their earlier developmental specification. (This is reminiscent of Jakobson's [1948] phonological development theory.)

Onset-Rime Description of Syllable Structure

In onset-rime terminology, basic onset-rime units with single branches were the most common word forms. Extension of this basic structure was occurring, as there were twenty-four words with two such units (i.e., a branching foot) and four with three or more. In those instances where branching at the level of the rime node licensed WF consonants, segmental realizations included laryngeal substitutions [ʔ] and [h] and a few nasal tokens (see table 8.2). The presence of

diphthongs (and compensatory vowel lengthening in a few cases for missing consonants) demonstrate the establishment of nucleus branching -- a branching structure within the rime, but at a lower level than the rime node itself. In its strictest form, the theory claims that onsets are obligatory. This appears to be the case for S6's data, with larygneal defaults appearing word internally and word initially in onset position, in contrast with their frequent absence word finally when WF adult target consonants were missing.

Moraic Description of Syllable Structure

The most common bimoraic word realizations were (C)V:, (C)VV (VV=diphthong), and (C)VCV. Occasional compensatory vowel lengthening also may have helped realize bimoraic syllable structure. The WF [ʔ]/[h] substitutions had two main types of prosodic effect: (1) creating a "choppy" speech stream, and (2) enhancing the prosodic meter by phonetic marking of segmental positions, and, perhaps, underlying prosodic (bimoraic) syllable structure.

The consistent prevocalic laryngeal substitutions created core syllables/minimum words and perhaps arose as a minimum word/core syllable default (CV(V) from UG).

Segmental Development

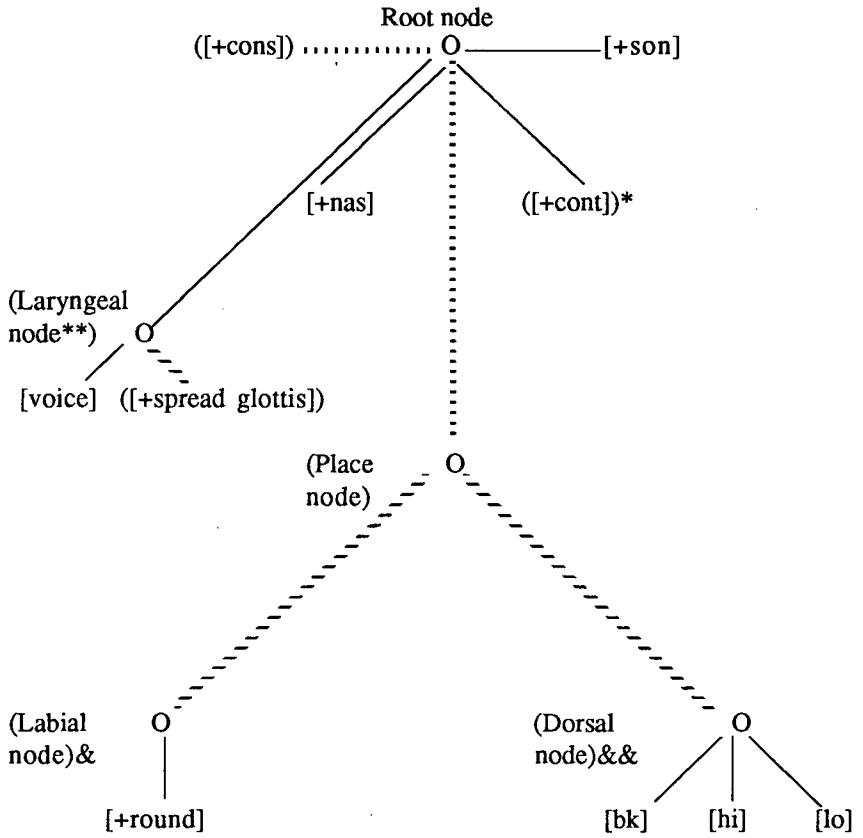
Across all consonants and cluster segments, 30.41% of the child forms matched adult targets. The only fully established categories were vowels, glides and the laryngeal consonant /h/. (See table 8.8, figure 8.1, and appendix 4, table 8.1.)

Table 8.8.--S6: Summary of singleton segmental acquisition at Initial Assessment

Sound class	Word position matches	Word position nonmatches	Main feature differences
Vowels, /h/, glides (/w, j/)	All		
Nasals	/m/: WI, (SIWW)[1] (WF) /n/ - WI, (SIWW)	/n/: (WF) /ŋ/	SIWW /m/: RN: [+cons] u, [+nas] u[2] WF /m/: RN:Ø or PN u /n/: RN: Ø or RN: [cons] u /ŋ/: RN: Ø (CL?)
Stops [-voice]	/p/ : WI, SFWW	/p/: (SIWW) /t/: (WI), (SIWW) All others	SIWW /p/: PN u WI /t/: PN u (2/6) or [+*dstr*] *m^2 (1/6) & [+spr gl] u (2/6) SIWW /t/: [+*dstr*] **m* /k/: PN u WF: PN u
Stops [+voice]	/d/: WI /b/: WI, SIWW	/g/ - ((WI)) All others	WI /g/: PN u SIWW /d/: RN: [+cons] u & PN u WF: RN: Ø or PN u
Fricatives -- Labial	/f/: WI /v/: WI	WF: both	WF /f/: PN u WF /v/: RN: Ø or PN u
Fric/Affricates -- Coronal	None	All	WI, SIWW: PN u (RN: [+ or - cont] WF: R:Ø or PN u (RN: [+ or - continuant]
Liquids	/l/ - Syllable-initial	/l/ - Syllable-final /r/ - All	Both: [+cons] u; **Labial* Place for Coronal

[1]Single parentheses indicate partial establishment: 40% - 80% in the Matches column; 10% - 40% in the Nonmatches column. Double parentheses indicate marginal development -- less than 10%.

[2]u= unspecified; *italics*, **m* = specified inappropriately with reference to appendix 2



Note: Parentheses and dotted lines indicate marginally established constituents in system development.
*Branching structure ('complex') not established for affricates
**Lack of aspiration (redundant feature [+spread glottis]) for many WI stops and (possibly) [h] default substitution
&Established except in SF and cluster positions
&&Established for all contexts except WI for consonants

Figure 8.1. S1: Feature geometry at Initial Assessment

Match data revealed the following:

1. The order of sound class establishment for the more established WI word position was vowels and glides > nasals > voiced stops > voiceless stops > fricatives/liquids. Labial and Coronal Place nodes were established for both nasals and voiced stops, with one high interest, high frequency word -- gum -- showing Dorsal Place specification for stops. In the voiceless stop category, Labial Place was advanced over Coronal Place and Dorsal Place was unestablished. At the time of the assessment, /t/ was just starting to appear (1/6 matches). Substitutions for /t/ were either [T], [t] (i.e., unaspirated) or [ʔ]. Prior to the assessment period, glottal substitutions were the common realization for /t/, as they were at the time of the assessment for /k/ and /g/. The three matching tokens of /g/ were for an advanced form -- gum -- a high frequency, high interest word. At age 2;6, glottals appeared in place of both WI labiodental fricatives and /l/. However, when S6 was between ages 2;6 and 2;8, spontaneous development resulted in the establishment of WI /f/, /v/ and /l/. Fricative production was limited to Labial Place (the marked Place node for fricatives). Thus the fricatives appeared to be developing in the same order for place establishment as the stops. The /f/ was not completely stable, as the between-word process and resulting [h] substitutions indicate in the repetition of the sentence My shoe fell off (twice) > [maɪ fu hʌʊ -fʌʊ ʔɑᵊ] . Liquid production was limited to /l/, the least marked liquid. The /l/ was not completely stable either, as the two following examples show:

lamb > [næʔ^{h}ᵊ$_{o}$]

little > [Lɛɾ{ɔ/ʊ}]

In summary, the Place node was less established than Root node and Laryngeal node for consonants, Dorsal Place specification appearing only for the /g/ in gum. Where established, Place node markings were dependent on sound class and syllable position. For stops, Labial Place was better established than Coronal across positions,the latter showing up only in SI position. Fricatives were limited to WI labiodentals. The liquid /r/ and SF /l/ were realized as *Labial* rather than Coronal Place glides.

Feature Differences for Consonants

Nonmatch feature differences were as follows (in an approximate descending order determined partly by word/consonant frequency and partly by feature difference salience):

A. Unspecified child forms where adult targets are specified

1. Root node and Place node: Either Root node was missing or Place node was unspecified for: WF consonants, except for a few tokens of /m/ and /n/ ; WI stops /k/, /t/, /g/, coronal (and a few labial) fricatives/affricates; and SIWW obstruents, except for single matching tokens of /p/, /b/ and /t/.

2. Place node: Dorsal Place was unspecified except for the word gum.

3. Root node: [+continuant] was unspecified for /ð/.

4. Laryngeal node: Some of the time WI /t/ and /p/ did not show aspiration (redundantly applied with [+spread glottis]).

5. Root node: [+consonantal] was unspecified for /r/ in all word positions and for SF /l/.

6. Coronal Place was not specified for [+distributed] or [-anterior].

B. '*Specified*' child forms where adult targets are unspecified or otherwise specified

1. Place node: Coronal [+*distributed*] dental or interdental place was used sometimes for /z/ and /s/.

2. *Labial* Place [w] appeared for Coronal Place /r/.

Intervention Plan: Block 1

In Blocks 1 and 2, conditions for S6 followed the pattern segmental/syllabic. The segmental subblock order was higher level feature/lower level feature and the syllabic subblock order moraic/onset-rime. In this way, S6 contrasted with S2 for subblock orders, and with S3 and S4 for main condition order.

Segmental Intervention Plan

Higher Level Feature Subblock

Targets: WI Coronal obstruents /t/ and /s/ -- Place node; Root node [+continuant]

Lower Level Feature Subblock

Target: WI /k/ -- Dorsal Place

Rationale

By the time of the last sample prior to intervention, S6 was starting to use WI /t/ occasionally in conversation, even though one month previously all but one of fourteen tokens of WI /t/ were [ʔ]. (The other was [b], a regressive reduplication for the /t/ of tubby > [bʌbi].) The inconsistent realization of /t/ made it a viable first training target. In order to provide equivalence across subblocks, a second completely unestablished coronal obstruent -- /s/ -- was also chosen as a contrast with the completely unestablished dorsal consonants. The coronals were considered higher level than the dorsals. Although they appear to be equivalent in level in terms of the tree portrayal (see figure 8.1), the Coronal Place node is also considered the default Place node. As a default, the Coronal Place node becomes assumed at the level of Place node (and thus "higher"), whereas the Dorsal node is dominated by the Place node.

Syllabic Intervention Plan

Moraic Subblock

Targets: 1. WF /p/ and /f/

2. SIWW /p/ and /n/

Onset-Rime Subblock

Targets: 1. WF /t/

2. SIWW /t/, /d/ and /m/

Rationale

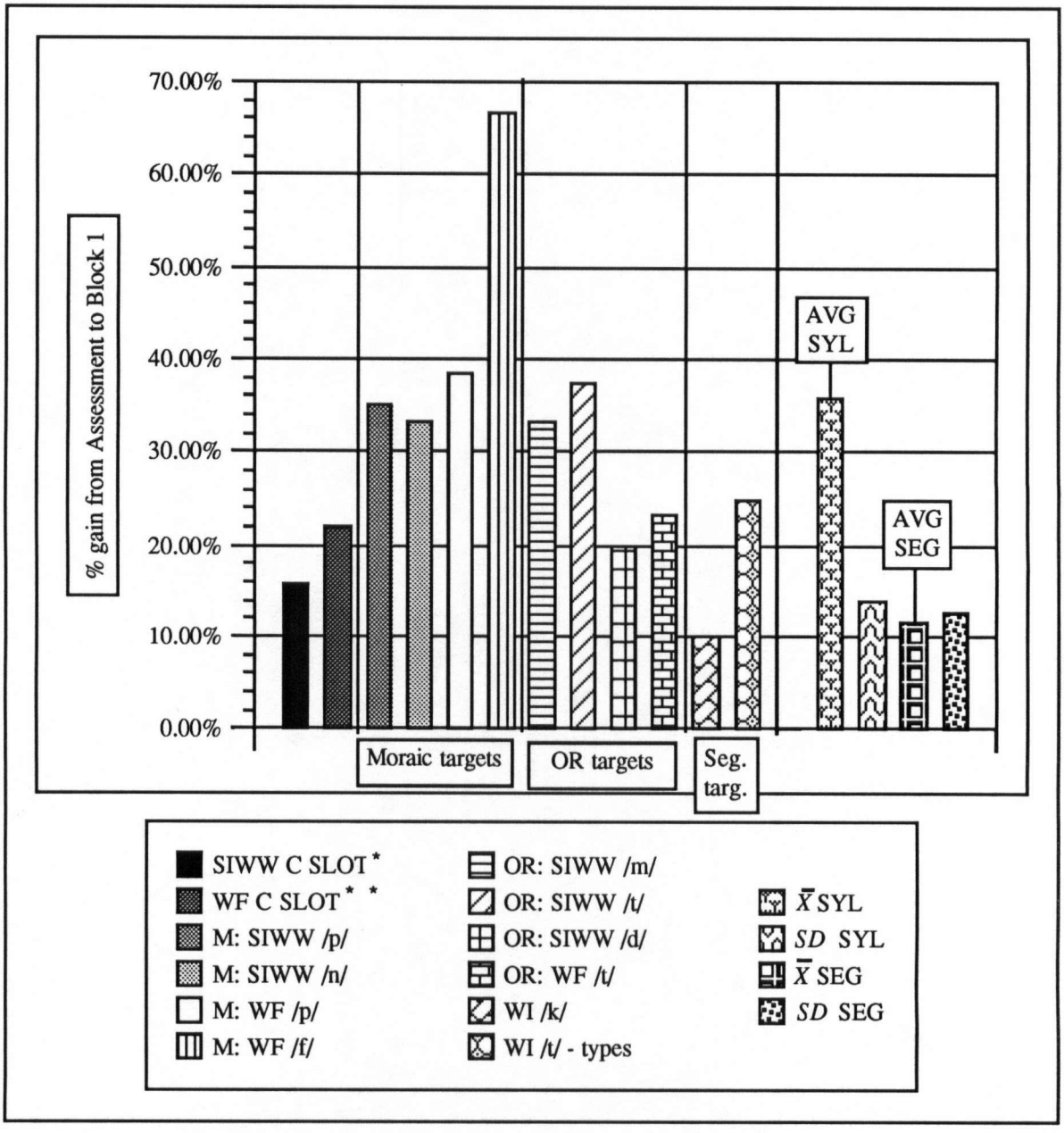
The low numbers of WF and SIWW consonants resulted primarily from syllabic constraints on CVC and CVCV productions. In order to develop these syllable and word shapes, target choice was limited to labial and coronal nasals and stops. Within the moraic condition, two labial obstruents (/p/ and /f/) and the coronal nasal were targets, and within the onset-rime condition, two coronal obstruents (/t/ and /d/) and the labial nasal were targets, creating a balance between conditions although not an identity. In both conditions, there were both labial and coronal

targets for the development of CVCV (SIWW consonants). Although the O-R condition appeared to have three targets, and the moraic, two, the /t/ and /d/ were phonetically one -- the intervocalic flap.

For development of the CVC word shape, however, there were two (labial) targets for the moraic condition and only one (coronal) target for the onset-rime condition. I would have preferred to target four WF consonants (two per subblock) in order to establish maximum generalization potential for CVC. Because the moraic subblock was ordered first, two consonants -- p/ and /f/ -- were available as targets. Choice for the onset-rime subblock was limited to /m/, /n/, /l/, /b/, /d/, /l/ and /t/ (which had been established within the segmental sub-block). The nasals were eliminated because they were in use as WF consonants some of the time, and thus not equivalent targets to the unestablished moraic WF targets -- /p/ and /f/. The /l/ was unpreferred, because WF /l/ generally develops late in comparison with other final consonants. Voiced stops were not a choice because of children's phonetic tendencies to devoice or overarticulate WF voiced stops in imitative training. This left /t/ -- not a preferred choice because of its use in the segmental subblock. However, because S6 was using WI /t/ consistently by the beginning of the onset-rime subblock, it was considered a viable target, especially as a contrast to the labials targeted in the moraic condition.

Results of Block 1 Intervention

There were changes in both syllabic and segmental conditions, with notable increased use of CVCV and CVC wordshapes, and incipient establishment of coronal and dorsal obstruents. Proportional gains were greater for the syllabic condition (average gain of 35.95%, *SD*, 14.04% compared with average gain of 11.67%, *SD* 12.58% for the segmental condition. See figures 8.2, 8.8, and 8.9 and appendix 4, table 8.1.) Syllabic condition results are reported first in order to follow the general data description for the assessment sample.



*Singleton consonants only. Consonant slot marked for a specific Place node, although not always the *correct* Place node.
**Singleton consonants -- no liquids. Consonant slot marked for a specific Place node, although not always the *correct* Place node.

Figure 8.2. S6: Proportional gain in matches for syllabic and segmental training targets between Initial Assessment and Block 1 major probes

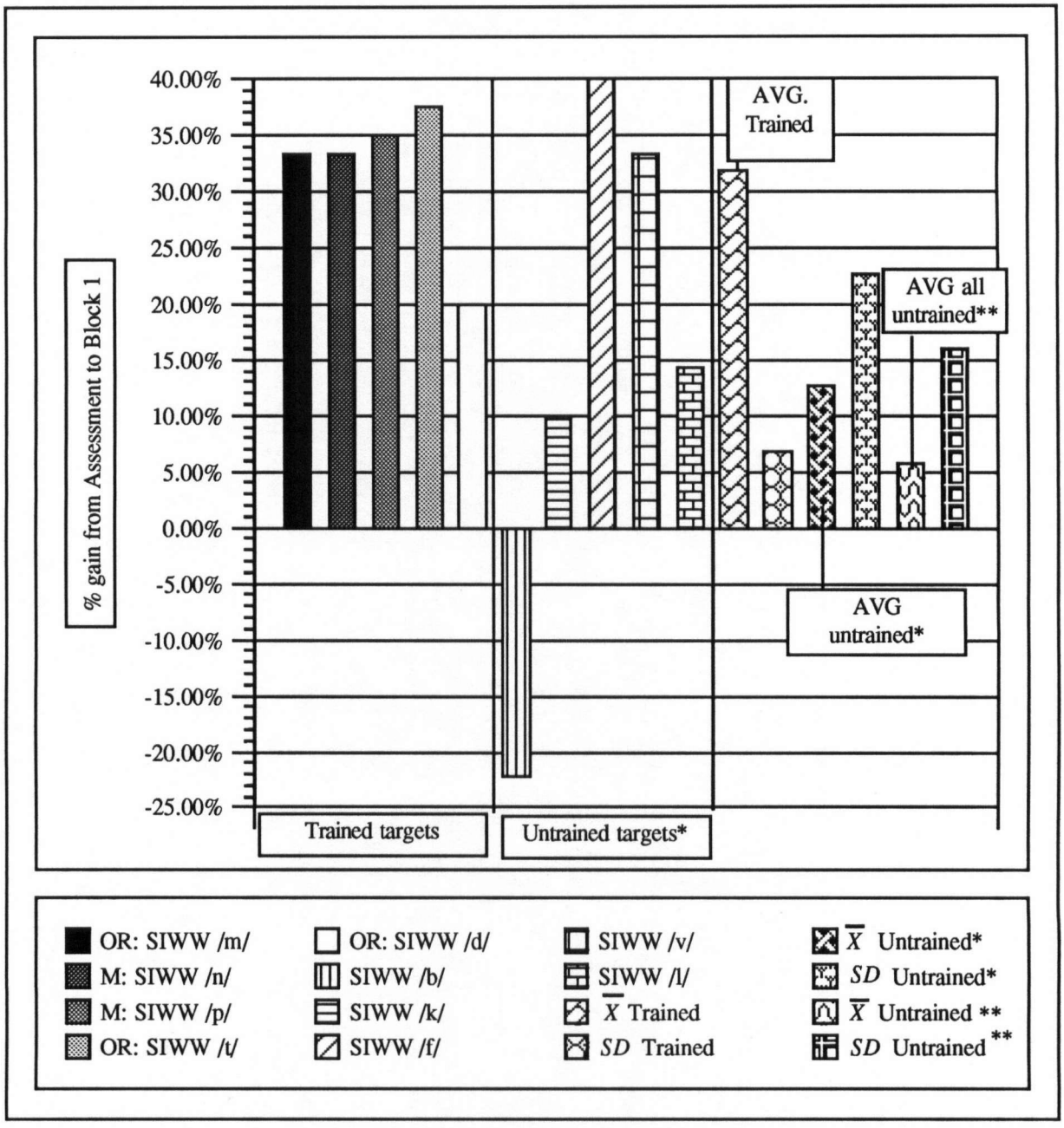
SIWW Consonants (CVCV(C))

Overall, there was a 15.87% gain in matching SIWW consonants (primarily for CVCV word shapes). Figure 8.2 shows specific gains for the moraic condition training targets /p/ (3/5

matches) and /n/ (5/6), onset-rime condition training targets /m/ (5/6), /t/ (10/16) and /d/ (3/15), and generalizations to other segments (see figure 8.3, table 8.8, and appendix 4, table 8.1). The latter included partial establishment of /f/ (2/5 matches), /v/ (6/9) and /w/, as well as marginal development of SIWW /l/ (1/7) and /k/ (1/10 matches for a reduplicated, often practiced "word" -- cawcaw). Although regression was observed for SIWW /b/ (-22.22%), there were still seven matches out of a possible nine, indicating no noteworthy dropoff for that segment. The changes for the labials probably reflect generalization from moraic condition training on labial obstruents, both for WF and SIWW consonants. The single /k/ token was a rote-learned item. The single /l/ token, on the other hand, may indicate some generalization of coronal segments in SIWW position from the onset-rime training on coronal stops.

Apart from increases in matches, there were changes in types of substitutions for nonmatching SIWW consonants (see tables 8.9 - 8.11). The decrease in number of missing consonants (-11.96%) reflects a decrease in the number of word reductions.

It appears that development in syllable/word congruency was effected not only through an increase in use of glides (6.1%) and consonants (4.88%), but also through an 8.78% increase in glottal use (see table 8.11), one of the substitutions the training was designed to reduce in frequency. For the glottals and glides, there was minimal specification of the Root node, i.e., either other Root node feature specification ([+sonorant]) for glides or Laryngeal node specification for glottals. In table 8.9, the specific consonants showing changes within each of the subsitution categories do not form natural classes. Since the segments involved were from random categories, syllable/word congruency did not appear to be segment-dependent, but predicated by the prosodic level only -- a prediction of nonlinear theory in terms of autonomous levels.



Note: Other than glides, there were no matches other than those presented above.
*Includes segments for which there were matches in some word position, i.e., /b/, /k/, /f/, /v/, /l/, /g/.
**Includes all untrained targets except glides, including those for which there were no SIWW matches - - coronal fricatives/affricates, /r/, dorsal consonants.

Figure 8.3. S6: Proportional gain in matches for trained and untrained SIWW syllabic targets between Initial Assessment and Block 1 major probes

Table 8.9.--S6: Substitutions for SIWW singletons at end of Block 1

Child forms>	Matches	Substitutions				
		[ʔ]	[h]/[C]	Glide	Consonant	R.N.: Ø
	/m/ - 5/6 /n/ - 5/6 /p/ - 3/5 /b/ - 7/9 /t/ - 10/16 /d/ - 3/15 /k/ - 1/10 /f/ - 2/5 /v/ - 3/9 /l/ - 1/7 /w/ - 4/6 /j, h/ - All	/p/ - 2/5 /b/ - 1/9 /t/ - 2/16 /k/ - 7/10 /g/ - 2/2 /θ/ - 1/2 /ʃ/ - 1/3 /ʧ/ - 1/1 /ʤ/ - 1/2 /r/ - 1/5	/d/ - 4/15 /k/ - 1/10 /f/ - 1/5 /s/ - 7/8 /ʃ/ - 1/3 /ʤ/ - 1/2 /l/ - 1/7	/n/ - 1/6 /t/ - 2/16 /d/ - 1/15 /k/- 1/10 /v/ - 4/9 /ð/ - 1/1 /z/ - 1/2 /l/ - 2/7 /r/ - 1/5 /w/ - 2/6	/b/ - 1/9 /t/ - 2/16 /d/ - 2/15 /f/ - 1/5 /v/ - 1/9 /θ/ - 1/2 /ð/ - 1/3 /s/ - 1/8 /z/ - 1/2 /ʃ/ - 1/3 /l/ - 1/7 /r/ - 1/5	/d/ - 5/15 /v/ - 1/9 /ð/ - 2/3 /r/ - 2/5 Only in cases of word reduction for /m (1), f (1)/

Note: Underlining indicates change from assessment sample.

Table 8.10.--S6: Proportion of substitution types over total nonmatches for singletons within and across word positions at the end of Block 1

Substitution	WI	SIWW	WF	TOTAL
[ʔ]	38/187 (20.32%)	19/69 (27.54%)	163/284 (57.39%)	220/540 (40.74%)
[h]/([C])	29/187 (15.51%)	10/69 (14.49%)	9/284 (3.17%)	48/540 (8.89%)
[ʔ] + [h]	67/187 (35.83%)	29/69 (42.03%)	172/284 (60.56%)	268/540 (49.63%)
Glide	27/187 (14.44%)*	15/69 (21.74%)		42/540 (7.78%)
Consonant	92/187 (49.2%)	12/69 (17.39%)	9/284 (3.17%)	113/540 (20.93%)
[V:]/[Ṽ]			10/284 (3.52%)	10/540 (1.85%)
R:Ø	1/187 (.53%) (Wd. reduction)	9/69 (13.04%)	72/284 (25.35%)	82/540 (15.19%)

Note: Within word positions, proportions are calculated over totals for that word position. In the final column, proportions are calculated over the total number of substitutions.

*/r/ > [w]

Table 8.11.--S6: Differences between Initial Assessment and Block 1 for singleton substitution types expressed as a proportion of total nonmatches

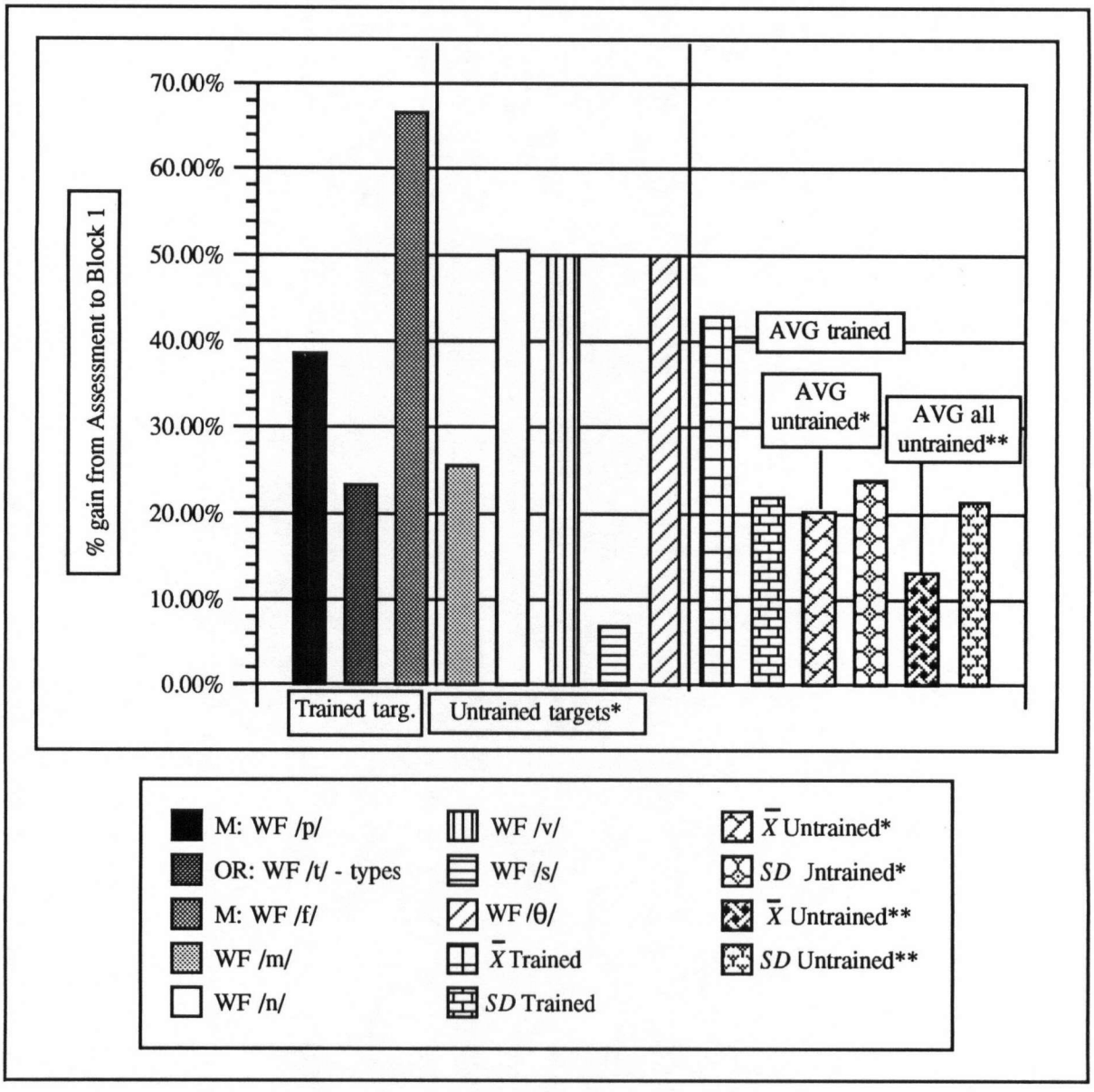
Substitution	WI	SIWW	WF	TOTAL
[ʔ]	-16.64%	8.78%	-1.39%	-3.56%
[h]/([ç])	-4.05%	-13.64%	-1.83%	-3.77%
[ʔ] + [h]	-20.69%	-4.85%	-3.19%	-8.60%
Glide		6.10%		3.97%
Consonant	31.80%	4.88%	3.17%	8.26%
[V:]/[V]			-6.48%	-3.21%
R:Ø	.53%	-11.96%	-.90%	-3.16%

Note: Differences calculated between identical cells in table 8.2.

WF Consonants (CVC)

Overall, there was an 18.76% gain in matching WF consonants (primarily for CVC wordshapes). This reflected specific gains for moraic condition segments /p/ (5/13 matches) and /f/ (6/9) and onset-rime condition segment /t/ (7/30 for word types), as well as generalizations to other segments (see figure 8.4, table 8.12 and appendix 4, table 6.1). Generalizations included increases in matches for partially established WF /m/ and /n/ (to over 80% matches each), as well as marginal development of WF /θ/ (1/2 matches) and /s/ (3/44). The changes for the nasals and /s/ may partially reflect training for these segments for other word positions, but they also demonstrate development of the CVC word shape beyond the segments targeted.

Apart from gains in matches, types of substitution for nonmatching WF consonants changed, so that 29.71% of consonant slots had specific Place node specification. Although glottals and missing consonants still accounted for about 75% of the WF nonmatches (see table 8.11), there was a small proportional decrease in use of laryngeal defaults (3.19%) and vocalic substitutions (-6.48%) and a concomitant increase in use of consonantal substitutions (3.17%) (see table 8.10).



*Includes targets for which there were matches in some word position, i.e., voiced stops and dorsal consonants
**Average includes zero matches for all untrained targets (except liquids).

Figure 8.4. S6: Proportional gain in matches for trained and untrained WF syllabic targets (excluding liquids) between Initial Assessment and Block 1 major probes

In table 8.12, the specific consonants showing consonantal substitutions (i.e., specification of Root node features and Place node features) are designated.

Table 8.12.--S6: Substitutions for WF singletons at the end of Block 1

Child forms >	Matches	Substitutions					
		[ʔ]	[h]/([ç])	[C]	[V]/[V:]	[Ṽ]	R.N.: Ø
	/m/ - 18/21 /n/ - 31/37 /p/ - 5/13 /t/ - 9/126 /f/ - 6/9 /v/ - 2/4 /θ/ - 1/2 /s/ - 3/44	/m/ - 2/21 /n/ - 2/37 /ŋ/ - 7/24 /p/ - 8/13 /b/ - 2/3 /t/ - 80/126 /d/ - 2/11 /k/ - 28/30 /g/ - 2/8 /f/ - 3/9 /v/ - 2/4 /θ/ - 1/2 /s/ - 15/44 /z/ - 7/24 /ʃ/ - 3/10 /ʧ/ - 1/3 /ʤ/ - 1/3 /l/ - 3/14* /r/ - 6/33*	/t/ - 1/126 /g/ - 1/8 /s/ - 23/44 /z/ - 3/24 /ʃ/ - 1/10 /ʤ/ - 1/3	/n/ - 1/37 /ŋ/ - 8/24 /b/ - 1/3 /d/ - 3/11 /s/ - 1/44 /z/ - 3/24 /ʧ/ - 1/3	[V] -- /l/ - 11/14 /r/ - 4/33 [V:] -- /ŋ/ - 1/24 /t/ - 1/126 /d/ - 1/11	/m/ -1/21 /n/ - 1/37 /ŋ/ - 5/24	/n/- 2/37 /ŋ/ - 3/24 /t/-35/126 /d/ - 5/11 /k/ - 2/30 /g/ - 5/8 /s/ - 2/44 /z/ -11/24 /ʃ/ - 5/10 /ʧ/ - 1/3 /ʤ/ - 1/3 /r/ - 2/33

Note: Underlining indicates changes from assessment sample. An important development not evident in the tables was the emergence of a few WF clusters (nasal-obstruent and stop-fricative clusters).

*Because /l/ and /r/ were realized as vocalic segments, the glottal may be phonetic.

Changes were most notable for the nasal /ŋ/ (as [n]) but there was also a marginal number of consonantal substitutions for sibilants /z/ and /s/ (as [θ]), voiced stops /b/ and /d/ (as [p] and [t]) and the affricate /ʧ/ (as [t^h]). The /b/, /d/ and /ʧ/ changes reflect training of (/p/ and /t/) directly, with the other changes showing indirect generalization of CVC, WI training of /s/, and SIWW training of nasals.

Comparison of the Onset-Rime and Moraic Conditions

A. Similarities

The SIWW results were identical for the onset-rime target /m/ and moraic target /n/ (5/6 matches for both, with a proportional gain of 33.33% for each). One of the SIWW O-R targets -- /t/ -- showed a similar relative increase of 37.5% (see figure 8.3 and appendix 4, table 6.1), as did the other moraic target -- /p/ -- with a 35% proportional gain. One of the WF moraic targets -- /p/ -- showed a similar gain of 38.76% (both relative and absolute).

B. Differences

One of the SIWW targets -- O-R target /d/ -- showed a notably lower gain than the others, with a 20% relative (and absolute) increase.

The results for WF targets were less consistent. Although the moraic target /p/ showed a 38.46% gain, the moraic target /f/ gain of 66.67% was notably greater (results for both targets being relative and absolute). The gain for the onset-rime target /t/ was notably lower, both for word types (23.33%) and tokens (7.14%, with both gains being relative and absolute).

C. Commentary

For SIWW targets, it appears that method was not directly relevant to progress made, since four of the five targets showed equivalent proportional gains. The variation noted for the WF consonants does not lead to any specific conclusions. It appears that development was faster for the moraic targets, but this may have reflected the difference between labial and coronal segments, rather than the condition itself. The lower score for the coronal SIWW target /d/ is another example that realization of actual syllabic slots can be segment-dependent, an interaction noted in the assessment sample, when S6 only used /m/ and /n/ as final consonants. This may appear to conflict with the deduction made in the previous section outlining SIWW results -- that syllable/word congruency is not segment-dependent. However, the syllable/word tier interface is distant from the segmental tier, whereas the syllable structure and segments are either directly linked, or mediated by a skeletal tier, which can "interpret" both types of information. In either case, the segments could be seen as more relevant for syllable structure realization than syllable-word congruency.

Segmental Goals

Higher Level Feature Subblock

Results for the coronal obstruents differed. For /t/, there was a 25% proportional increase in matches for word types (38.89% for tokens), but there was no change for /s/ in the major probe. S6 did produce some /s/-initial words during therapy sessions, but not during the probe sample. These results were predictable, since S6 used WI /d/ consistently, and was beginning to use WI /t/ prior to intervention. The unestablished /s/ was a more difficult coronal target.

Average gain for trained coronals was 23.26%. Some generalization occurred to untrained voiced coronal fricatives -- /z/ (1/3 matches) and /ð/ (5/65) matches. (See figure 8.5.)

Lower Level Feature Subblock

There was marginal establishment of Dorsal Place for consonants (13.64% absolute and relative gain), as the three instances of WI [k] for /k/ demonstrate (one spontaneous, connected speech token).

Comparison of the Higher and Lower Level Features

In comparison with the individual coronal segment results, the gain for the dorsal segment /k/ was less than for /t/ and greater than for /s/, but still less than the average of the trained segments. A further indication of slower Dorsal Place development for the dorsals was the lack of generalization to other dorsal segments. Because Dorsal Place was completely unestablished for consonants at the onset of intervention, these results are unsurprising.

Laryngeal Substitutions in WI Position

Tables 8.10, 8.11, and 8.13 show the reduced frequency of laryngeal substitutions (-20.69%) and concomitant increase in consonantal substitutions (31.8%) for WI position. These gains are greater for WI position than for the other word positions. The training of new segments implies the specification of previously unspecified features. For this child, the laryngeal substitutions were considered to be default substitutions. By training new segments in a reasonably well-established word position, an overall increase in feature specifications resulted, which resulted in a greater number of "true" consonant realizations of syllabic slots.

This demonstrates one advantage of the segmental condition training over the syllabic condition training, an advantage which is not observable in the match data alone. It is not a surprising result, given that the SIWW and WF word positions resulted from lack of developments at the syllabic level itself, a more profound constraint.

Table 8.13.--S6: WI singleton matches and substitutions at end of Block 1

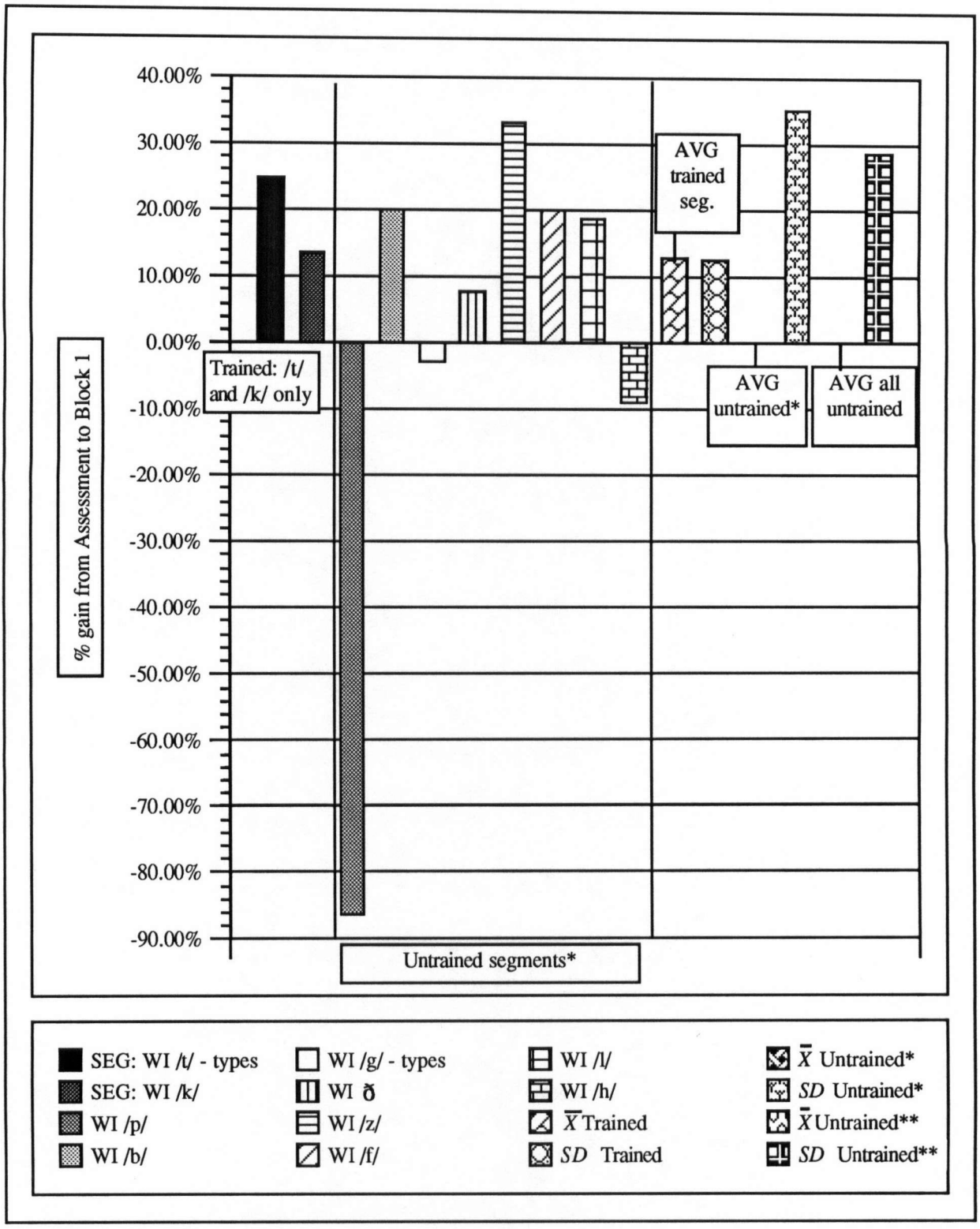
Child forms >	Matches	Substitutions				
		[ʔ]	[h]/[ç]	Glide	Consonant	R.N.: Ø
	/m, n, b d, f, v/ - All 100% /p/ - 3/22 /t/ - 10/18 /g/ - 7/14* /h/ - 40/44 /k/ - 3/22 /z/ - 1/3 1 error each- /l, w, j/	/t/ - 1/18 /k/-19/23 /g/ - 7/14 /ʧ/ - 5/5 /ʤ/ - 4/5 /h/ - 4/44	/s/-24/25 /z/ - 1/3 /ʃ/ - 3/4 /ʤ/ - 1/5	/r/- 26/27	/p/ - 19/22 /t/ - 7/18 /θ/ - 1/1 /ð/ - 60/60 /s/ - 1/25 /z/ - 1/3 /ʃ/ - 1/4 /l, w, j/	/r/ - 1/27 (Wd. reduc.)

Note: Underlining indicates change from assessment sample.

*gum (6) and Gummibear

Feature Changes for the Overall Segmental Data

Because consonant changes were pervasive across the system for S6, all changes are listed below in terms of the feature hierarchy. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Progressive feature changes are denoted with + and * for increases in matches on trained and untrained segments respectively, and with ++ and ** for changes on trained and untrained segments. Regressive changes are denoted with &.



*Includes any WI segments for which there is a match in some word position, i.e., /b/, /g/, /f/, /l/, /h/, /z/, and /ð/, (except for glides, which were all matches). There were no matches for /θ/.
**Includes all untrained targets except glides /w/ and /j/. There were no matches for /r/, alveopalatals, or /θ/.

Figure 8.5. S6: Proportional gain in matches for trained and untrained WI segmental targets between Initial Assessment and Block 1 major probes

A. Unspecified child forms where adult targets are specified

1. Place node: Fewer laryngeal substitutions and a greater number of Place node specifications were noted for: WF /m/ and /ŋ/, voiceless stops /p/, /t/, and /k/, voiced stop /d/, and fricatives /f/, /s/ and /z/ and /θ/; WI voiceless stops /t/ and /k/, labiodentals and /z/; and SIWW /p/ and /d/. There were increases in number of laryngeal substitutions for WF /b/, /n/, and SIWW /b/, /r/, /t/, /l/ and /g/. +, **, *, &

2. Root node: There were a few instances of two-element WF clusters, as well as a reduction in number of missing consonants across SIWW and WF positions (particularly SIWW position) with decreased numbers of word reductions. +, ++, *, **

3. Place node: Dorsal Place was specified for a few tokens of WI /k/ and SIWW /k/.+, ++

4. Root node: [+continuant] was specified for /ð/ (5/65). *

5. Laryngeal node: Redundant feature [+spread glottis] was more frequent in application forfor /t/, and less often for /p/. Distinctive feature [+spread glottis] was less frequently specified for WI /h/ (4/44 unspecified). +, &

Areas of No Change in Feature Specification

1. Place node: Coronal [*+distributed*] interdental or dental tongue place was still in use optionally for /z/ and /s/.

2. Place node specification: There was no change for /g/, alveopalatals, and /v/.

3. Root node: [+consonantal] remained unspecified for /r/ in all word positions and for SF /l/.

4. *Labial* for Coronal Place ([w]) continued for /r/ realization.

Intervention Plan: Block 2

Segmental Intervention Plan

Higher Level Feature Subblock

Targets: WI /s/ and /z/, WF /s/ -- Root node [+continuant], Place node

Lower Level Feature Subblock

Targets: WI /k/ and /g/, SIWW /k/ -- Dorsal Place

Rationale

Because S6 had mastered neither the coronal sibilants nor the dorsal consonants in Block 1, E retargeted them for Block 2, although in an extended number of word positions and with additional target segments in order to enhance generalization potential.

Because there had been one correct token of /z/ in the Block 1 sample, /z/ became a new coronal target in WI position. Because S6 had made steady progress in realization of final consonants in general, including producing a few tokens of WF /s/, E considered WF position to be well enough established to serve as a framework for segmental development.

Because of the stability of the word gum, WI /g/ became an additional dorsal training target. The single token of SIWW /k/ indicated potential for SIWW dorsal consonants and, thus, SIWW /k/ also became a training target. E included no final dorsal consonants in this subblock because the Block 1 probe showed no changes word finally for /k/ or /g/.

Syllabic Intervention Plan

Moraic Subblock

Targets: 1. /fl/

2. WI and SIWW /k/

Onset-Rime Subblock

Targets: 1. /bl/

2. WI /g/

Rationale

A. CCV(C)

Although the CVC and CVCV word shapes were not completely established for consonant slots (29.781% and 46.83%, respectively), all sound classes except liquids showed matches. There appeared to be a daily increase in matching word shape proportions, and, therefore, the development of a more complex word shape seemed to be an appropriate goal. Since WF clusters were emerging spontaneously, CCV(C) was considered to be a logical next target. E selected /l/-clusters for training because the labial obstruents and /l/ were established word initially. The /fl/ was easy to elicit as a moraic target because [f] can be prolonged as a singleton, and thus presented

separately from the moraic constituent [lV..], in which the prevocalic consonant is adjoined to the mora ([f:] -- [lV..]). The /bl/ was easy to elicit as an onset-rime target because the [l] can be prolonged with epenthesis, thus creating the onset constituent /bl/ ([bəl] -- V..).

B. Dorsal Place consonants

Choosing /k/ and /g/ as syllabic targets appears to be a departure from experimental design, since they were segmental targets within the same block. However, during the segmental subblock period, miniprobe results demonstrated mastery of untargeted *WF* /k/ and /g/ (see appendix 4, table 6.1). Once mastered in any given word position, a phoneme could not be a segmental target, according to general design. This "released" /k/ and /g/ to become syllabic targets in SI position. This decision for S6 paralleled a similar decision to transfer labiodental fricatives from the segmental to the syllabic condition for S2. Since S2 was the match subject for S6, the syllabic-segmental target manipulation increased the similarity of subject treatments for the two children. Because generalization of WI dorsal consonants was difficult for S6, it also seemed ethically advisable to retarget them, with the added advantage of syllable constituent training. Assignment of /k/ to the moraic condition and /g/ to the onset-rime condition was random.

Results of Block 2 Intervention

Segmental Goals

Segmental results are reported first, since their outcome affected choice of targets for the syllabic condtion (see figures 8.6 - 8.8).

Higher Level Feature Subblock

In terms of actual matches, appendix 4, table 6.2 shows a decrease for /s/ and /z/. This decrease resulted from an increase in use of interdental tongue position for production of these consonants. Overall, Place node specification increased for /s/ and /z/, as is shown in table 8.14 and figures 8.6 - 8.8. For the training targets, Coronal Place node was established with terminal features for 63.16% of the major probe tokens (24/38). The interdental tongue position, although a nonmatch, was not a concern considering the age of the child. She had the capacity to produce phonetically correct sibilants, but did not yet have the fine control needed for continuous precise

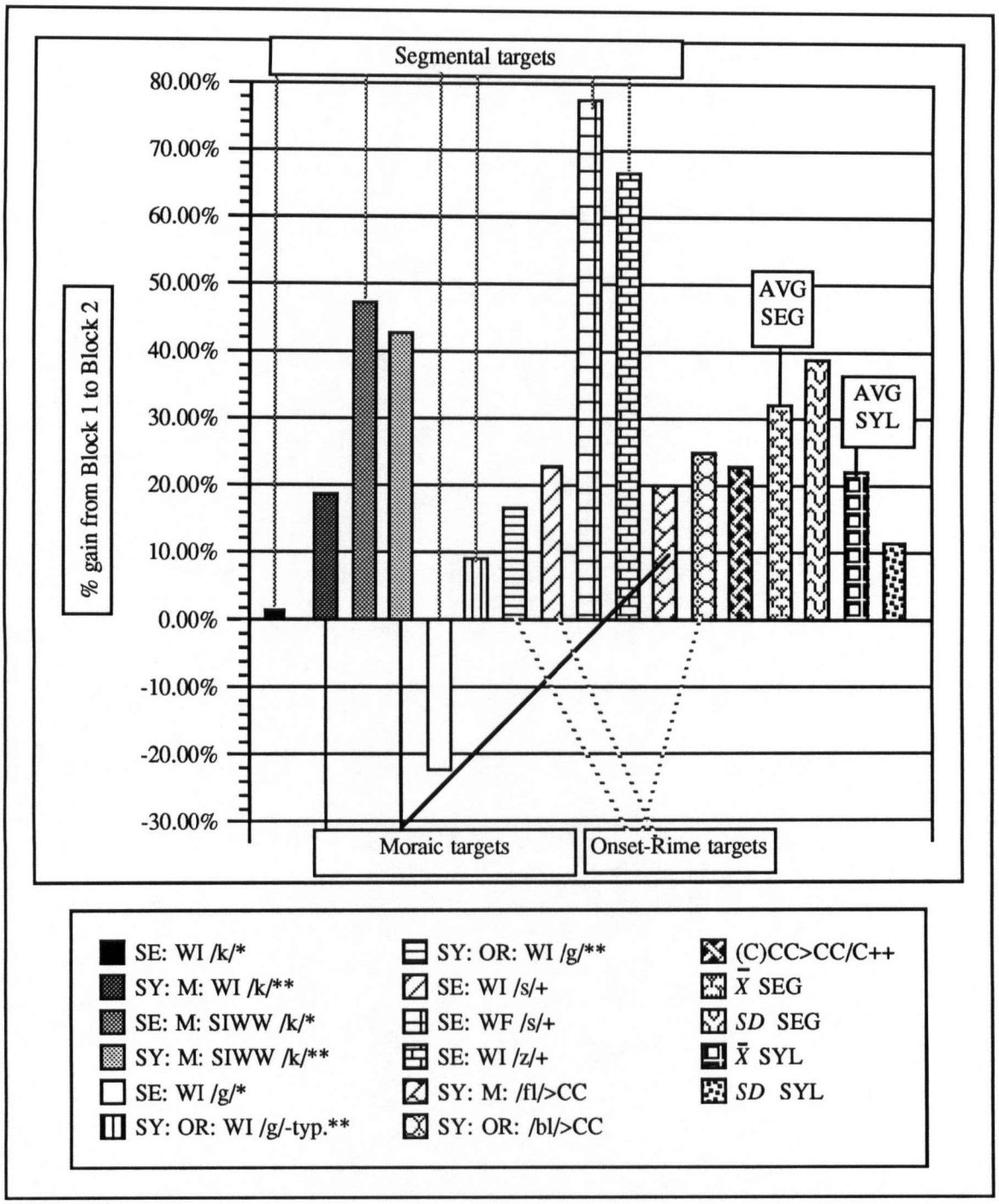
articulation in connected speech. The decrease in the default laryngeal substitutions with associated increase in Place node specification were the desired phonological advances. The spontaneous increases in matches for /θ/ and /ð/ ([+distributed]) and the establishment of WF /ʃ/ and SIWW /ʧ/ ([-anterior], 'complex') further demonstrate the specification of terminal features for Coronal Place.

Table 8.14.--S6: Substitution types for /s/ and /z/ singletons in WI, SIWW and WF positions at the end of Block 2

Phoneme	WI Subst.	SIWW Subst.	WF Subst.	TOTAL
/s/	[h] - 16 [θ] - 4 [s>] - 1 [ʔ] - 1	[θ] - 5 [h] - 4 R:Ø - 1	[θ] - 12 [s>] - 1 [h] - 1 [ʔ] - 1	[h] - 21 [θ] - 21 [s>] - 2 [ʔ] - 2 R:Ø - 1
/z/	[tθ] - 1	[ð] - 2 [θ] - 2 [ʒ] - 1	[θ] - 5 [ð] - 3 [s>] - 1 [tθ] - 1 R:Ø - 1	[θ] - 7 [ð] - 5 [tθ] - 2 [s>] - 1 [ʒ] - 1 R:Ø - 1
/s/ + /z/	[h] - 16 [θ] - 4 [tθ] - 1 [ʔ] - 1 [s>] - 1	[θ] - 7 [h] - 4 [ð] - 2 R:Ø - 1 [ʒ] - 1	[θ] - 16 [ð] - 3 [s>] - 2 [h] - 1 [ʔ]/ [tθ] - 1 R:Ø - 2	[θ] - 28 [h] - 21 [ð] - 5 [s>] - 3 [ʔ]/ [ʒ] - 1 R:Ø - 4

Lower Level Feature Subblock

WI /k/ and /g/ (both targeted) did not show gains by the end of the segmental subblock (see figures 8.6 - 8.8 and appendix 4, table 6.2). By contrast, the targeted SIWW /k/ had a notable gain of 47.14% in the segmental miniprobe (57.14% matches). Furthermore, the untargeted WF position showed substantial gains at that time -- 77.78% matches for /k/ and 50% matches for /g/. Segmental training undoubtedly influenced the establishment of these WF dorsal consonants by providing phonetic practice, but constraints of the system dictated that they be established following the stressed nucleus (the case for both SIWW and WF positions). Another generalization noted in the Block 2 major probe was the emergence of /ŋ/ when before /g/ or /k/.



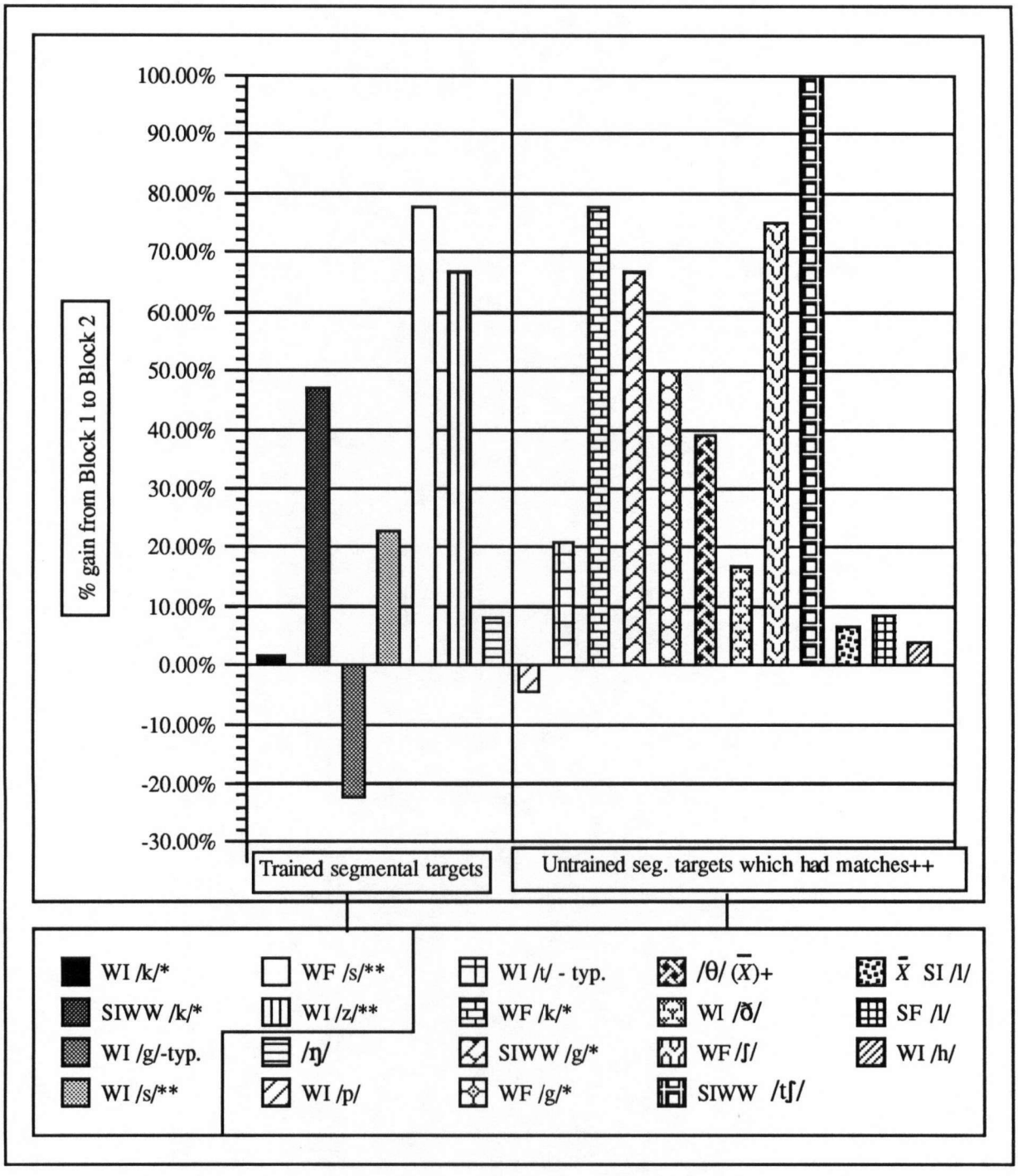
*For /k/ and /g/, segmental match differences represent the difference between Block 1 major probe and Block 2 miniprobe.

**For /k/ and g/, syllabic match differences represent the difference between Block 2 miniprobe and Block 2 major probe.

+Place node specification coronal, with *interdental* tongue position

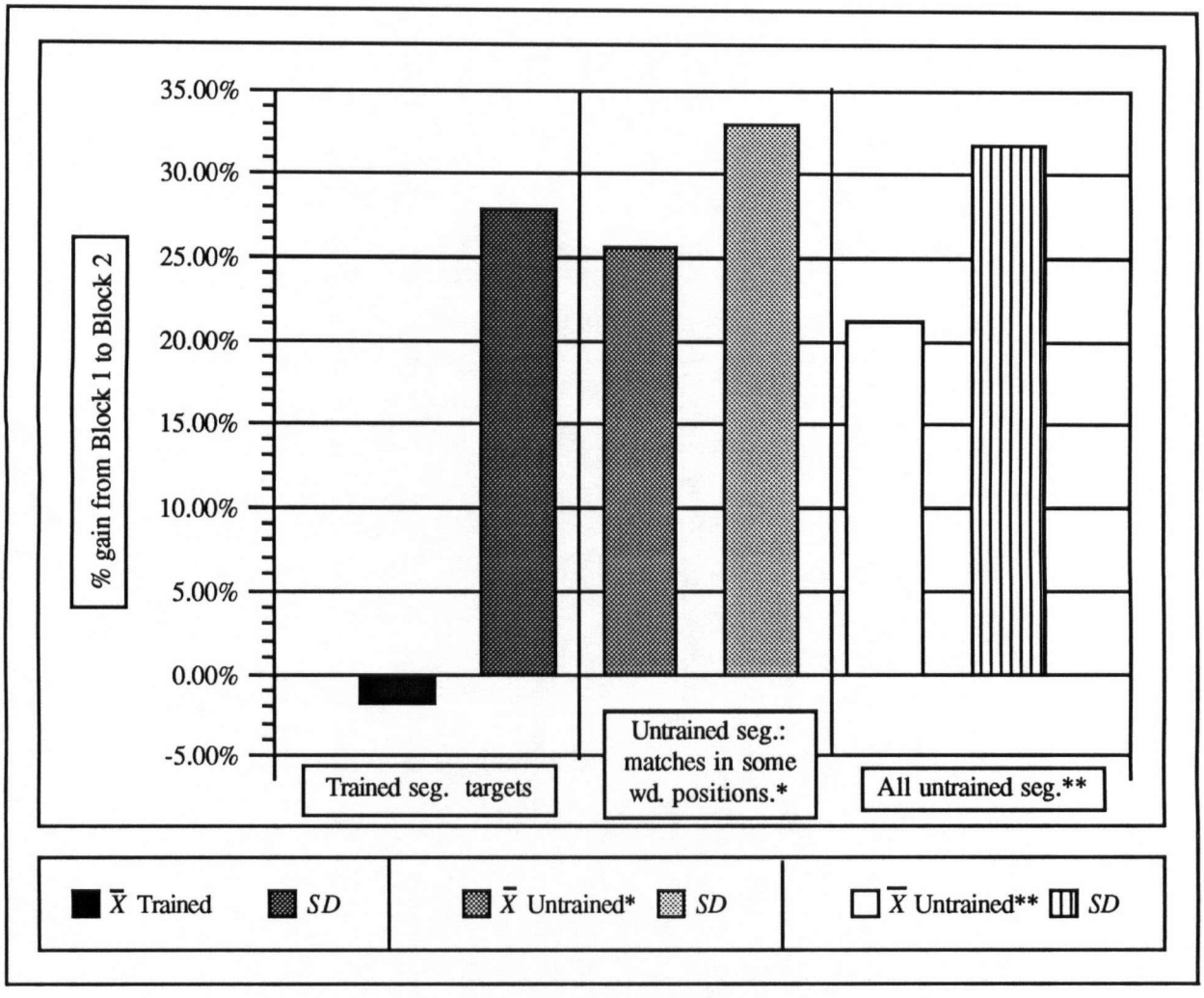
++C neither glottal nor [h]

Figure 8.6. S6: Proportional gain in matches for syllabic and segmental training targets between Block 1 and Block 2 major probes



*All /k/ and /g/ data based on differences between Block 1 miniprobe and Block 2 major probe
**No matches in WI position
+Place node specified as Coronal - - [+*distributed*], *interdental* tongue position
++No other matches, i.e., for /r/, /ʤ/ or segments in word positions other than above

Figure 8.7. S6: Proportional gain in matches for trained and untrained segmental targets between Block 1 and Block 2 major probes



*Untrained segmental targets with matches in some word position, i.e., /p/, /t/, WF /k/, WF and SIWW /g/, /θ/, /ð/, /ʃ/, /tʃ/, SI /l/, /h/. For /k/ and /g/, data represents difference between Block 1 major and Block 2 miniprobes.

**All untrained segmental targets. There were no matches for /r/, SF /l/, or /ʤ/.

Figure 8.8. S6: Average proportional gain in matches for segmental targets between Block 1 and Block 2 major probes

Comparison of the Lower and Higher Level Features

Solely in terms of the targeted segments in the targeted positions, greater gains appeared for the higher level features -- Place node and [+continuant] -- (if phonetic detail, i.e., *interdental* tongue place, is ignored). Generalization to other related segments and word positions was approximately equivalent for the two sets of phonemes: (1) from /s/ and /z/ to other coronals -- /θ/, /ð/, and alveopalatals, and (2) for the dorsals, to WF position and /ŋ/

Feature Changes for the Overall Segmental Data

All changes including the above and others are listed below in terms of the feature hierarchy. The more prevalent changes are noted first, but the order is only relative, because of varying number of tokens across phonemes. Increases in matches are denoted with + and * for trained and untrained segments respectively , progressive feature changes with ++ and ** for trained and untrained segments, and regressive changes with &.

A. Unspecified child forms where adult targets are specified

1. Place node: There was a notable decrease in laryngeal substitutions across the board for SIWW and WF segments. This correlated with consonant slot realization with Place specification for 75.21% of WF singletons (excluding liquids, which had vocalic substitutions) and 73.64% of SIWW singletons. For WI position, there was an increase in laryngeal substitutions from 35.83% to 59.09% of the total (including liquids, which did not have laryngeal substitutions). This proportion directly reflects laryngeal substitutions for dorsals and sibilants, still prevalent for those sound classes in this word position. +, *, ++, **, &

2. Root node: The proportion of matching WF diconsonantal cluster slot realizations increased by 44.62% to 57.78%. In WI position, emergence of two-element clusters was observed (3/50 = 6%). The developments noted above for SIWW and WF position reflected a reduction in number of missing consonants as well as a decrease in laryngeal substitutions. +, *

3. Place node: Dorsal Place was specified for WF and SIWW /k/ and /g/ with minimal gains in WI position for /k/. *, +

4. Place node: Coronal Place [-anterior] was specified for WF /ʃ/ and SIWW /ʧ/. *

5. Root node: [+continuant] specification increased by 16.63% for /ð/. *

6. Laryngeal node: [+spread glottis] was specified more often for WI /h and was apparent as a redundant feature for /t/ and /k/, and slightly less often for /p/. *, &

7. Place node: There was an increase in instances of Coronal Place specification of [+distributed] for WF and SIWW /θ/. *

8. Root node: [+consonantal] was specified once for WF /l/ in the phrase all alone (between-word facilitation). *

9. 'Complex' structure was in place for more exemplars of SIWW and WF affricates. **

B. *'Specified'* child forms where adult targets are unspecified or otherwise specified

Place node: Coronal [+*distributed*] dental or interdental place was consistently used for /z/ and /s/ (i.e., an increase).

Areas of No Change in Feature Specification

1. Root node: [+consonantal] remained unspecified for /ɹ/.

2. *Labial* Place remained for /ɹ/ and WI /θ/ substitutions.

Syllabic Goals

All syllabic targets except WI /g/ showed gains, with most notable gains for SIWW and WI /k/. Progressions from WI cluster training were:

1. Specification of at least one consonant for Place node for 84% of the WI clusters (a proportional gain of 22.71%), so that the sole cluster showing *only* laryngeal substitutions was /gr/.

2. Specification of two consonants for Place node for trained WI clusters /fl/ and /bl/ and untrained /mj/ (all imitated items).

Moraic Subblock

1. /fl/: S6 imitated one imitated [fl] correctly (with no epenthesis) out of five sample tokens (flop, a trained item). (See appendix 4, table 6.2, and figure 8.8.)

2. WI and SIWW /k/: S6 mastered production of SIWW /k/ within the subblock (a 42.86% gain, to 100%), and improved in use of WI /k/ (12/37 matches, an 18.64% gain).

Onset-Rime Subblock

1. /bl/: There was one imitated [pəl] for trained item blue, considered a syllabic match according to the epenthetic training method.

2. WI /g/: Because the well-practised word gum appeared in the major probe sample (while missing in the miniprobe), there was an apparent gain of 9.09% from the segmental to the syllabic subblock. However, there was no progress noted for WI /g/.

Comparison of the Onset-Rime and Moraic Conditions

No difference in outcomes was observable for the clusters. The imitated productions of flop and blue did reflect the stimuli, i.e., epenthesis for the onset-rime target [pəl] but no epenthesis for the moraic target [fl]. During training sessions, S6 readily imitated either type of stimulus. Fortuitously, on the day that we were to practise /bl/ words, S6 entered the therapy room telling me she had a [bɑl], her first use of WF /l/. This facilitated use of [bəl] as an onset constituent. She appeared to be equally motivated by the activities in both conditions, i.e., finding blue things (a favorite color) and blowing bubbles in the onset-rime condition sessions, versus making things fly, flop and float in the moraic condition sessions.

In terms of the dorsal consonants, both absolute and relative gains were greater for /k/ than /g/. Prior training for /k/ in Block 1 may have influenced this outcome. It is equally possible that the method of separating the rime and onset may have impeded learning of WI /g/ as it is phonetically difficult to produce isolated prevoiced segments -- [$_{v}$g]. Since she frequently used the word gum , transfer to new WI /g/ words was expected, however. Furthermore, E had tried to enhance the salience of /g/ onsets by using contrasting word pair stimuli with and without /g/-onsets in perception and production games. This was perhaps less facilitative than anticipated, even though meaning-based: the aim game, oh (= stop) versus go, on versus gone, etc..

Comparison of the Segmental and Syllabic Subblocks

S6 made gains in both segmental and syllabic development during Block 2. Proportional gains overall were higher for segmental goals (average gain of 32.01% , *SD* 38.87%) than syllabic (average gain of 22.04%, *SD* 11.44%). This reflects the increase in Place node specification for sibilant segmental targets and SIWW /k/, in comparison with the marginal gains for syllabic target clusters and the necessarily lower proportional gain for SIWW /k/ (with a ceiling of 100%). The WI /k/ gain was greater for the syllabic subblock. That /g/ did not change and that the WI /k/ matches were still less than 40% imply that syllable-type training did not accelerate S6's learning of the WI dorsals.

Block 3 and Beyond

Segmental targets in Block 3 included the alveopalatals (except for acquired WF /ʃ/ and SIWW /ʧ/), and WI /k/ and g/. S6 mastered all of these. Syllabic targets included /l/-clusters. The /s/-clusters developed spontaneously in the two months following the project. Since S6 began to use /r/ occasionally and demonstrated inconsistently correct tongue placement for /s/ and /z/, (average phenomena for a 3-year-old), E discharged her from therapy.

Discussion

In terms of the research questions the following interpretations are offered.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

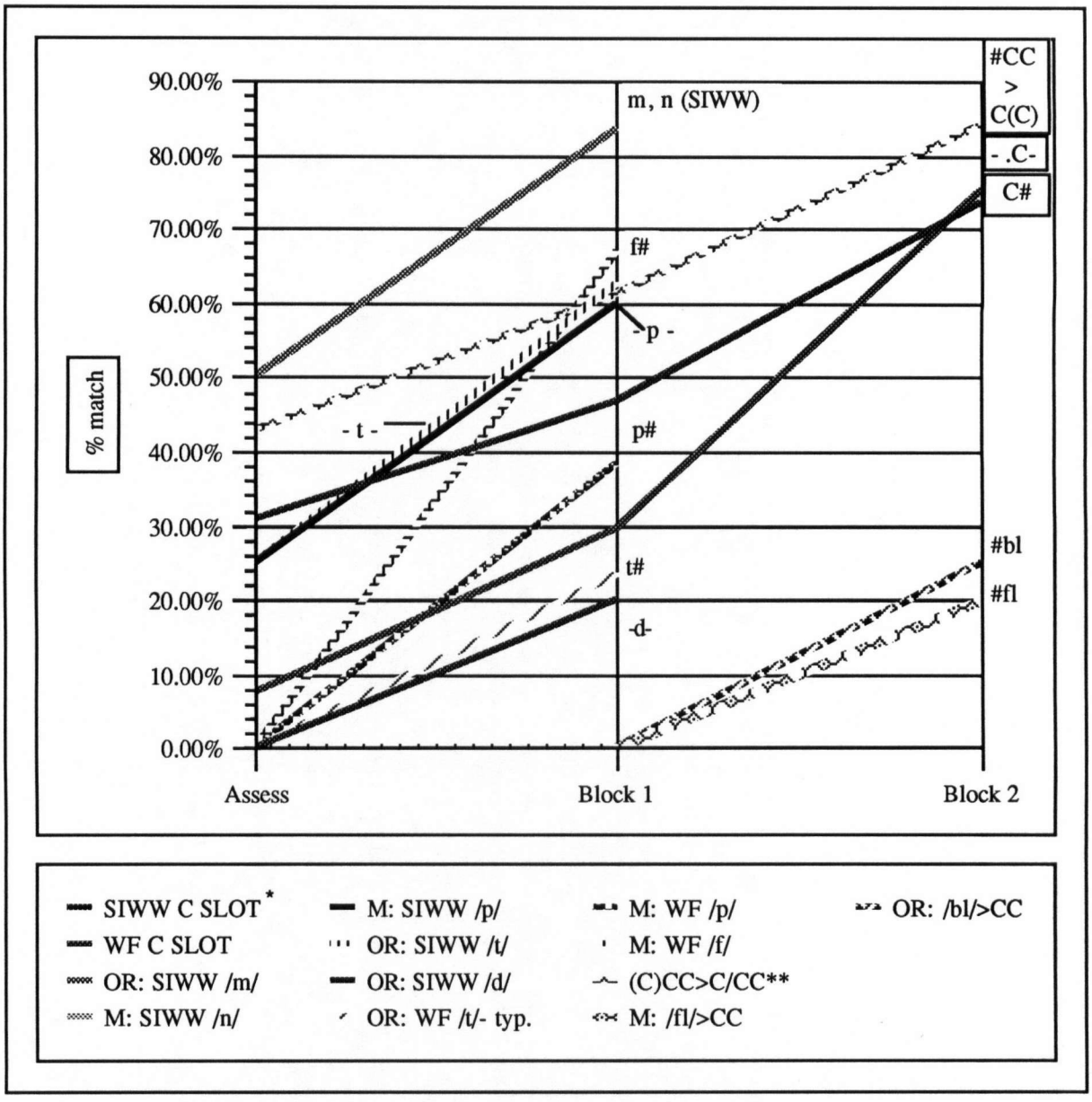
As with the other subjects, the nonlinear frameworks did lead to reasonable targets for intervention. The intervention for S6 may have been successful for reasons other than the choice of targets, such as the intensive stimulation, the mutually enhancing effect of a variety of approaches, and the age of the subject (suggesting spontaneous development). However, the nonlinear frameworks did lead to attainable goals for S6.

Conversational Intelligibility Gains

There was improvement in S6's intelligibility due to her attainment of conversational proficiency with all consonants but /r/ over the course of the project. (See figures 8.9 - 8.11.) Because of her young age, she was observed for three-and-a-half months prior to enrolling her in the project, in order to monitor spontaneous development. Although there was some change in the first of those months, with acquisition of WI /f/ and /l/, there was no change in the subsequent period and, thus, the changes over the project period can be attributed mainly to training.

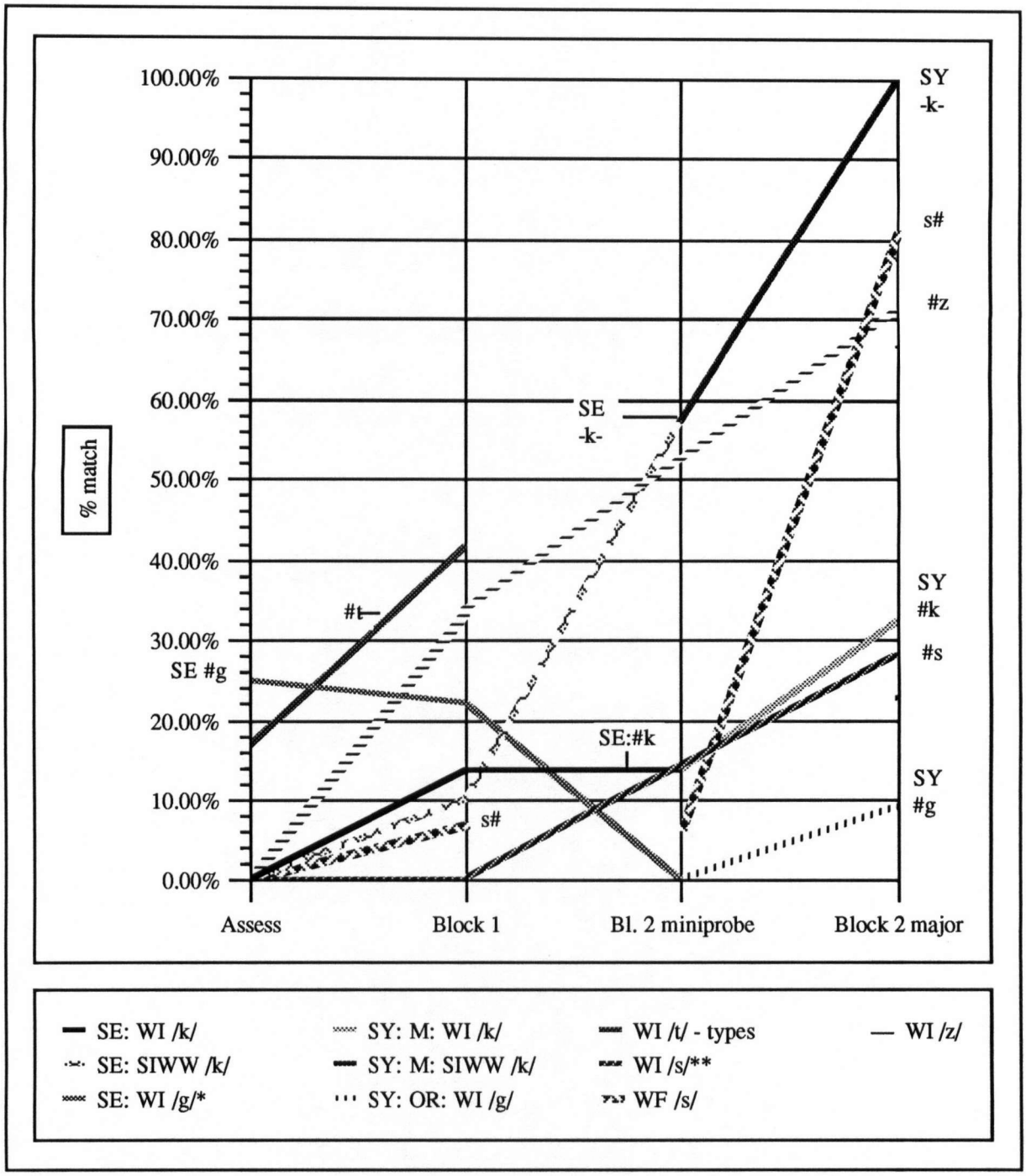
Several of the types of generalizations observed also demonstrate that changes in the phonological system reflected intervention. In Block 1, the following generalizations occurred as a result of syllabic training:

1. Training of SIWW /p/ resulted in realization of other SIWW labials -- /f/, /v/, /w/.



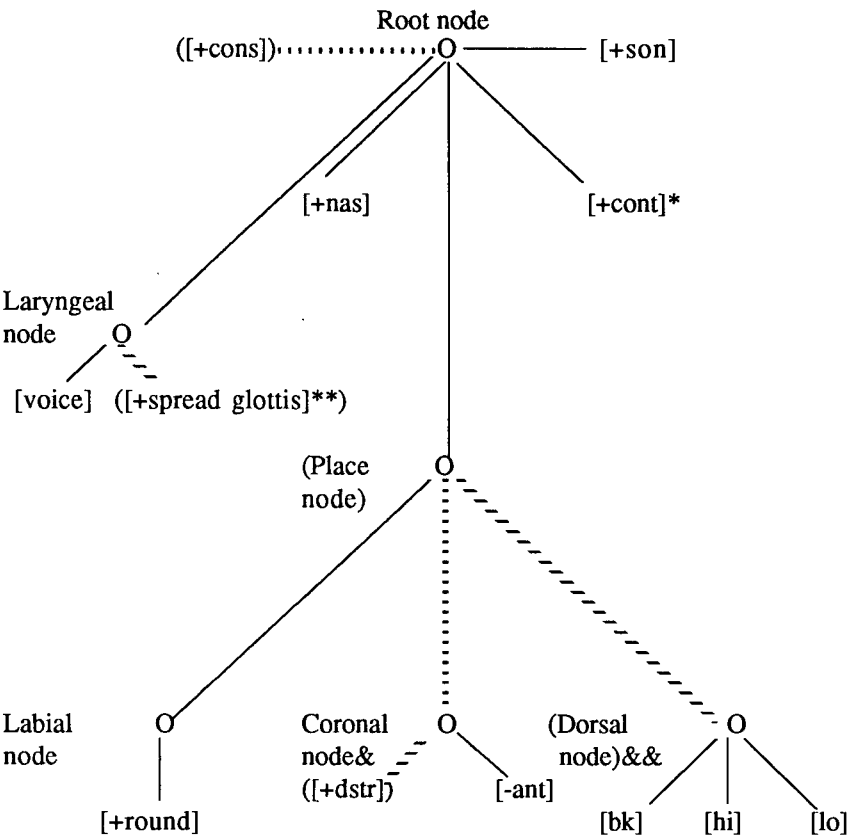
Note: Data is entered only for training periods.
*C SLOT = Singleton consonant slot only, specified for a particular Place node (no liquids for WF C SLOT)
**Consonant clusters realized with at least one consonant

Figure 8.9. S6: Developmental progression in proportional matches for trained syllabic targets (except Block 2 targets /k/ and /g/) across the intervention period



*Type data for /g/: matching items being gum or derivative
**Place node features established for /s/ and /z/, but [+*distributed*] substitution common

Figure 8.10. S6: Developmental progression in proportional matches for trained segmental targets and Block 2 syllabic targets /k/ and /g/ across the intervention period



Note: Parentheses and dotted lines indicate marginally established constituents in system development.
*Branching structure ('complex') established for most affricates
**More WI unvoiced stops show redundant feature [+spread glottis] &[+distributed] partially established for interdentals
&&Established for all contexts except WI for consonants

Figure 8.11. S6: Feature geometry at end of Block 2

2. General focus on SIWW consonants resulted in a higher proportion of syllable/word congruency, with fewer word reductions. This created an increase in laryngeal substitutions for this word position.

3. Training on WF labials /p/ and /f/ and coronal /t/ enhanced WF realization of partially established labial /m/ and coronal /n/.

4. Focus on WF consonants resulted in a change in type of substitutions, with a +3.17% increase in consonantal versus laryngeal substitutions word finally.

5. Block 1 segmental training on WI coronal fricative /s/ resulted in realization of WI /z/ and /ð/ and WF /s/ and /θ/, the WF fricatives also enhanced by syllabic training on WF obstruents.

6. In Block 2, training on dorsal stops resulted in appearance of dorsal nasal /ŋ/.

7. Segmental focus on sibilants resulted in appearance of two alveopalatals. (Specification of [-anterior] was itself a spontaneous development, however. Syllabic training on /fl/ and /bl/ resulted in a 22.71% increase in number of WI clusters with at least one consonant realization.

Language Test Results

Comprehension language test results at the end of the project were within the same range as the pretests. The Peabody Picture Vocabulary Test (Form L) showed a gain from the first test (*SS* of 104 compared with 97 previously), but these scores are still both within average range within overlapping confidence intervals. Both pretest and posttest for the Sequenced Inventory of Communication Development (Receptive Scale) showed an age score of 36 months. The posttest reliability was only fair, however, since S6 failed to identify all colors on the color identification task, although she usually could identify colors in therapy sessions. The Auditory Comprehension Scale of the Preschool Language Scale, administered only as a posttest, was notably higher than the other two comprehension tests, with an age score of 4;7.15.

Language sample observation showed changes in morphology which reflected phonological developments. Otherwise, syntactic development appeared to be progressing as expected. The Verbal Ability Scale of the Preschool Language Scale age score was 3;10.15, above average for S6's age, and parallel to results on the comprehension scale, but trailing it by nine

months. Whether this is significant , a reflection of an earlier start for comprehension skills, or something particular to the test design is not possible to say based on this one-time score.

The clearest indication of significant gains in phonology compared with other communcation scores was S6's passing of the articulation subtest of the Preschool Language Scale at the 4 1/2-to-5-year-old level. Six months earlier, before intervention, she would not have passed the 2-to-2 1/2-year-old checklist. Such rapid gains were not apparent for any other communication skill.

In terms of language production, observation of language sample data revealed expected language test results -- small gains in vocabulary, phonemic discrimination and sibilant morphophonology alongside minimal gains in syntax -- and, as such, lend support to the claim that the changes in phonology were a direct result of intervention.

2. *Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real?*

At the end of both blocks, the average proportional gain in matches differed for syllabic and segmental targets. In the first block, the average gain for syllabic targets was greater, and in the second, that for the segmental targets.

However, the average gains camouflage specific gains within the conditions. The notably lower gains for segmental targets /s/ and /k/ in comparison with gains for SIWW and WF targets indicate disparity in syllabic versus segmental learning. However, in the first condition, gain for the segmental target WI /t/ was equivalent to that for the all /t/ and /d/ syllabic targets except the SIWW /t/ (which had a greater gain). This suggests that the differences may only partially reflect syllabic versus segmental learning disparity. Specific segments -- in this case coronal obstruents -- were slower to change, irrespective of condition.

In the second block, on the other hand, coronal obstruents showed a higher rate of gain than other types of targets. Success for the segmental targets reflected success with Place node specification for coronal sibilants, compared with low gains for the syllabic goal of cluster development. However, dorsal consonant targets were not notably different between conditions.

Interaction of the Syllabic and Segmental Tiers

It was possible to set separate goals for syllable structure and segmental development. Gains in syllable structure as separate from segmental change are indications of tier autonomy. However, as for all other subjects, interactions of the syllabic and segmental tiers also reveal their interdependence as follows:

1. At the onset of intervention, gaps in segmental development conspired with syllabic constraints on syllable/word production to limit realization of even the 'minimal word' -- CV.

2. Default laryngeal substitutions often served to specify a weakly established consonant slot or an unestablished segment, or both.

3. Coronal and Labial Place nasals were the first consonants to appear in WF position, suggesting that nasal consonants, with their higher level marked Root node feature, may be most likely candidates for word position establishment.

4. Word position realization of segments depended on the phoneme, e.g., dorsal consonants and [s] appeared first in WF position; voiced segments and /l/ appeared first in WI position. Natural phonetic tendencies appeared to have influenced word position realization of segments.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of interventions that contrast the onset and rime versus those that utilize the mora as a constituent?

Equivalent gains were observed for Block 1 onset-rime targets SIWW /m/ and /t/, and moraic targets SIWW /n/ and /p/ and WF /p/ (about 35%), and for Block 2 moraic target /fl/ and onset-rime target /bl/ (about 20%).

Differences

In Block 1, WF /f/, a moraic target, showed a greater gain (66.67%). Similarly, in Block 2, there were greater gains for moraic targets WI and SIWW /k/ (13.64% and 42.86%) compared with onset-rime target /g/.

Lesser gains were observed for onset-rime targets WF /t/ and SIWW /d/ in Block 1, although these were equivalent to the gains for segmental target WI /t/.

Although the few differences appeared to show superiority for the moraic condition targets, the possibility that these differences may be segmentally based cannot be ruled out (ease with labials over coronals, /k/ over /g/). In general, for S6, methods appeared to be equivalent. A Kolmogorov-Smirnov measure was used to test the following hypotheses:

H_0: There will be no difference between the proportional match scores for all of the moraic (m) and onset-rime (n) measures across the study.

H_1: Moraic targets had proportionately higher proportional match scores across the study.

Only major probe data were used to calculate the test statisitic, (1) since different targets were in each subblock, and (2) since previous use of session and miniprobe data had not produced any significant changes in the calculations of this statistic for the previous subjects.

Table 8.15.--S6: Proportional matches for onset-rime and moraic targets across the study cast for Kolmogorov-Smirnov test

	<10%	16-20%	21-25%	31-35%	56-60%	61-65%	66-70%	81-85%	100%
s_m (x)	0/7	1/7	1/7	2/7	4/7	4/7	5/7	6/7	7/7
s_n (x)	2/7	4/7	5/7	5/7	5/7	6/7	6/7	7/7	7/7

$p > 0.1$

The largest discrepancy is 4/7, yielding a test statistic of (7)(7)(.571)=27.97, which fails to reach the level of significance at the $p > 0.1$ level (one-tailed).

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

In both blocks, the higher level feature segments (coronals) showed greater gains than the dorsals, as predicted. The dorsals were slow to emerge, taking three blocks for consolidation.

During more than one session, S6 used [t] for /k/, although probe data never showed that particular substitution (glottals only). This indicated neutralization with respect to lingual Place nodes in system development (a common occurrence in phonological acquisition), the more marked node (Dorsal) being replaced by the default Coronal Place. Training the two Place nodes in the same time period may have resulted in some confusion between them, but the direction of substitution is congruent with the longer lag in development for the marked Dorsal node.

Summary

For S6, the nonlinear frameworks provided an organized and effective system for facilitating phonological change. Within the training period, S6's phonological development accelerated at a faster rate than her language development, resulting in attainment of age-appropriate and intelligible speech. Segmental trained targets generally progressed faster than untrained. Generalizations occurred within sound class for labial and dorsal consonants and coronal fricatives, and across word positions for dorsal consonants and fricatives. Training of a few targets resulted in general learning at the syllabic level for CVC and CVCV development as well for specification of skeletal slots for WI clusters.

Tier autonomy was evident in the asynchronous attainment of syllabic and segmental goals. In the first block, average gain was greater for syllabic goals -- CVC and CVCV establishment -- than for acquisition of Coronal and Dorsal Place node features. In the second block, CCVC and WI Dorsal consonant development (as a syllabic goal) were slower than establishment of Dorsal and Coronal Place in the segmental subblock. Interactions of the tiers, however, played a notable role in development, as the default glottal substitutions and WF learning of Dorsal and sibilant consonants indicated.

Moraic and onset-rime constituent stimuli appeared equally effective in syllabic training, with the moraic approach of adjoining units to the core CV perhaps slightly more facilitative for establishing WF consonants.

Higher level features and nodes appeared to emerge more quickly in training than lower level features and nodes, suggesting relevance of level for acquisition. Generalization within

sound classes, such as labial consonants, coronal fricatives, or dorsal consonants, demonstrated general relevance for feature theory.

CHAPTER 9

DISCUSSION

The purpose of this investigation was to examine the utility of nonlinear phonological frameworks for designing and executing an intervention program for phonologically disordered children. Six such children between the ages of 3 and 6 years participated in an 18-week intervention study. The study addressed the following questions:

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real ?

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of intervention methods that contrast the onset and rime versus those that utilize the mora as a constituent?

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting specified features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

A combined alternating block, multiple baseline single subject design was utilized to study the above questions. The multiple baseline aspect of the design allowed comparison of treated and untreated parts of each child's linguistic system in order to assess effects of intervention. With an alternating treatment design, E was able to contrast intervention for and observe developmental differences between: (1) segmental versus prosodic (syllabic[5]) intervention targets, (2) prosodic targets presented as moraic versus onset-rime constituents, and (3) segmental targets with distinctive features at higher level versus lower levels in the feature hierarchy.

The within-subject results reported in the preceding chapters generally indicated the following with respect to the four research questions:

1. The nonlinear frameworks provided a logical model for deriving attainable phonological intervention goals.

2. Rate of attainment of syllabic and segmental goals differed, suggesting independence of segmental and prosodic tiers.

3. Moraic and onset-rime condition quantitative results were essentially equivalent, but some qualitative differences appeared which bore on the theories in question with respect to status of the onset, WF consonants, and epenthesis.

4. Generally, higher level features in the feature hierarchy appeared to be acquired before lower level features.

Between-Subject Comparisons

Between-subject comparisons follow, to elaborate on results relevant to the four research questions.

1. Will nonlinear phonological frameworks help to predict logical and attainable intervention goals for phonologically disordered children?

All of the children became intelligible by the end of the project as a result of attaining the goals determined by nonlinear phonological theory. The effectiveness of the phonological intervention is evident from the faster rate of phonological change during the study than before or after it and the types of generalization which occurred. As predicted, generalizations to segments or syllable/word shapes related to training targets occurred more often than to segments or syllable/word shapes unrelated to targets. Generalizations occurred (1) within sound classes, (2) across word positions, and (3) for prosodic structure.

2. Are the separate prosodic and segmental levels of representation of nonlinear phonology psychologically real ?

It was hypothesized in chapter 1 that, if the prosodic and segmental/melodic levels of

representation are psychologically real, then it should be possible to plan phonological intervention that focuses separately on the two levels. For each of the subjects, this was possible.

In chapter 1, it was further hypothesized that, if the assumed dominance of the prosodic tier over the segmental is developmentally relevant, one might expect to find a faster rate of change for prosodic intervention than for segmental intervention. This appeared to be true for each of the subjects, as the following discussion demonstrates.

Tier Autonomy

Table 9.1 shows differences in average proportional gain for segmental and syllabic targets for each child's major probe. During the study E's clinical impressions were that: (1) major prosodic development took place by the end of the first syllabic subblock, (2) initial segmental goals were not met until the end of Block 2, or, in the case of Dorsal Place consonants, Block 3, and (3) syllabic/segmental condition order did not appear to influence these outcomes. A summary of the individual results which led to those impressions follows.

For S1, Block 1 syllabic training which focused on /Cw/ and /Cj/ clusters resulted in (1) two-element clusters across all cluster types, (2) elimination of the default [fw] obstruent-approximant substitution, and (3) increase in the use of epenthesis as a means for realizing cluster elements. In contrast, he did not master segmental targets /l/ and the alveopalatals introduced in Block 1 until the end of Block 2.

S5 was the other half of the matching S1/S5 pair. He showed greater proportional gains for syllabic *skeletal slot* development (CC) in both blocks. *Exact* matches (i.e., with C[r]) did not show greater gains for syllabic targets for Block 1, however, since he had not completely mastered /r/ as a segment (see table 9.1). As with S1, consolidation of segmental targets /l/ and the alveopalatals introduced in Block 1 took place in Block 2. Since S1 and S5 had opposing condition orders, but generally similar results in terms of time of target establishment, order of conditions did not play a role for either of these subjects.

Changes in rate of development of syllable/word shapes was the most dramatic for S3. The consolidation of CVC, CVCV and CVCVC in Block 1 set up the entire system for further development. He acquired the Block 1 segmental targets /h/ and /l/ only at the end of Block 2.

Table 9.1.--Difference in average proportional gains between syllabic and segmental conditions in Blocks 1 and 2, by subject

	Block 1			Block 2		
	% Average Gain		Difference	% Average Gain		Difference
S	SYL	SEG	SYL-SEG	SYL	SEG	SYL-SEG
S1	Skel. slots:CC 16.65 (*SD*:5.36)		+14.51	Skel. slots[a] 48.92 (*SD*:7.25)		-31.92
	Phonemic targets	2.14 (*SD*:5.36)			80.85 (*SD*:17.65)	
S2	Skel. slots[b]: 36.43 (*SD*:34.48)		+18.37			
	Targets: 0	18.06 (*SD*:18.79)	-18.06	83.02 (*SD*:19.56)	21.99 (*SD*:19.89)	+61.03
S3	Skel. slots (CVC, CVCV) 33.08 (*SD*:.49)		+19.55			
	Targets: 60.75 (*SD*:9.75)	13.53 (*SD*:12.27)	+47.22	Targets 37.11 (*SD*:41.03)	36.56 (*SD*:42.81)	+.55
S4	Skel. slots (CVC, CVCV) 31.38 (*SD*:5.32)	With WF /f/ 41.6 (*SD*:38.96)	Skel. slots: With WF /f/ -10.22 No WF /f/ +9.24			
	Targets 40.49 (*SD*:27.43)	22.14 (*SD*:1.85)	Targets: With WF /f/ -1.11 No WF /f/ +18.35	Targets 35.81 (*SD*:28.15)	35.26 (*SD*:42.64)	+.55
S5	Skel. slot: Cr > CC 55.02 (*SD*:30.77)	30.03 (*SD*:23.23)	+14.99			
	Targets 25.63 (*SD*:18.30)		-4.4	Targets 30.97 (*SD*:35.62)	19.02 (*SD*:32.61)	+11.95
S6	Targets 35.95 (*SD*:14.04)	11.67 (*SD*:12.58)	+24.28	Targets 32.01 (*SD*:38.85)	22.04 (*SD*:11.44)	+9.97

Note: Syllabic goals are calculated on the basis of skeletal slot establishment and matching phonemic targets in those slots for most children.

[a]Skeletal slots for /st/ indicate that the dental substitution for /s/ was ignored; /tw/ and /kw/ data were match data, short epenthesis ignored as a mismatch.

[b]CC production or compensatory lengthening of the singleton consonant; WI /z/ 0% matches included

The equivalent gain for Block 2 syllabic and segmental targets (the latter of which had already been targeted in Block 1) shows further precedence for syllabic development during intervention for S3.

During the study, E's clinical impression was that S4 (S3's match for within-block condition orders) had results similar to S3's. However, the inclusion of WF /f/ as a segmental target produced opposite *quantitative* results for syllabic versus segmental gains (see table 9.1). Quantitative results, were, however, skewed by three matching tokens on three attempts for WF /f/. Discarding the WF /f/ data, quantitative analysis upholds the clinical impression of greater gains for syllabic targets in Block 1. S3 and S4 had similar Block 2 results, with a marginally greater average gain for syllabic targets.

In terms of syllable/word structure at assessment, S6 was similar to S3 and S4. Although her condition order was the opposite of theirs (i.e., segmental/syllabic for S6, versus syllabic/segmental for the other two), syllabic development still outpaced segmental. Once again, condition order did not appear to influence the results. Having a very limited phonological system at the beginning of the study, she learned to specify all consonant slots with Place features. All consonant word positions were weakly established at the outset. In the best-established word position -- word-initial -- phonemes representative of all sound classes appeared, but there were still many missing WI phonemes. The faster rate of syllabic development was evident in her consolidation of basic word shapes (CVC, CVCV, CVCVC) including CVCC, both with existing and emerging segmental inventory.

S2 , the match for S6 by Laryngeal node substitution types, had opposing within-block condition orders to hers. (He was one of the three children whose condition order was segmental/syllabic.) For him, skeletal slot marking (CC) and compensatory lengthening of the prevocalic consonant resulted from Block 1 /s/-cluster training, although segments within the clusters were not realized as such until the end of Block 2. Furthermore, Block 1 and Block 2 syllabic WI /z/ training facilitated the realization of WI fricatives, a sound class previously realized only postvocalically. Gains in S2's segmental blocks were faster for labiodentals than for syllabic target matches, but much slower for the dorsals, which were mastered only by the end of Block 3.

In summary, the order of conditions did not seem to affect the outcome. Overall, the children appeared to make faster gains in prosodic/syllabic development, whether by skeletal slot establishment or strengthening of weakly established word positions through licensing of segments established in other word positions in those new or weak positions.

In order to ascertain whether the clinical impression of difference between the syllabic and segmental conditions was statistically significant, the Sign test was utilized to test the null (H_0) and alternative (H_1) hypotheses noted below:

H_0: There is no difference between syllabic and segmental conditions across subjects and blocks in average proportional gain for training targets.

H_1: Syllabic condition target average proportional gains are greater than those for segmental condition targets.

As a nonparametric statistic, the Sign test allows between-subject comparison in small *n* studies. It does not assume that the six children are from the same population, or that the distribution has any particular form. Further effects of individual difference were minimized by counterbalancing of order of conditions across subjects in the experimental design.

Deciding what type of data to select for the statistical test was not straightforward. Outliers may skew averages, particularly when averages are based on a small number of points as they are for the scores in table 9.1. Averages did provide, however, one score per child per condition in each block.

In the most lenient data analysis, all positive signs were used, which meant using skeletal slot results for the syllabic condition. This yielded 11/12 positive signs and a test statistic of 2.886, significant at the .005 level (one-tailed).

A more stringent analysis was performed, using only differences of more than 2% and using phoneme targets rather than skeletal slots as syllabic data. This yielded 6/9 positive signs and a test statistic of 1.02, which was not significant at the 0.1 level (one-tailed).

If skeletal slots rather than phoneme targets are the basis for comparison, then, the null hypothesis is rejected, indicating a difference between conditions favoring the syllabic condition. Since the prosodic tier provides a framework for realization of segments, it seems reasonable to

use the skeletal slot data (i.e., the framework) as primary data for the syllabic condition, i.e., the lenient interpretation. In this study, development of the prosodic framework involved the manipulation of pronounceable segments in unestablished or weakly established word positions, whereas segmental development required the learning of new articulations in well-established word positions. It took longer for the children in this study to learn new segments than to realize familiar ones in a new structural frame. Phonological development at the segmental level involved phonetic learning.

Interaction of the Syllabic and Segmental Tiers

In spite of the apparent tier independence in development, interactions of the tiers were also noted for each child. A summary of the most common interactions follows below.

A. Default segments and syllable structure

In all of the children's assessment data, default (minimally specified) consonants appeared as general substitutions in marginally established skeletal slots. These took the following forms, among others:

1. Laryngeal substitutions in all word positions for S6 and S2

In this case, the Root node feature [+consonantal] was specified (except perhaps when [ʔ] appeared word initially). Pronounceability, however, requires specification at the level of the Laryngeal or Place node. In this study, laryngeal node segments [h] and [ʔ] were considered less complex (more underspecified) than segments with Place node specification, since they require no oral cavity shaping.

The [h] appeared for S2's SI fricatives and the [ʔ] for his SIWW and WF dorsal and coronal stops. These facts suggest specification of the Root node feature [continuant] consistent with the target input as stop or fricative. Although [continuant] was not considered a feature of laryngeal consonants during the study (following McCarthy [1988]), the difference between /h/ and /ʔ/ is similar to differences between oral continuants and noncontinuants. Without Place node specifications, the [h] and [ʔ] possibly replaced [+continuant] and [-continuant] obstruents

and /ʔ/ is similar to differences between oral continuants and noncontinuants. Without Place node specifications, the [h] and [ʔ] possibly replaced [+continuant] and [-continuant] obstruents respectively. The specification of [continuant] was, perhaps, not consistent for S6, resulting in the default Laryngeal consonant [ʔ] appearing more commonly than the [h].

For S2, the positional consistency of the substitutions -- SI for [h] and SIWW or WF for [ʔ] -- demonstrates the interaction of the syllabic and segmental tiers. The prevocalic consonantal slot (onset) was established for only certain sound classes, fricatives being excluded; the SIWW and WF slots were also established only for certain sound classes -- lingual voiceless stops, some fricatives and /l/ being excluded. The basic phonological framework for English was in place, but not in elaborated form.

Although WI position was better established than the other word positions for S6, laryngeal substitutions also appeared there for unestablished segments, e.g., /t/ and the coronal fricatives. In the most weakly established word position -- WF -- most voiced segments were missing (i.e., had no Root node specification), in comparison with consistent substitutions of [ʔ] for voiceless stops. This is another example of interaction of the tiers. Voicing status of the target played a role in S6's specification, or lack thereof, for WF segments. (That the less marked unvoiced consonants appeared more often than voiced stops word finally suggests that markedness also played a role in consonant realization for S6.)

2. A coronal fricative substitution as a post-CV position marker for S3 ([s/ʃ]) and a SIWW position marker (and less frequently a WF position marker) for S4 (SIWW [z/ʒ], WF [s])

Coronals are generally considered to be the default segments for English. Other child phonologists have previously noted a tendency for children to acquire fricatives first postvocalically (Farwell 1977; Ferguson 1978; Edwards 1979). There may be a natural phonetic tendency favoring a [+continuant] release of an obstruent after a vowel. Thus the coronal fricative could be considered an expected default obstruent in a weakly established postvocalic word position.

3. [θ] substitution for /st/ for S5 and S1

The interdental tongue place (rather than the [+anterior] alveolar place) is developmentally common as the unmarked coronal place for children with immature swallowing patterns or lack of tongue-tip control . The [θ] appeared for S5, S1, S2, and S6 as the default coronal obstruent. For S5 and S1, the last /s/-cluster to be realized with two elements was /st/. A phonetic variant ([θ]) of the more marked of the two obstruents -- /s/ --surfaced in place of the cluster. This conflicts with the hypothesis of extrametricality for /s/ (Kiparsky 1979), which would make /s/ a natural prosodic candidate for omission in cluster reduction. Segmental composition and relative degree of specification apparently influenced the type of reduction for S5 and S1.

Another example of this type of interaction was observed in Block 2 for S3. Block 2 targets included WI coronal obstruents and /st/. Overgeneralization of /s/ resulted in use of [{s/z}] or [{ts/dz}] for WI /{t/d}/ and /st/ some of the time, although other /s/-cluster mismatches lacked /s/.

4. The appearance of /sn/ as the earliest /s/-cluster for S5, S1, S3, and S4

The early appearance of the /sn/ cluster is probably a result of: (1) the sharing of the default Coronal Place between the two segments, reducing both the representational and phonetic complexity of the cluster, and (2) the fact the cluster does not violate the sonority hierarchy for syllabification (Kiparsky 1979), i.e., /s/ is not extrametrical. By contrast, the cluster /st/, which also has two Coronal segments, has a (more marked) extrametrical /s/.

5. S1's [fw] substitution for WI obstruent-approximant clusters with [w]

The assimilatory substitution [fw] facilitated the realization of two consonant slots for clusters with [w]. As an alternative, epenthesis facilitated realization of the actual underlying initial obstruent and the [w]. In output derivation, once epenthesis separated the two consonants of a cluster at the prosodic level, assimilation through feature-spreading appeared to be blocked. The blocking of spreading appears to indicate adjacency for the epenthetic vowel and consonants by maximal scansion (Archangeli and Pulleyblank 1986).

B. Positional development of sound classes

Word position interacts with sound class development. The following was observed:

1. Fricatives tended to appear first postvocalically (S2, S6, S3, S4).

2. Dorsal stops tended to appear first postvocalically (S3, S6). For S6, dorsal stops, although *targeted* in SI position, appeared first in WF position in spontaneous utterances.

Continuant obstruents may be more easily produced after, rather than before, vowels because of continuing airflow from well-established vowel articulation. Retraction of the tongue for dorsals may be easier after, rather than before vowels, since the tongue is already in the dorsal position familiar for vowel articulation.

C. Extrametricality and segment realization in /s/-clusters

With the exception of /st/ targets for S5, S1 and S3 (in which 'extrametrical' /s/, rather than 'syllabifiable' /t/, was realized) cluster realizations generally supported the Kiparsky (1979) claim that /s/ is extrametrical before stops. Since extrametrical segments are marked, they are developmentally less expected, and thus candidates for omission. For S1, /sl/ and /sw/ patterned with the /C[w]/ clusters, showing up as [fw] (when [w] appeared for /l/), whereas /sp/, /sn/, /sm/ and /sk/ lacked /s/. S5's reduced /s/-clusters showed retention of /s/ in /sl/-clusters, versus omission of the /s/ in clusters without approximants.

However, there were two main exceptions: (1) the aforementioned /st/ realizations of S5, S1, and S3, in which 'extrametrical' /s/, rather than 'syllabifiable' /t/, appeared, and (2) S2's /fl/- and /sl/-cluster realizations, in which the liquid, not the fricative, appeared. The influence of tier interaction and relative default status (i.e., /s/ being relatively more specified than /t/ -- the maximally underspecified consonant -- and therefore a stronger segmental candidate for retention) were suggested as contributory factors in the /s/ realization of /st/. In the case of S2, fricatives were missing in general, whereas SI /l/ was acquired. Again, segmental influences affected prosodic slot realization.

3. If the 'prosodic tier' has some observable clinical reality, will there be a difference in proportion and rate of syllable/word shapes acquired as a result of interventions that contrast the onset and rime versus those that utilize the mora as a constituent?

Quantitative Analysis

In the individual chapters, no statistically significant differences were found between the moraic and onset-rime proportional matches for training targets using the Kolmogorov-Smirnov test. Pooling the data for the children, the following null and alternative hypotheses were tested with the same measure:

H_0: There is no difference between proportional match results for moraic and onset-rime targets across subjects' Block 1 and Block 2 data.

H_1: There is a difference between proportional match results for moraic and onset-rime targets across subjects' Block 1 and Block 2 data.

The large sample analysis with the Kolmogorov-Smirnov test failed to show a difference between the conditions: $(4)(.18)^2_{57,63}(57)(63)/57+63=3.878$ (d.f. 2).

As stated at the outset in chapter 2, although the most extreme version of each constituent was used to create intervention stimuli, those stimuli may not have been completely contrastive as onset-rime versus moraic constituents. Thus the similar results may reflect similarity of stimuli.

Another training factor producing similar results may have been response-related. Once able to imitate a whole word correctly without imitating its separate constituents, (e.g., [swIm] versus [s]-PAUSE-[wIm]), a child may ignore any aspect of the condition that focuses on the stimuli in a particular way. The child's agenda at the point of whole word imitation is on using the word in as many (fun) contexts as possible.

Overall, in terms of stimuli and responses, the conditions may have been more similar than different. The positive aspect of the observed lack of difference is that both types of constituent stimuli facilitate and enhance prosodic development. The use of both may have in fact helped the child learn the prosodic structure of English by "breaking up" words in different ways.

Qualitative Analysis

Data from the individual children with respect to final consonant position marking and cluster and diphthong development have some bearing on the moraic and onset-rime theories outside the arena of quantitative analysis, however.

A. CVC

S6 and S3 appeared to have greater ease learning the CVC word shape (when C_2 was a final voiceless stop) in the moraic condition than in the onset-rime condition. The onset-rime stimuli (C_1 - VC_2) included the VC unit for imitation. In this case the WF stop was presented as *already incorporated* into rime structure, although that final consonant was the intervention target. The moraic stimuli (C_1V - C_2), on the other hand, included the CV unit, which was already in the child's system, and a *separately* presented C_2, the new component. Apart from that apparent advantage, the moraic stimuli also included associated observable "beats" (clapping, tapping) for the final C (following a "prosodic" approach), making the extra stop even more salient.

S4, on the other hand, mastered onset-rime target WF /m/ more easily than moraic traget WF /n/. The sonorant nasals are in general more pronounceable as extensions of the sonorant vowels rather than as separate additions; i.e., the onset-rime unit VC_2 is phonetically more pronounceable than the moraic units CV- C_2 when C_2 is a sonorant. Furthermore, the moraic stimuli for CVC were connected to CVCV with SIWW /n/, by the deletion of /i/, i.e., bunny > bun. This may have increased the phonological complexity of the learning task, since the /n/ had to be resyllabified from SIWW to WF position. (For S4, the learning of WF /m/ before WF /n/ may also have had other bases: (1) a social basis, since he was highly motivated to pronounce a name that ended with the /m/, and/or (2) a more general linguistic basis, since the syllable [ən] was a frequently used syntactic filler (Bernhardt and Johnson, forthcoming). Trying to have S4 integrate this independent morphosyntactic syllable [ən] into word codas may have violated his general use of that phonetic form.)

These cases are further demonstrations of the need to consider tier interaction in intervention, this time for word constituency type and segment type.

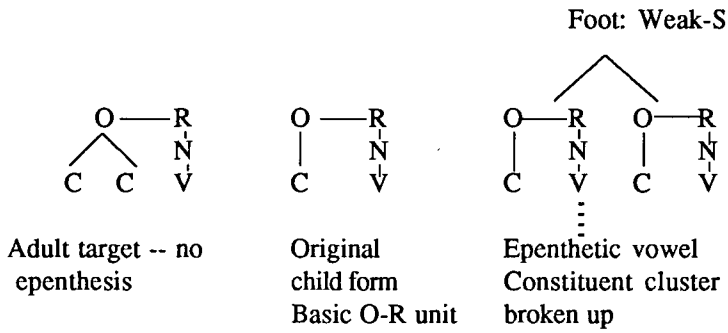
B. Clusters

1. Epenthesis

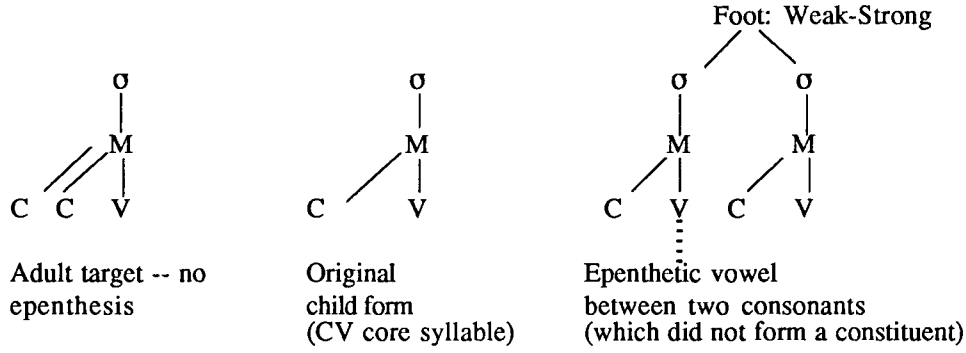
When pronouncing clusters with approximants, all children but S6 used epenthesis occasionally before intervention for cluster production. When clusters with sonorants were intervention targets, E often used epenthetic vowels in onset-rime condition stimuli in order to create pronounceable onset constituents, (e.g., [bəl] for /bl/ or CVC for CC). The sonorance of the approximant lends itself easily to prolongation and, thus, vowel insertion. Epenthesis became more prevalent in the cluster production of S1, S2, S5, and S6. By increasing its use, those subjects achieved more proportional matches for cluster skeletal slots within the first block.

Ironically, epenthesis breaks up the CC unit (never a constituent in any case according to moraic theory), creating a pronounceable CVC word, with the two consonants separated into the onset and rime, or into a premoraic and postvocalic moraic position. When this CV_1C "word" is adjoined to the following V_2 of the original word, resyllabification takes place, i.e., CVC+V > CV.CV', creating a new word with a branching (weak-strong) foot. (See figure 9.1.) In onset-rime terms, two sequential (weak-strong) O-R units are the result, the second onset to the stressed vowel being the approximant. The approximant is usually not the dominant onset cluster element in O-R structure, but, with prolongation, and hence, epenthesis, it acquires temporary salience as an obligatory singleton onset, which possibly facilitates its pronounceability. In moraic terms, epenthesis results in a word gaining an extra unstressed weight unit, either by prolongation of a sonorant consonant in the prevocalic part of the word, or, if between /s/ and a stop, from an autosegmental "floating" weight unit (such as in Hyman 1985). Since moraic condition stimuli did not have prolonged resonants, but, rather, average duration or prolonged obstruents (e.g., [f]-PAUSE-[laɪ] or [f::]-PAUSE-[laɪ]), the increase in epenthesis use was possibly a result of onset-rime condition training. That particular method of training possibly enhanced general developmental tendencies to prolong the most sonorant elements when learning to pronounce clusters with approximants.

Clusters in onset-rime representation



Clusters in moraic representation



Key: O: Onset N: Nucleus
R: Rime σ: Syllable
M: Mora

Figure 9.1. Representation of clusters -- adult targets, children's reduced forms, and clusters articulated with unstressed epenthetic vowels

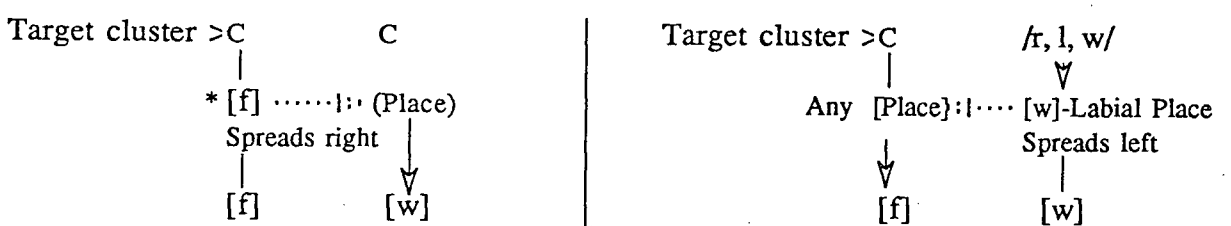
According to either theory, the word structure expands temporarily (probably close to the time of actual pronunciation) to allow skeletal slot realization, i.e., there is a prosodic solution to an articulatory constraint. As the child learns the ballistics of consonant-consonant transition (timing), the use of epenthesis decreases, first through epenthetic vowel reduction, and then altogether.

2. Onset status

Several data provide evidence that the onset has constituent status, contrary to the moraic theory positions advanced by McCarthy and Prince (1986) and Hayes (1987).

During Block 2, S2 began to manipulate singleton and cluster onsets of words in sound play games, e .g., [bænɪtθ] for sandwich (singleton for singleton substitution), [spip] for sheep (cluster substitution for singleton) and [bupid] for stupid (singleton substitution for cluster). (See appendix 4, table 2.4 for more examples.) This seemed to indicate phonological awareness of onset and rime constituents. The manipulation of onset and rimes in intervention may have fostered this awareness.

For S1, the [fw] cluster substitution showed leftward spreading from Labial Place [w] to the initial cluster element -- one of a number of possible consonant targets -- within the prevocalic consonant pair (with no cases of adjacent spreading within rime or from rime to onset). Kaye et al. (1987) hypothesize that direction of intraconstituent government, (creating a domain for spreading) is from left to right. The [fw] substitution appears to show the reverse (see figure 9.2).



*There is no motivation elsewhere in the system for this general [f] realization of consonants.

Kaye et. al's (1987) prediction of rightward spread from [f] to the unspecified slot based on direction of intraconstituent government

Proposed alternative: S1: Apparent leftward spread of Labial Place from [w] to the underspecified consonant

Figure 9.2. Comparative derivations of S1's [fw] substitution for obstruent-approximant clusters based on Kaye et al. (1987) and a proposed alternative

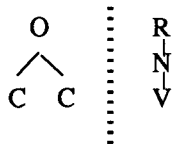
3. Before learning to pronounce /s/-clusters, S2 first lengthened the existing prevocalic consonant -- by prolonging the consonant, e.g., ([n:ɛɪ] for snake or [p:^{h}ɑɪdɛ^{ə}$_{0}$] for spider). (Aspiration of unvoiced stops may have also been a type of prolongation although the aspirated stop remains a singleton [see figure 9.3]). The first realizations of /s/ were also long -- [s:] or [s::]. Contrary to direction of spreading suggested by the Kaye et al. (1987) intraconstituent government hypothesis, this appears to be another example of leftward spreading (within the onset), from the existing prevocalic slot to a segmentally empty cluster slot created by the syllabic training. This datum suggests constituent status of the onset. In Hayes (1987), compensatory lengthening is a phenomenon of the moraic structure of syllables, and, as such, is realized in those segments which project morae -- vowels or postvocalic consonants. For S2's /s/-cluster development, 'weight' was apparently assigned prevocalically to compensate for unrealized prevocalic segments.

On the one hand, the prosodic "solution" of compensatory lengthening of the prevocalic consonant for cluster slot realization supports the existence of separate prosodic and segmental tiers. On the other hand, prevocalic compensatory lengthening defies the primacy of vowel/rime dominance for expansion of prosodic structure. (It must be noted that cluster stimuli in the syllabic subblock were exaggerated in length for reasons of salience and facilitation of imitation. The noted prosodic aberration may be a result of this training. However, E never presented as stimuli what S2 gave as responses.)

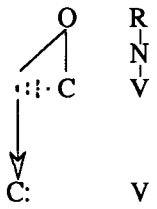
C. WF versus WI clusters

WF clusters emerged prior to WI clusters for all subjects but S4. Phonetic constraintss may result in a predisposition for WF consonant combinations, since they "cascade" from the sonority peak. In moraic theory prevocalic consonants have minimal status prosodically. Perhaps, once the immediately postvocalic consonant is designated as having moraic status in English, it is a small developmental step to incorporate extra postvocalic consonants into prosodic structure. On the other hand, to add a second (or third) prevocalic consonant may be a larger developmental step, since prevocalic consonants have less status in the syllable.

Onset-rime representations



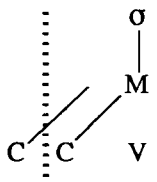
CC + V stimuli
for /s/-cluster training
(Dotted lines here and below indicate separate stimuli.)

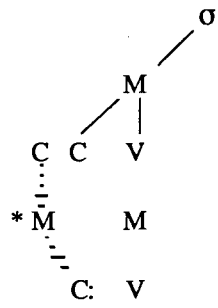


S2's Block 1 realization of /s/-clusters with prevocalic compensatory lengthening

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Moraic representations





* Impossible projection of a mora from a prevocalic slot

C + CV stimuli
for WI cluster training

S2's Block 1 realization of /s/-clusters with prevocalic compensatory lengthening

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Figure 9.3. Alternate representations of S2's Block 1 cluster realizations in onset-rime and moraic theories

In onset-rime theory, the onset is a prime, but the other principal constituent -- the rime -- governs the onset. As the governing constituent, the rime perhaps take precedence over the onset in development, WF clusters developing before WI clusters.

S4, as the exception, was also the only subject to demonstrate lack of diphthong development. This fact may be related to the lack of development of final clusters (see discussion below on CVVC and CVCC).

S4's Prosodic Development

S4's prosodic development could be characterized as "step-like," with the "steps" being "plateaus." Learning one targeted word/syllable type did not immediately lead to production of other (presumably) related word/syllable types. Although his phonological disorder may have been responsible for this lack of prosodic generalization, an examination of the specific failures to generalize may lead to elucidation of or new questions about development in terms of onset-rime and moraic theories.

A. Relationship of CVV and CVC monosyllabic words

At the onset of intervention, S4's monosyllabic word template was CV (where V= tense or lax vowel, with phonetic offglide or lengthening). Following the establishment of CVC (V=tense or lax vowel), the CVV word shape (where VV=diphthong) did not arise spontaneously through generalization.

In onset-rime theory, CVC and CVV structures differ in that the latter has branching at a lower level, under the nucleus rather than under the rime node (see figure 1.2). One could suggest, logically, that generalization did not occur because the two structures were unrelated in representation.

In moraic theory, CVV is bimoraic. Assuming that CVC is bimoraic, E hypothesized that establishment of CVC would lead to spontaneous production of another marked bimoraic form -- CVV where VV = diphthong, since all other bimoraic word types were then in the repertoire.

Moraic theory fails to explain the lack of generalization in this case except as a general developmental delay for diphthongs.

If, on the other hand, one assumes the final consonant of CVC monosyllables to be adjoined rather than moraic in status, the lack of generalization from CVC to CVV (VV=diphthong) is understandable. Although S4 may have learned consonant adjunction, his monosyllabic moraic structure did not change and, therefore, CVV did not generalize from CVC learning. This would be a logical developmental prediction of moraic theory formulated with an assumption that CVC monosyllables in English are monomoraic (not assumed in this study)

A possible nonprosodic explanation for the delayed development of diphthongs could be segmental; i.e., vowel-vowel transitions were perhaps more difficult than vowel-consonant transitions for some articulatory reason . Because of general difficulties in prosodic structure, still observable in multisyllabic words when S4 was 5;8, some type of prosodic explanation, such as outlined above, may be preferable.

B. Relationship of CVVC and CVCC in monosyllabic words

Although diphthongs were targeted in open and closed syllables, only those in open syllables generalized, even though CVC (V=tense or lax vowel) was well established at that point. In either onset-rime or moraic theory, establishment of CVVC from CVV involves single consonant adjunction. Once retargeted in Block 3, CVVC emerged, suggesting that this developmental step is separate from establishment of CVC (V=tense).

As stated above under the section on WF clusters, the CVCC shape did not emerge as a corollary to CVVC until targeted six months later (except with plurals, which involves morphological learning, and, hence, may be different). Contiguous consonant production (CC) did not appear to be an articulatorily-based problem, since S4 produced plural morphemes on consonant-final words, and mastered most WI clusters during Block 3.

According to onset-rime theory, CVVC and CVCC are structurally different (see figure 1.2). CVCC involves consonant adjunction of the last consonant to an already branching rime node, whereas CVVC involves single branches under both the rime and nucleus. It is not clear that the consonant adjunction for CVCC is more complex (and therefore expected to develop

later) than the two levels of branching for CVVC. However, the onset-rime explanation does at least demonstrate a structural difference (an extension of the difference between CVC and CVV), which may be developmentally relevant.

In terms of moraic theory, if one assumes that CVC is bimoraic, then CVCC involves single consonant adjunction to the second mora. This makes the lack of generalization from CVVC to the moraically equivalent CVCC unexpected, except as developmental delay, just as the lack of generalization from CVC to moraically equivalent CVV (VV = diphthong) was unexpected.

If one assumes that CVC monosyllables are monomoraic, however, double consonant adjunction is required for production of CVCC, perhaps a more marked phenomenon (and a predictably later development) than the single consonant adjunction required for CVVC. This is more explanatory than the moraic interpretation with a bimoraic CVC monosyllable hypothesis, and possibly more explanatory than the onset-rime interpretation, in which CVC involves single branching of the rime node, and CVCC requires single consonant adjunction to that branching rime node.

4. If the 'segmental/melodic tier' has some observable independence, is there any advantage to be gained from targeting features at 'higher' versus 'lower' levels in the feature hierarchy in phonemic inventory intervention?

In general, the feature hierarchy model was useful for setting attainable segmental goals. At assessment, comparison of the feature hierarchy figures for each child with the adult model immediately demonstrated gaps in the system that provided a set of goals for intervention. Because the research question addressed the usefulness of the feature hierarchy model, not only in a general way, but also in terms of change potential for higher versus lower levels in the hierarchy, E selected contrasting intervention targets on the basis of hierarchy height. (See rationales for target selection in chapter 2 and the data chapters.)

Target selection

Determining relative feature height for higher and lower level feature target selection was easier for some subjects than others. For example, selected intervention targets for S5 and S1 were /l/ and the alveopalatals. The Place node was the same for both target sets -- the default Coronal Place. For /l/, specification of the Root node feature [+consonantal] was needed in order to establish the default liquid. For the alveopalatals, the terminal Coronal feature [-anterior] was needed in order to distinguish them from other coronal fricatives. The feature [+consonantal] and the intermediate Place node were clearly higher than the terminal feature [-anterior].

However, for S6 and S3, determination of relative height was not as obvious. For S6, Coronal Place was considered higher level than Dorsal, because Coronal is considered the default Place node and, therefore, assumed at the (higher) level of the Place node itself. In other words, another assumption beyond the feature tree, i.e., underspecification, was needed to determine relative height (also noted in chapter 2 in the section on determination of feature height).

The most problematic case was for S3. In Block 1, Root node feature [+consonantal] plus Laryngeal node feature [+spread glottis] for /h/ production (substitution of [ʔ] inconclusive for [consonantal] status) were designated as higher than specification of the intermediate node -- Place -- for /l/. (See table 9.2.) At the time of Initial Assessment /l/ was realized most often as [w] -- i.e., as a default glide with Root node [+sonorant] specification and *Labial* Place node "*specification*". Requirements for /l/ included Root node specification of [+consonantal] as well as a change from *Labial* to the default Coronal Place. Following another assumption beyond the feature diagram itself, Place node features were considered to be lower than Laryngeal node features (see chapter 2 section on feature target selection). Specification of Place node was considered lower level than establishment of [+spread glottis], although both were equivalent in terms of need for Root node feature specification of [+consonantal].

Other assumptions were possible for the /h/-/l/ contrast for Block 1.

1. If I had not assumed Place to be lower than Laryngeal node[+spread glottis], but equidistant to the Root node, feature height for targeted features would have been equivalent in Block 1.

2. If only the Root node features of /l/ were considered important for specification (Place node being redundant and therefore not in need of specification), then the features for /h/ would have been lower level than those for /l/ in Block 1 as they were for Block 2 (see below).

Table 9.2.--Feature specifications for /h/ and /l/ and S3's realizations of these in Blocks 1 and 2

Segment	Target		S3's representation of /h/ and /l/ at Assessment		S3's representation of /h/ and /l/ at end of Block 1	
	Specified features	Underspec. features	Substitution and specified features	Underspec. features	Substitution and specified features	Underspec. features
/h/	RN:[+cons] LN:[+sp gl]	RN:[-son]	[ʔ] = RN:[+cons] ???? LN	RN:[-son] LN: [-sp gl]	[ʔ] = Same	Same
/l/	RN:[+cons] and [+son]	Place node	[w] = RN:[+son] *Labial* Place --- ([ʔ]) (RN: [+cons]) ???? (*LN*)	RN:[-cons] --- (RN: [-son]) (*LN*: [-sp gl])	[ʔ] RN:[+cons] ???? *LN*	RN:[-son] *LN*:[-sp gl]

Note: Underlying indicates target features which require establishment.

3. If markedness assumptions implied that specification of both [+consonantal] and [+sonorant] for /l/ was more marked than the single [+consonantal] specification required for /h/, (laryngeal node notwithstanding), /h/ would have been predictably faster in development.

Results for Block 1 showed a slight advantage for /h/ over /l/. If the features for /h/ were considered higher level, predictions of developmental dominance for higher level features are

supported. If, on the other hand, features for /h/ were lower level, then those predictions are not supported, but markedness may have influenced the outcome (see above and also further discussion on /h/ at end of this section).

At the end of Block 1, [w] did not appear for /l/ but, rather, [ʔ] appeared consistently. (At Initial Assessment, four of the eleven mismatches for /l/ were [ʔ].) Because of this change, requirements for /l/ establishment were for Root node feature specification of [+consonantal]/[+sonorant], considered higher than [+consonantal]/[+spread glottis] establishment for /h/. (A similar subcondition order change in terms of height was made between blocks for S2: Dorsal Place was designated as a lower level node in Block 1 and a higher level node in Block 2.) Results for this block were equivalent for the two segments, demonstrating a "catch-up" effect for development of /l/. Although the "catch-up" effect was predictable if /l/ features were higher, results for S3 remain ambiguous since relative feature height was ambiguous at the outset.

Results for Trained Targets

Overall, the prediction that higher level features would be acquired first was confirmed for all subjects except S4 and S3, for whom results were ambiguous (see above for S3). (See table 9.3.) S4 's Block 1 data was divergent a result of the three matching tokens (in three attempts) for WF /f/. In WI position /l/ was marginally advanced over /f/, in marginal support of the prediction. By the end of the second block, the higher level feature targets -- for SI /l/ -- were better established than those for /f/, but only 2/8 utterances with WI /l/ were spontaneous, compared with 10/11 spontaneous ones with /f/.

A further complication arose from the differential needs for /f/ specification word finally versus word initially for S4. Word finally, two of the four /f/ realizations at Initial Assessment were [s], and two were missing segments. Where missing, the WF /f/ was similar to WI /f/, in that all features needed to be specified. However, where WF /f/ was realized as [s], all that was required for /f/ was Labial Place specification. Although the Labial Place feature was lower than the Root node features required for /l/ development, *WF* /f/ might emerge earlier because some of its specification was assumed with specification of WF /s/, a related obstruent.

Table 9.3.--Summary of intervention targets for subjects across blocks

	Block 1		Block 2	
Subject	Features	Segments	Features	Segments
1	L: [-ant]	/ʃ/, /ʤ/	Same features	Same segments
	H: [+cons/+son]	/l/	Same	Same
2	L: Dorsal Place	/k/	*H: Dorsal Place*	Same
	H: [+cont]/Lab	/v/	L: [-ant]	/ʃ/
3	*H: [+sp gl]*	/h/	L: Same	Same
	L: Place node/ [+cons/+son]	/l/	H: [+cons/+son]	Same
4	*L: Labial Place*	/f/	Same	Same
	H: [+cons/+son]	/l/	Same	*Same*
5	*H: [+cons/+son]*	/l/	*Same*	Same
	L: [-ant]	/ʃ/ /ʤ/	Same	Same
6	*H: Coronal Place*	/t/ /s/	*[+continuant]/ Coronal Place*	/s/ /z/
	L: Dorsal Place	/k/	Same	Same

Note: *Italics* designate the feature/node with a faster rate of development.

The interaction of tiers might interfere with /f/ development in other word positions, however, so that the higher level Root node features for WI /l/ production could still be specified before the (lower level [+continuant]/Labial Place) features for *WI* /f/. Results appear to confirm all of these possibilities, but with minimal quantitative differences.

Overall, the faster rate of development for targeted higher level features was not outstanding *quantitatively* for any of the subjects except with respect to Dorsal Place. However, earlier emergence is possibly significant from a linguistic point of view, and clinically has an effect on child and parent motivation. (It should be noted that learning even a few words with a new segment is a welcome advance in clinical intervention.)

Results for Trained Targets in terms of Sound Class and Place Features

Extracting relative gains from table 9.3, table 9.4 demonstrates development in terms of place and manner for targeted segments. Tables 9.3 and 9.4 demonstrate the relative dominance of the *default* Coronal Place node (as unspecified) for development during intervention. It is a prediction of underspecification theory that defaults are universal, and thus more likely to emerge before more marked categories, which need to be specified. It also lends credence to an assumption of this study that Coronal Place is higher than other Place nodes because it is assumed at the level of Place node.

Table 9.4 also shows dominance of Labial over Dorsal Place in one case, not a prediction of feature height in this study (equal level Place nodes) but a general observation in terms of normal and delayed phonological development (Ingram 1981, 102). In this case, markedness possibly plays a role in rate of development for the two Place categories (as per Jakobson, 1968).

In terms of sound class, distinctions were less clear, although the liquid /l/ with its Root node features and default Coronal Place was more quickly acquired with training than alveopalatal fricatives for S5 and S1 (and also S2 and S6 before the study, and S3 after the study) and labidoental fricatives for S2 (and possibly S4), although the others had acquired labiodentals before liquids. This was a general prediction of feature height, /l/ requiring features integral to the Root node -- [+consonantal] and [+sonorant] -- and those fricatives needing both the lower Root node feature [+continuant] and lower Place node features -- Labial and [-anterior].

Table 9.4.--Summary of intervention contrasts in terms of place and sound class and identification of faster rate of acquisition within those categories

PLACE	SOUND CLASS
COR unspecified / COR specified (S1, S5)	*Liquid* / fricative (S1, S5, [S4])
COR unspecified /LAB (S4)	*/h/* / Liquid (S3)
COR unspecified/ DORS (S6, S2)	*Fricative* / stop (S2, S6)[a]
LAB / DORS (S2)	*Stop* / fricative (S2, S6)[b]
DORS/ COR specified (S2)[c]	
LN / PN (S3)	

Note: Italics designate a faster rate of development for the contrasted Place or Sound Class designation.

[a]For S2: Block 1 -- /v/ over /k/; for S6: Block 2 -- /s/ over /k/, /g/

[b]For S2: BLock 2 -- /k/ over /ʃ/; for S6: Block 1 -- /t/ over /s/

[c]For S2: Block 2 -- Block 1 target /k/ versus Block 2 target /ʃ/

The fact that Root node features needed to be targeted at all, when Root node features dominate the hierarchy, appears to be counterevidence for the hypothesis that higher level features should be generally acquired first. In terms of [+consonantal] for /l/, later acquisition is predictable from markedness assumptions; i.e., specification of *both* defining Root node features -- [+consonantal] and [+sonorant] -- is marked in comparison to specification of one versus the other.

The feature [continuant] has been used to define obstruents as a class. As a redundant feature for stops ([-continuant]) it does not present problems for development, since stops are the default consonantal category. However, fricatives are slower to develop as a class, particularly for phonologically disordered children. The narrow constriction required to produce a

[+continuant] obstruent requires greater tongue control than complete occlusion or no occlusion (as for vowels). Thus this higher level feature does not develop before at least some of the lower level features of Place as a general rule. (The contrasting results with stops and fricatives with S2 and S6 reflect both the difficulty with Dorsal Place /k/ and /g/ and, in Block 2, S2's difficulty with [-anterior] Place; i.e., place was more relevant than manner for rate of development in these cases.) I will return to this problem in the section on feature specifications for English.

Generalizations of Features/Nodes to Other Segments

Most generalizations from trained to untrained segments were predictable given the features trained, and support the concept of segments as pronounceable "bundles of features." For example, generalization occurred:

1. Across voiced cognate pairs, such as from targeted /k/ to untargeted /g/ (S2, S6), from targeted /v/ to untargeted /f/ (S2) or the reverse (S4), from targeted /z/ to /s/ (S2) or the reverse (S3)

2. Across sound classes such as from the Dorsal Place oral stops /k/ and /g/ to the Dorsal Place nasal /ŋ/ (S2 and S6), or WF Labial Place stop /p/ to WF Labial Place fricative /f/ (S3)

3. Within sound classes across Place nodes for [+continuant], such as from WI /f/ to WI /s/ (S4), or /f/ to /θ/ (S2)

4. Within intermediate node groupings but for different marked features such as from /z/ and /s/ to the [+distributed] interdentals or [-anterior] alveopalatals (S6, S2).

Phonetic stimulability changes for /r/ for S3 and S1 may have been a result of the establishment of the default liquid /l/. Changes in voice specification and increased use of aspiration are not predictable as feature changes, but byproducts of the (usually syllabic) training that focused on WI stops.

Most commonly, the segments which did not develop or progressed marginally were /r/, /θ/ and /ð/ (all needing [+distributed] specification according to appendix 2), and the [+anterior] version of the coronal fricatives (i.e., [s] and [z] as opposed to default [*distributed*] dentalized versions thereof). The feature [distributed] seems to capture this pattern. Whereas [*distributed*] describes the default coronals for young children, it is possibly marked as an *appropriately*

specified feature, and therefore, late-developing. The rapid gain for trained and predictable generalization targets in comparison with these reinforces the conviction that intervention, based on the feature hierarchy, was responsible for the changes.

Feature Hierarchy Specifications for English (Appendix 2)

In general, the feature hierarchy model as set up in figure 1.1 and appendix 2 helped predict logical goals. Some ambiguities in description of the children's systems, target selection, and interpretation of results may be clarified by changing some of the appendix 2 feature specifications for English.

A. Root node [+continuant]/Larygneal [+spread glottis] and /h/

S3's earlier success with /h/ compared with /l/ may have been because of the [w] substitution for /l/, requiring emphasis of redundant features other than Labial, or because of relative ease of articulation -- a laryngeal articulation being "easier" than a lingual articulation. Alternately, a different set of features for /h/ may provide a better explanation for the faster access to /h/ in Block 1. Halle and Clements (1983) label /h/ as [+continuant] (contrary to McCarthy [1988] -- followed in this dissertation). With [+consonantal], [+continuant], and Laryngeal node as the specifications for /h/, then /h/ has two Root node features which are higher than the (lower) Place node change for /l/ (*Labial* to default Place node). This contrasts with the ambiguously higher designation of [+spread glottis] suggested in the intervention plan for S3.

A stronger argument for retaining [+continuant] for /h/ comes from the assessment data for S2 and S6, who had laryngeal substitutions for consonants. S2's [h] and [ʔ] substitutions matched [+continuant] and [-continuant] values for fricatives and stops consistently. S6 showed more variability for matching of [h] and [ʔ] with stop and fricative targets, although the general trend was similar to that of S2. Using [spread glottis] as a feature was redundant, since it became necessary to comment that [spread glottis] functioned for the laryngeals as [continuant] did for the obstruents. If /h/ is [+continuant] rather than [+spread glottis], this redundancy can be eliminated, which makes a more parsimonious system. Furthermore, it shows that [+continuant] can be an

early-acquired higher level feature, which may not be specified through the Place nodes -- predictably a later development based on the feature hierarchy.

A third possible advantage for eliminating [+spread glottis] for the phoneme /h/ is that it then remains as a postlexical feature for aspiration. (As commented earlier, it is necessary to account for aspiration, but it is unconventional to attribute equivalent status to phonemic and allophonic features as was necessary in the discussion of feature differences for each of the children.)

Returning to the problem of [+continuant] as a higher level, later-acquired feature, it appears that it is often acquired early but defined only on particular nodes -- Laryngeal node (as /h/, e.g., S2, S6,), or Place nodes (S3, S1) -- or only in certain (usually word final) positions (S3, S4, S2). it may be specified early in development, but be protracted in its overall range of application because of syllabic constraints (tier interactions) or articulatory constraints (feature interactions of place and manner).

B. Designation of /l/ and /r/ in relation to the common [w] substitution

The appearance of [w] as an /r/ or /l/ substitution is common. Without the [+consonantal] specification, [j] might be expected as a default Coronal Place substitution, however, according to radical underspecification and the 1988 feature model used for the study. For [w] to surface, the child has to "*specify*" the incorrect *Labial* Place node according to the model used for the study. This seems too complex, however, considering incremental development, the developmental hypothesis for this study (see section on theoretical deficiencies of the phonological process approach, point 4).

If Labial Place is a secondary redundant feature of /r/, the child has to have "knowledge" of the redundancy, in order for [w] to surface for /r/. Having knowledge of it may mean that more information is stored in representation than minimal features as per a radical underspecification approach, or that the child is accessing a later level of specification where this redundant feature may be specified. If Labial Place is a primary feature for /r/ and /l/, then radical underspecification can still be accepted, since the Labial Place segment [w] will show up when the Coronal features remain unspecified. This would mean extra designation for /r/ and /l/ in appendix 2, as Place:

Labial, Coronal. An extra feature designation also seems complex, however. The optimum designation is yet to be determined for the liquid category.

Limitations of the Study

Sample Size

Sample size limits population generalizability. However, the detail gained in observation of a small number of single subjects compensates for that particular limitation.

Design

An alternating block design was useful for examining the contrasting interventions based on different phonological levels and theories. The time period for each subblock may have influenced the outcome, either by being too long or too short. The small differences in rate of change for the features and the lack of differences for the syllabic methodologies may have resulted from interaction of the contrasting subblock methodologies (moraic/onset-rime) and features (higher/lower) due to time proximity. Longer subblocks or alternating moraic/higher level feature or onset-rime/lower level feature subblocks may have produced different subblock results. However, the consolidation of syllabic and segmental methodologies in three-week blocks gave an opportunity for significant changes in the children's phonological development within those main conditions. The sacrifice for the subblock conditions was considered acceptable in the context of the overall design.

Having one experimenter provided continuity across the study. However, it also increased the probability of experimenter bias. The equivalent results for moraic and onset-rime conditions suggest experimenter consistency at least for that part of the study. The time constraints for this type of intensive study resulted in E making isolated decisions from time to time that departed from some assumptions of current theoretical frameworks -- specifically, the counting methodology for morae (ignoring the tense/lax distinction for English vowels in morae counting for one type of CVC training, and considering CVC monosyllables to be bimoraic), and the decision to consider Laryngeal node to be higher than Place node. As much as possible, these departures have been indicated throughout the text.

Extraneous Variables

Factors other than the nonlinear frameworks undoubtedly helped facilitate the rate of change: (1) the intensive program schedule, (2) E's motivation to secure favorable results, and (3) the high degree of parent participation. However, the nonlinear frameworks led to reasonable and attainable goals within the time allotted, confirming their use for phonological intervention.

Syllabic/Segmental Condition Contrast

Target selection was clearly contrastive for syllabic and segmental conditions when new segmental inventory versus new syllable/word shapes were the targets, i.e., /l/ versus CVC. The contrast between the two conditions is less definite when the other syllabic target type was used: the establishment of available segments in reasonably well-established word positions, e.g., a target of fricatives in WI position, when stops, liquids and glides already appear in WI position and fricatives already appear in WF position. At the outset of the study, E decided to consider positional distribution of segments a syllabic concern, since that particular syllable position was weakly established, i.e., underspecified for certain features. (This follows from the theory.) The features were already present in the system, but a particular consonant position was not specified for them (see also chapter 2 on syllabic target selection).

The differences between the syllabic and segmental conditions were measured on the basis of proportional gain, in order to reduce the effects of prior knowledge of targets in either condition. More of the syllabic targets were marginally established at the outset, however, and this may have resulted in their faster rate of consolidation. Emergence may be as big a developmental step as mastery, meaning that the results are more equivalent than they appear. However, in terms of the child's general communicative efficiency, the step from emergence to mastery is more meaningful.

Subblock Conditions

Moraic/Onset-Rime

Several factors may have led to equivalent results for moraic and onset-rime conditions that do not reflect on the theories themselves.

1. As stated in chapter 2, under treatments particular to the syllabic condition, it was not possible from the outset to differentiate moraic and onset-rime stimuli completely, although E used stimuli which enhanced constituents proposed for each theory.

2. Ignoring the tense-lax distinction for vowels in intervention that affected moraic development (CVC training with C[V::] and C, see chapter 2) may have obscured some developmental potential that would have resulted in differences in acquisition rate between conditions.

3. Interaction of the syllabic and segmental tiers, as discussed above, with respect to intervention with WF nasals versus stops may have confounded results. Some segments are more easily learned in certain contexts and, thus, treatment method may be less important some of the time than the segments in question (WF stops being more easily learned in the moraic condition, and WF nasals in the onset-rime condition).

4. Contiguity of the moraic and onset-rime conditions may have resulted in mutually beneficial overlap between them.

Feature Hierarchy

The feature hierarchy model is a working hypothesis in nonlinear phonological theory. The designation of specified features for segments as assigned in appendix 2 are a further set of working hypotheses. These factors need to be kept in mind for sections of the study dealing with the feature hierarchy.

Future Research

Expanding the number of experimenters and subjects would reduce experimenter bias, increase the potential for generalizability, and allow for different permutations and combinations in design, both overall and within the subblocks for time periods, types of alternations, types of target selection and stimuli presentation.

Issues to explore would include among others:

1. The comparison of data from this study with data from normally developing children analyzed within the nonlinear frameworks

Spencer's (1984 and 1986) papers on disordered and normal development portrayed the usefulness of the frameworks for analysis of both populations. Although no children, whether phonologically disordered or normally developing, show identical patterns of acquisition (as shown in studies of individual variation, as for example, the one by Ferguson and Farwell [1975]), predictions and results of the study described in this dissertation concord with knowledge of general phonological development patterns in terms of developing syllabic structure and feature establishment. Further analyses within the nonlinear framework will enhance our understanding of phonological development at the syllabic and segmental levels, both as autonomous and interacting tiers, for all children..

2. A further delineation of independent and interactive aspects of the tiers

The hypothesis of tier autonomy was a useful starting point for an intervention plan. Future research could compare autonomous with interactive targeting, i.e., new segments in old word positions versus new segments in new word positions.

3. A further exploration of the relevance of higher and lower features for acquisition, independently and in interaction, concurrently and sequentially

4. Exploration of the effects of tense and lax vowels, diphthongs, and WF consonants in English prosodic structure development, both through phonological and acoustic investigations

5. Investigation of the use of epenthesis in cluster development, both through phonological and acoustic investigations

6. Exploration of V-Place in development, both independently, and as it interacts with C-Place development.

Summary

Overall, the nonlinear frameworks provided a useful methodology for setting attainable goals for phonological intervention. The concept of autonomous prosodic and segmental tiers led to independent goal-setting for the two tiers. This in turn led to rapid development at the prosodic level and, in turn, relatively immediate increased communication efficiency. The alternating block design was harmonious with the nonlinear frameworks, allowing a "nonlinear" manipulation over time of the tiers, features and syllabic methodologies. The contrasting of two prosodic methodologies probably enhanced the children's ability to segment the speech stream and gain access to the constituents of English syllable structure, whatever the psychologically real representation. The training of segments based on features at different hierarchical levels seemed to support the notion of hierarchy, since the higher level features had an initially faster rate of development. At the same time, the contrasting of the features resulted in changes in more than one part of the segmental system in the same *general* time period, increasing the child's communication efficiency, and perhaps the child's understanding of the scope of the English phonemic system.

Implications for Intervention

Syllabic and Segmental Tiers

As stated in the introduction, previous authors had begun to group phonological processes as syllabic or feature-changing (particularly Nettelbladt [1983] and Grunwell [1985]). Nonlinear phonology captures this difference in a principled way through its representation of autonomous, hierarchically organized tiers. The assumption of autonomous and hierarchical levels for prosodic structure and segment then leads to a coherent and effective framework for intervention with alternating syllabic and segmental treatment blocks. The goals for intervention become the establishment of syllable/word shape and segmental inventories in a cumulative view of development, rather than a 'negative progression' as assumed in phonological process theory (through its suppression of simplification processes).

Which of the prosodic or segmental subblocks should precede the other may depend on the need to gain the child's collusion in therapy. If segmental goals take longer to achieve, some

children might prefer to work on syllabic goals first, since success may be achieved more rapidly. However, short treatment blocks may obviate the need to guess which type of block will be successful first.

While automony can be assumed as a basis on which to construct an intervention program, the interaction of the components must also be taken into consideration. Certain word/syllable shapes appear to license certain segments first and vice versa.

Syllable Constituents

The division of words into opposing types of constituents for development of syllable structure helps focus a child's attention on the composition of words in various ways, thus facilitating development of metaphonological awareness which, in turn, may facilitate change. Practice in producing various kinds of syllable portions may assist in breaking down phonotactic constraints which have a representational and/or articulatory basis.

Feature Hierarchy

The constructing of feature hierarchies presents a graphic description of a child's segmental system at a given time and leads to immediate goal-setting when compared with the adult model and feature specifications for segments of a given language. By establishing marked features and nodes, particularly by contrasting those which are at different locations in the hierarchy, a phonologically disordered child's phonological development can be accelerated in a logical sequence.

Intervention and Phonological Theory

The nonlinear phonological frameworks stimulated a successful intervention study. Hypotheses regarding the type of prosodic constituents, interactions of tiers, and composition and role of feature hierarchies are under current debate in phonological theory. The external evidence gained through this study may contribute to the understanding of the nonlinear constructs in a reciprocal way.

NOTES

1. Explanatory and descriptive adequacy are used here in the generative grammar sense as outlined in Radford (1981, 25-26)

2. Only the basic aspects of nonlinear phonology are addressed in the text. For more information, the reader is directed to Van der Hulst and Smith (1985) and other papers listed in the references.

3. Modifications of Sagey (1986) reflect changes in McCarthy (1988) and Lombardi (1989) and were developed in consultation with Shaw (1988, personal communication). The features [nasal] and [sonorant] are attached to the Root node. Root node features [continuant] and [nasal] are considered dependents of the Root node; [sonorant] and [consonantal] define the Root node. At the level of the Laryngeal node, [+/-voice] replace [stiff]/[slack] vocal folds. The term 'complex' is a mnemonic the branching structure of [continunat] for the English affricates, but is not a feature designation. (The term is borrowed from Lombardi [1989] but does not imply her analysis.)

4. The first table of each subject chapter contains a list of detailed subject characteristics.

5. In using the term 'syllabic', I acknowledge that the onset-rime theory version of Kaye et al. (1987) does not include a syllable node. Because the contrasting intervention occurs below the level of the word, but above the level of the segment, the term 'syllabic' is a general term defining that part of the prosodic domain.

6. Descriptive terms and their abbreviations are taken from Grunwell (1985), with omission of the designations 'syllable-initial' and 'syllable-final' before 'word-initial' and 'word-final' respectively, i.e., WI instead of SIWI, and WF instead of SFWF. E determined syllable position for word-internal consonants by using a maximal onset hypothesis, e.g., in tractor, the /k/ was classified as SFWW (syllable-final-within-word) and the second /t/ as SIWW (syllable-initial-within-word) whereas in money, the /n/ was classified as SIWW. There were few exemplars of the SFWW category within the samples.

The word-internal consonant classification with the syllable denotation does not follow from either the onset-rime theory or moraic theory versions used for this research. (In the onset-rime theory version [Kaye et al. 1987], there is no syllable constituent; in Hayes (1987) version of moraic theory, prevocalic consonants are adjoined to the mora, not the syllable.) The SIWW/SFWW designations served as initial codings. E reanalysed words according to the theories under investigation when intervention involved the SIWW word position (see S3 , S4, and S6 Block 1 interventions).

7. For S1, the sequence /CjV/ was considered a cluster followed by a vowel, although some linguists consider the sequence to be a consonant followed by a light diphthong. S1's singleton substitution for /l/ was [j]. Both /ClV/ and /CjV/ sequences were realized with missing /l/ or /j/. It seemed more appropriate to consider the /j/ a 'consonant' than to consider /l/ a vowel in the particular context. This decision permitted consistency of /l/ specification as [+consonantal], the higher level feature being contrasted with lower level [-anterior] in the Block 1 and Block 2 feature conditions.

8. For S1, [+round] was frequently not specified for /ʊ/, whereas /ɚ/ > [+round]. Rhotacization was never specified for /ɚ/.

9. Percentages are rounded off to two decimal places throughout.

10. Aspiration of WI voiceless stops is not phonemically contrastive in English, but is phonetically contrastive. English-speaking adults' perception capacity to distinguish unaspirated and voiced WI stops is reduced, and thus the child's articulation of pig versus big becomes homophonous for the adult, even though it may be contrastive for the child (i.e., [pɪg] versus [bɪg] sounds like two articulations of [bɪg] to the adult). Therefore, the feature [+spread glottis] for voiceless stops is included under feature differences.

11. Italics and apostrophes indicate divergence from adult specifications. Where child forms *appear* to be specified inappropriately, it is not assumed that the features are in fact specified. This would require the child's retreating from inappropriate representations. The child's divergent forms have more of a default status which lacks the appropriate specification.

12. Intelligibility is used here in a nontechnical sense.

13. A Kolmogorov-Smirnov Test was also performed just for the session data across blocks and was not statistically significant ($p > 0.1$).

14. Kolmogorov-Smirnov Tests for session results (Block 1 separately and Blocks 1 and 2 together) were not statistically significant ($p > 0.1$).

15. S6 had a tendency to vocalize with glottal fry during the Initial Assessment period, particularly when feeling self-conscious.

REFERENCES

Archangeli, D. 1988. Aspects of underspecification theory. *Phonology Yearbook* 5: 183-207.

Archangeli, D. and D. Pulleyblank. 1986. The content and structure of phonological representations. TMs. University of Arizona, Phoenix and University of Southern California, Los Angeles; Also (in press) Cambridge, MA: MIT Press.

Barlow, D., S. Hayes and R. Nelson. 1984. *The scientist practitioner: Research and accountability in clinical and educational settings*. Elmsford, NY: Pergamon Press, 1984.

Bernhardt, B. and C. Johnson. (forthcoming) "[ən] you get green": Use of syntactic fillers in children's syntactic development. University of British Columbia.

Branigan, G. 1976. Syllable structure and the acquisition of consonants: The great conspiracy in word formation. *Journal of Psycholinguistic Research* 5: 117-133.

Carrow-Woolfolk, E. 1985. *Test for Auditory Comprehension of Language* (Revised). Allen, TX: DLM.

Chiat, S. 1989. The relation between prosodic structure, syllabification and segmental realization: Evidence from a child with fricative stopping. *Clinical Linguistics & Phonetics* 3: 223-242.

Chomsky, N. Principles and parameters in syntactic theory. In *Explanation in linguistics: The logical problem of language acquisition*, ed. N. Hornstein and D. Lightfoot, London, England: Longman, 1981.

Chomsky, N. and M. Halle. 1968. *The sound pattern of English.* New York: Harper and Row.

Clements, G. 1987. Towards a substantive theory of feature specification. Paper presented at the University of California Symposium on Segment Structure, Los Angeles, October 1987.

_____. 1989a. A unified set of features for consonants and vowels. Address to the Institut de Phonétique, Paris, France, August, 1989.

_____. 1989b. On the representation of vowel height. TMs. Cornell University, September, 1989.

Dinnsen, D. 1989. Toward a unified model of language and learning. Paper presented at the Conference on Phonological Development, Stanford University, September, 1989.

Dunn, L.M. and L.M. Dunn. 1981. *Peabody Picture Vocabulary Test. (Revised).* Circle Pines, MN.: American Guidance Service.

Edwards, M.L. 1979. Patterns and processes in fricative acquisition: Longitudinal evidence from six English-learning children. Ph.D. diss., Stanford University.

Edwards, M.L. and B. Bernhardt. 1973. Phonological analyses of the speech of four children with language disorders. TMs. The Scottish Rite Institute for Childhood Aphasia, Stanford University.

Elbert, M. and J. Gierut. 1986. *Handbook of clinical phonology.* San Diego, CA: College-Hill Press.

Farwell, C.B. 1977. Some strategies in the early production of fricatives. *Papers and Reports on Child Language Development,* 12: 97-104.

Ferguson, C.A. 1978. Fricatives in child language acquisition. In *Papers on linguistics and child language*, ed. V. Honsa and M.J. Hardman-de-Bautista, 93-115. The Hague: Mouton.

Ferguson, C.A. and C. Farwell. 1975. Words and sounds in early language acquisition. *Language*, 51: 419-439.

Gardner, M. 1979. *Expressive One-Word Picture Vocabulary Test.* Novato, CA: Academic Therapy Publications.

Goldman, R., M. Fristoe, and R. Woodcock. 1974. *Goldman-Fristoe-Woodcock Diagnostic Auditory Discrimination Battery.* Circle Pines, MN: American Guidance Service.

Goldsmith, J. 1976. *Autosegmental phonology.* Ph.D diss., Indiana University; Published 1979, New York: Garland Press.

Grunwell, P. 1985. *Phonological assessment of child speech.* San Diego, CA: College-Hill Press.

Halle, M. and G. Clements. 1983. Problem book in phonology: A workbook for introductory courses in linguistics and in modern phonology. Cambridge, MA: Cambridge University Press.

Hayes, B. 1987. Compensatory lengthening in moraic phonology. TMs. Department of Linguistics, University of California, Los Angeles.

_____. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20: 253-306.

Hedrick, D., E. Prather, and A. Tobin. 1975. *Sequenced Inventory of Communicative Development.* Seattle, WA: University of Washington Press.

Hegde, M. 1985. *Treatment procedures in communicative disorders.* San Diego, CA: College-Hill Press.

Hodson, B. and E. Paden. 1983. *Targeting intelligible speech -- a phonological approach to remediation.* San Diego, CA: College-Hill Press.

Hyman, L. 1985. *A theory of phonological weight.* Paris, Dordrecht: Foris.

Ingram, D. 1981. *Procedures for the phonological analysis of children's language.* Baltimore, MD: University Park Press.

_____. 1988. Language acquisition, learnability, and underspecification theory. Paper presented at the Linguistics Society of America meeting, December, 1988, New Orleans.

International Phonetics Association. 1979. *The principles of the International Phonetic Association* (Handbook of the IPA). London: London University College.

Jakobson, R. 1968. *Child language, aphasia, and phonological universals.* (A.R. Keiler, trans.). The Hague: Mouton.

Kaye, J., J. Lowenstamm, J. and J.-R. Vergnaud. 1987. Constituent structure and government in phonology. TMs. University of McGill, Montreal.

Kenstowicz, M. and C. Kisseberth, C. 1979. *Generative phonology: Description and theory.* New York: Academic Press.

Kiparsky, P. 1979. Metrical structure assignment is cyclic. *Linguistic Inquiry* 10: 421-441.

_____. 1982. Lexical morphology and phonology. *Linguistics in the morning calm*, ed. I.-S. Yang, 3-91. Seoul: Hanshin.

Lombardi, L. 1989. The nonlinear organization of the affricate. TMs. University of Massachusetts, Amherst.

Maxwell, E. 1984. On determining underlying phonological representations of children: A critique of the current theories. In *Phonological theory and the misarticulating child* (ASHA Monograph No. 22), ed. M. Elbert, D. Dinnsen, and G. Weismer, 18-29. Rockville, MD: ASHA.

McCarthy, J. 1981. A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* 12: 373-418.

_____. 1986. OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17: 207-263.

_____. 1988. Feature geometry and dependency: A review. *Phonetics* 43: 84-108.

McCarthy, J. and A. Prince. 1986. Prosodic morphology. TMs. University of Massachusetts and Brandeis University.

Menn, L. 1978. Phonological units in beginning speech. In *Syllables and segments,* ed. A. Bell and J. Bybee Hooper, 157-171. Amsterdam: North-Holland.

_____. 1983. Development of articulatory, phonetic, and phonological capabilities. In *Language production* 21, *Development, writing,z and other language processes.* ed. B. Butterworth, 3-50. New York: Academic Press.

Nettelbladt, U. 1983. *Developmental studies of dysphonology in children.* Lund, Sweden: Liberförlag Lund.

Newcomer, P. and P. Hammill. 1982. *Test of Language Development - Primary (Revised).* Austin, TX: PRO-ED.

Paradis, C. and J.-F. Prunet. (in press). *The special status of coronals.* Dordrecht: Foris.

Pinker, S. 1984. *Language learnability and language development.* Cambridge, MA: Harvard University Press.

Pulleyblank, D. 1986. Underspecification and low vowel harmony in Okpẹ. *Studies in African Linguistics* 17: 119-153.

Radford, A. 1981. *Transformational syntax.* Cambridge, England: Cambridge University Press.

Robbins, J. and T. Klee, T. 1987. Clinical assessment of oropharyngeal motor development in young children. *Journal of Speech and Hearing Disorders,* 52: 271-277.

Sagey, E. (1986). The representation of features and relations in non-linear phonology. Ph.D. diss. Massachusetts Institute of Technology, Cambridge, MA.

Sadanandan, S. 1987. The acquisition of phonology: A reanalysis. Paper presented at the Linguistics Society of America Conference, San Francisco, December 1987.

Secord, W. (1981). *Clinical probes of articulation consistency.* Columbus, OH: Charles Merrill Publ. Co.

Selkirk, E.O. 1980. The role of prosodic categories in English word stress. *Linguistic Inquiry* 8: 249-336.

Spencer, A. 1984. A nonlinear analysis of phonological disability. *Journal of Communication Disorders* 17: 325-348.

_____. 1986. Towards a theory of phonological development. *Lingua* 68: 3-38.

Stampe, D. 1969. The acquisition of phonetic representation. In *Papers from the Fifth Regional Meeting of the Chicago Linguistic Society*, ed. R.T. Binnick et al., 433-444. Chicago: Chicago Linguistic Society.

Stemberger, J.P. 1988. Between-word processes in child phonology. *Journal of Child Language* 15: 39-61.

Stemberger, J. P. and C. Stoel-Gammon. (in press) The underspecification of coronal: Evidence from language acquisition and performance errors. In *The special status of coronals*, ed. C. Paradis and J.-F. Prunet. Dordrecht: Foris.

Steriade, D. 1987. Redundant values. In *Papers from the parasession on autosegmental and metrical phonology,* ed. A. Bosch, B. Need and E. Schiller, 339-362. Chicago: Chicago Linguistic Society.

Stevens, K. and S.J. Keyser. 1989. Primary features and their enhancement in consonants. *Language* 65: 81-106.

van der Hulst, H. and N. Smith, eds. 1985. *Advances in nonlinear phonology.* Dordrecht: Foris.

Ventry, I. and N. Schiavette. 1980. *Evaluating research in speech pathology and audiology.* Reading, MA: Addison-Wesley.

Werner, E. and J. Kresheck. 1983. *Structured Photographic Expressive Language Test - Preschool.* Sandwich, ILL: Janelle Publications.

Zimmerman, I., V. Steiner, and R. Pond. 1979. *Preschool Language Scale (Revised).* Columbus, OH: Charles Merrill Publishing Co.

APPENDIX 1

BASIC WORD LIST FOR ELICITATION

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BASIC WORD LIST FOR ELICITATION

Vowel-initial	/b/	/k/ (cont)	/s/	/ʤ/
airplane	basket	comb	Santa Claus	"G"
all	bee	combing	scarf	judge
ear	bib	cook	screwdriver	jump
eat	black	cooking	see	jumping
eating	boot	crayons	sewing machine	
egg	bootie	key	sis	
eye	boots	quarter	sleep	/r/
ice	brush		sleeping	rabbit
icecubes	brushing	/g/	smooth	radio
icy	buzz		snake	read
itch	buzzing	glasses	snakey	reading
itchy		glove	snow	red
off	/t/	glovey	snowing	roar
on		go	soap	row
orange	television	green	soapy	rowing
	toe	gum	spoon	
/m/	toot	gummy/i	spring	/l/
	tooth		squirrel	
mask	toothbrush	/f/	star	la
me	toothy		starry	laugh
milk	truck	feather	string	laughing
mom	tub	finger	sun	leaf
mommy	tubby	fish	sunglasses	leafy
money	T.V.	fishing	sunny	Lyle
mouth		five	sweater	
mouthy	/d/	flower		/w/
music		frog	/z/	
musicbox	dad			wagon
	daddy	/v/	zipper	watch
/n/	dive		zoo	watching
	diving	van		wave
nine	doll		/ʃ/	waving
no	dollhouse	/θ/		why
noise	dolly		shoe	
noisy	dress	throw		
		throwing	/ʧ/	yellow
/p/	/k/	thumb		you
			chair	
page	cage	/ð/	cherries	/h/
pages	cagey		chicken	
pie	cake	that	church	hang
pig	call			hanger
piggy	calling			hi
plum	candle			horse
pour	clock			hug
pouring	coffee			hugging
present				

APPENDIX 2

FEATURE SPECIFICATIONS FOR ADULT ENGLISH

APPENDIX 2

FEATURE SPECIFICATIONS FOR ADULT ENGLISH

Assumptions

1. The following encodings and feature hierarchy presented in Figure 1.3 are derived from Sagey (1986). In addition, [+distributed] is used to distinguish interdentals from alveolars, and /r/ from /l/. The feature [+nasal] is attached to the Root node, which then leaves the Supralaryngeal node basically a Place node (McCarthy, 1988). Furthermore, the mnemonic 'complex' is used to describe the branching structure of complex for affricates (Lombardi, 1989).

2. Because the glottal stop [ʔ] is not phonemic in adult English, I have not provided a designation for it in the following descriptions. For children who use it as a substitution, it is sometimes considered a default Laryngeal node consonant and as such predictably [-spread glottis].

3. Following from the above, it is to be emphasized that the following are designations for adult English. Child phonologies may or may not match the following descriptions. Throughout the case study chapters, matches and nonmatches with the adult system are noted.

4. For coding, only marked features are indicated as per a radical underspecificaton hypothesis.

Node Abbreviations

R(N):	Root node	L/Lab:	Labial Place node
LN:	Laryngeal node	C/Cor:	Coronal Place node
PN:	Place node	D/Dors:	Dorsal Place node

Feature Abbreviations

[cons]	[consonantal]
[son]	[sonorant]
[cont]	[continuant]
[nas]	[nasal]
[sp gl]	[spread glottis]
[rd]	[round]
[ant]	[anterior]
[dstr]	[distributed]
[bk]	[back]
[hi]	[high]
[lo]	[low]
[ts]	[tense]

Table 1.--Marked consonant specifications for adult English

Segment	Root node	Laryngeal node	Place node
/m/	[+cons], [+nas]		Lab
/n/	[+cons], [+nas]		
[ŋ]	[+cons], [+nas]		Dors[1]
/p/[2]	[+cons]		Lab
/b/	[+cons]	[+voice]	Lab
/t/[2]	[+cons][3]		
/d/	[+cons]	[+voice]	
/k/[2]	[+cons]		Dors
/g/	[+cons]	[+voice]	Dors
/f/	[+cons], [+cont]		Lab
/v/	[+cons], [+cont]	[+voice]	Lab
/θ/	[+cons], [+cont]		Cor: [+dstr]
/ð/	[+cons], [+cont]	[+voice]	Cor: [+dstr]
/s/	[+cons], [+cont]		
/z/	[+cons], [+cont]	[+voice]	
/ʃ/	[+cons], [+cont]		Cor: [-ant]
/ʒ/	[+cons], [+cont]	[+voice]	Cor: [-ant]
/ʧ/	[+cons]		Cor: [-ant]; (comp)[4]
/ʤ/	[+cons]	[+voice]	Cor: [-ant]; (comp)[4]
/w/	[+son] [5]		Lab
/h/	[+cons]	[+sp gl]	
/j/	[+son]		Cor: [-ant][5]
/l/	[+cons], [+son]		
/r/	[+cons], [+son]		Cor: [+dstr][6]

[1]Although /ŋ/ can be considered an allophone of /n/ in English, it is listed here to show feature markings at the phonetic level. Several of the children did not produce /ŋ/ and thus its feature specifications need to be noted somewhere.

[2]Allophonic marking of [+spread glottis] is assumed for word initial voiceless stops and the lack thereof is noted for the child data. Although in this context [+spread glottis] is not a distinctive feature for English, the lack of aspiration in children's voiceless stop productions makes it difficult for adults to differentiate children's voiced and unvoiced stops. It is therefore relevant in adult's interpretation of children's utterances.

[3]The least specified consonant is considered to be /t/. This implies for consonants that marked features are [+consonantal], [+continuant], and [+nasal] at the Root node, [+voice] and [+spread glottis] at the Laryngeal node, and [-anterior] and [+distributed] at the Coronal node (itself the least marked node for consonants in English). The segment /t/ only needs to be specified for [+consonantal]. (See discussion following on markedness.)

[4]Affricates are treated as having one Root node, although they appear to be units with two components. The branching structure of the affricates is indicated by the mnemonic 'complex', assumed to be [-continuant][+continuant] for English.

[5]In the above formulation, glides are uniquely [+sonorant] among the consonants. They are vowel-like in their specification but consonant-like in their syllable position. They could also be left unspecified for both [consonantal] and [sonorant].

There is some controversy whether /j/ has a Coronal or Dorsal Place node. In this paper it is assumed to have a Coronal Place node, following Halle and Clements (1983).

[6]Liquids are distinguished from each other by the feature [+distributed] for /r/. According to developmental data, /r/ is often acquired after /l/and like the interdentals, is a late development. The use of a [+distributed] feature for both /r/ and /θ/ is appealing in relating their development to each other, and in creating a difference in complexity between /l/ and /r/. When a child has a [j] for one or both of the liquids, the feature difference between the adult and child forms is the lack of marking of [+consonantal] ([-anterior]). Without [+consonantal], [+distributed] cannot be marked, resulting in a glide.

However, when the child uses [w] (a relatively common substitution), the author is compelled to indicate a change of Place nodes from Coronal to Labial, which seems like an unnecessary complexity. The difference between the two glides may be minimal, however, and relate back to the voweliness, where /i/ is [-back] and /u/ is [+round]. The substitution of /j/ versus /w/ may be a result of random assignment of primary vowel features from the [+sonorant] group. (There is a possibility that a redundant feature available at a later stage of derivation -- Labial [+round] -- becomes realized at the surface when the major features of /r/ are unrealized.)

Table 2.--Marked vowel specifications for adult English

Segment	Root node	Laryngeal node	Place Node
/ə/[1]	[+son]		
/i/	[+son]		Dors: [-bk]
/æ/	[+son]		Dors: [-bk],[+lo]
/u/	[+son]		Lab: [+rd]
/ɑ/a/[2]	[+son]		Dors: [+lo]
Lax vowels: /ɪ, ɛ, ɔ, ʊ/	[+son]		Dors: As /i, ɛɪ, oʊ, u/ but with [-ts][3]
Diphthongized vowels:			
/ɛɪ/[3]	[+son]; [+son]		D: [-bk],[-hi]; [-bk]
/oʊ/	[+son]; [+son]		D: [+rd],[-hi]; [+rd]
Diphthongs:[4]			
/ɑɪ/aɪ/[2,5]	[+son]; [+son]		D: [+lo]; [-bk]
/ɔɪ/	[+son]; [+son]		D: [+rd],[-hi]; [-bk]
/aʊ, ɑʊ/[5]	[+son]; [+son]		D: [+lo]; [+rd]

[1]The least specified vowel is considered to be /ə/ ([ʌ] is the stressed counterpart of /ə/). For vowels, it implies that [+sonorant] is the marked Root node feature, as are the Vowel-Place node features [+round], [-back], and [+low]. (See discussion following on markedness.)

[2]There appears to be some nonsignificant shifting in the low vowel series in the Vancouver dialect of English between /a/, /ɑ/ and /æ/. The latter is differentiated from the former two by its feature [-back]. It is acknowledged, however, that the /a/ is further front phonetically than the /ɑ/ and sometimes appears to be more closely related to the front than to the back series of vowels.

[3]The feature [tense] is designated as a Dorsal feature in this paper, since it refers to lingual tension. Diphthongs have [-tense] second components as a redundant feature in the dialect area. Tense vowels are slightly diphthongized as well in the dialect area. Originally these were the long vowels of English. In a moraic account of syllable structure, this phonetic tendency may satisfy a metrical 'preference' for bimoraic syllables.

[4]Diphthongs are treated as having two Root nodes.

[5]Canadian 'raising' results in [ʌɪ] for /ɑɪ/ and[ʌʊ] for /aʊ/ in closed syllables with final voiceless consonants.

Markedness

Marked Vowel Features and the Default Vowel

For vowels, the unmarked value for [consonantal] is [-] and the marked value for [sonorant] is [+]. This appears to create a problem with features for glides, which are also [-consonantal], [+sonorant]. If the ability to identify relative prominence is added to the machinery of the syllabic algorithm, however, a glide will not be involved in nucleus projection, because it is less prominent than the vowel that precedes or follows it.

The question is then whether there are unmarked vowels. Generally one assumes that the epenthetic vowels are the unmarked vowels. If the least marked vowel system contains the three maximally distant points on the vowel triangle -- /i/, /a/, and /u/ -- then the features [-back], [+low], [-high], and [+round] become the primary marked features for a system.

Assigning those marked values, implies that default values are [+back], [-low] ([+ high]), and [-round]. In Kaye et al. (1985), the "barred i" is the 'cold' or least marked vowel. This would be the correct unmarked vowel for the aforementioned default values. I consider [ə] to be the universally unmarked vowel, however, primarily for pragmatic reasons (it is the most common epenthetic vowel). The "barred i" and /ə/ differ with respect to [+high] for the former, as the *implied* opposite of [-low]. If one does not imply [+high] as a necessary corollary of [-low], /ə/ can be the realization of [+back], [-low], [-round], demonstrating the designation of alternate possibilities for the unmarked vowel.

Absolute Marked Values

When considering markedness, some values can be considered absolute marked values and some relative, depending on supracategorical distinctions. The following are treated as *absolute marked* (non-default) values : [+consonantal], [+nasal], [-back], [-high].

1. Consonants are, in the majority of cases, the nonprojecting elements for syllabicity and thus need to be marked for their consonantality (i.e., this lack of capacity to project nuclei), hence [+consonantal].

2. Because nasals are a specific group of segments which require resonance in a cavity other than the oral cavity, the marked value is [+nasal].

3. If [+low] is chosen as the marked feature for [ɑ], then the feature [high] for [ɑ] is by default [-high], since low vowels can never be high. This might be an indication that the *unmarked* value for [high] is [-]. Chomsky and Halle argue that the *marked* value can still be [-], however, since what is low cannot be high by definition and thus the features can operate independently for markedness (1968, 409). (This inelegant and possibly circular default situation arises from the need to utilize both [low] and [high] as features for the (at least) three heights for vowels.)

Relative Marked Values

The following marked values are *dependency or relative marked values* (proceeding from the Root node down the feature tree).

A. Root and Laryngeal node features

Once a segment is designated as [+sonorant], the marked values for major features [continuant] and [voice] are necessarily [-]. Voiceless vowels are very marked segments.

The [+consonantal] segment, as a complement to the vowel, has complementary marked values for Root and Laryngeal node features: [+continuant], since fricatives are more

marked than stops and nasals; [+voice], since voiced obstruents are less common than unvoiced, and [+spread glottis], since /h/ and aspirated stops are less common than /ʔ/ and unaspirated stops.

B. Place node features

Complementarity of marking with respect to consonants and vowels may apply as well to Place nodes, but the scope of this thesis does not include vowel analyses. Hence this will not be discussed.

With respect to the nodes, Dorsal and Labial are marked in comparison with Coronal, but no claims are made about the relative markedness of Dorsal and Labial.

With respect to the features dominated by the nodal categories, any deviation from [+anterior] under Coronal may be considered marked (i.e., [+distributed] or [-anterior]). The English affricates need to be distinguished from their fricative counterparts in some way, with the branching 'complex' structure being the marked parameter. The Labial node appears to be marked for both vowels and consonants, with the value [+round] being the marked value.

APPENDIX 3

INTERTRANSCRIBER RELIABILITY DATA FOR S1, S4, AND S5

APPENDIX 3. Table 1.--S1: Intertranscriber reliability data: Block 1 probe

E's transcription Phones	Match	Alternatives - Transcriber 2 Phones	Non Match	Notes/Solution
m	6			
n	7	Missing-wf	1	
ŋ	1			
p	7			
b	1			
t	2	t^h-wf	1	Irrelevant
d	3	t	1	/g/-sub
Dent-d		d	1	
k	4	g	1	
g		gj	1	Completely disagree-
		k	1	('gum')
		d	1	Ditto above
f	2	fw	1	
v	2	Missing-coda	1	
ɸ	1			
θ		Dental s	7	Sib-sub-Between teet
		s	1	
ð		missing-wf()	3	
		dent. z-ð	1	
		ts	1	
		Dent. z	1	
		d	1	
tθ		ts-dental-θ	1	sub-tʃ
tʃ				
ʤ				
r				
l				
w	6	ʊ	1	/r/,/j/-sub-3
		(ʊ)w	1	
j	5			/l/-sub
ʔ	1	h	1	/h/ sub-[h] unlikely
ʊ		l-wf for /r/	1	
ɔə		ɔĩ-not included	1	/r/-sub-wf
TOTAL	48		30	
% AGREE	61.54%			
TOTAL	55	Ignoring different symbols for interdental	23	
% AGREE	70.51%			
Aft. Discuss	76	Resolved	2	
% AGREE	97.44%			

Table 3.1- Continued: Block 2 probe				
E's transcription		Alternatives - Transcriber 2	Non	Notes
Phones	Match	Phones	Match	
m	4	b	1	
n	3	Missing-wf		
ŋ				
p	1			
b	4			
t	3	t(unrel)wi, ç¬missing-wf	2	2-unresolved
d	4	missing-wf, C	1	
Dent-d		d		
k		g		
g	5	gj		
		k		
		d		
f	4	fw		
v		Missing-coda		
ɸ				
θ	2	Dental s	4	
		s		
ð		missing-wf()		
		dent. z-ð		
		ts		
		Dent. z	3	
		g	1	
ʃ		s-L2	1	
ʒ				
tθ		dent z	1	
tʃ				
ʤ		dent on d part	1	
r	1			
l	1			
w	6	ʊ		
		(ʊ)w		
j	2			
h	3			
ʔ	2	h	1	
ʊ		l-wf for /r/		
ɔə		ɔĩ-not included		
TOTAL	45		16	
% AGREE	73.77%			
TOTAL	50	Ignoring different symbols for interdental	11	
% AGREE	81.97%			
Aft. Discuss	59	Resolved	2	
% AGREE	96.72%			
BL 1+BL2	93		46	
% AGREE	66.91%			
TOTAL	105	Ignoring different symbols for interdental	34	
% AGREE	75.54%			
Aft. Discuss	135		4	
% AGREE	97.12%			

APPENDIX 3. Table 2.--S4: Intertranscriber reliability data: Block 1 probe

E's transcription Phones	Match	Alternatives - Transcriber Phones	Non Match	Notes	Agree
m*	8			Nasals √	
n*	9				
ŋ	2				
p					
p^h	3	p	1	Labials - asp 5/6 √	+
b	1				
t*	1				
t^h		d	1	t-asp, comp	t/d
		t͡	1		t͡ʒ
T		dð	1		dð
d*	3		1	d OK	
D					
k	3	t^h	1	Velars-fronting? 3/5√	k
		d	1		
g	3	ŋk	1	SIWW x, WI √	ŋ k, ɤ
		ɤ	1		
pː		fː	1	Lab fric 2/3 √	ᶠ ɸf
f*	1				
v	1				
z-L2**	1			SIWW z-L2 √	
ɾl		(ʊ)w	1		
l*	1			l √	
w		w	1	Retroflexion?	[w]-r-colc
j	2			j√	
h					
ʔ	4	Nothing	8	Glottal?4/12√	8/12√
ɔ for ɔɪ *	1	ɔ ᴵ	1	Not a diphthong	ʊ
ɑɪ/aɪ *	2	aɪ			
TOTAL	46	Including glottals	21		
% AGREE	68.66%				
Place			2		
Voicing/asp			5		
Complex/diphthong			2		
Glottal/not			8		
Fric/stop			1		
Retroflexion			2		
Total glottals and voicing mismatches			8		
Aft. Discuss	62	Including glottals	5		
% AGREE	92.54%				
TOTAL	59	Omitting glottals	8		
% AGREE	88.06%				
Aft. Discus	66	Omitting glottals	1		
% AGREE	98.51%				
* Training targets					
**L2 = laminal production					

APPENDIX 3. Table 3.--S5: Intertranscriber reliability data: Block 1 probe

E's transcription Phones	Match	Alternatives - Transcriber 2 Phones	Non Match	Notes/Solution
m	8			
n	11	Dentalized n(2), nas V	3	All 3 - √
ŋ	1			
p	5			
b	1			
t	2			
t^h	1			
T	1	voiced	1	unasp
d	2			
Dent-d	1			
dð	3			
k	1			
g	1			
g ə w	0	gw	1	Perhaps retro, but ep
f	9			
v	0	f	1	v dev
ɸ				
θ	3			
(t)θt(θ)	2			Stop in "puddle" of
ð	0	dð	1	frication
ç	1			
s				
z				
ʃ				
ʒ				
tθ	1			
tʃ				
ʤ	2			
r				
l	2			
w	6	Ø	1	
ɰ	1			
j	1	Ø	3	
h	3			
TOTAL	69		11	
% AGREE	86.25%			
Voicing/asp	2	Disagree		
Dentaliz	2	Agreed		
Pres/absent	5	Agreed		
Retroflex.	1	Disagree		
Comp/not	1	Agreed		
Resolved	8			
Aft. Discuss	77		3	
% AGREE	96.25%			

APPENDIX 4

MATCH AND NONMATCH DATA FOR ALL SUBJECTS

APPENDIX 4. Table 1.1.--S1: Assessment and Block 1 proportional match data							
	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
CATEGORY	BL. 1	BL. 1	BL. 1	ASSESSMENT			BL. 1 - ASMT
SY:WI: CC-1 syllable	55.81%	24	19	42.31%	11	15	13.51%
SY:WI: CC -2 syllable	64.71%	11	6	30.77%	8	18	33.94%
SY:WI: CC-4 syllable	0.00%	0	1	0.00%	0	2	0.00%
SY: SIWW CC	37.50%	3	5	14.29%	1	6	23.21%
SY: WI CCC	0.00%	0	6	0.00%	0	4	0.00%
SY:TOTAL: EPEN x	50.67%	38	37	30.88%	21	47	19.78%
SY: TOTAL: EPEN √	64.00%	48	27	32.35%	22	46	31.65%
SEG:WI / l / (ASMT:all	15.00%	3	17	0.00%	0	35	15.00%
(WI,SIWW=13)							
SEG: SIWW /l/	0.00%	0	1				0.00%
SEG: /bl/	5.26%	1	18	0.00%	0	13	5.26%
SUM: Trained /l/	14.29%	3	18				14.29%
SEG: ALVEOPAL.	0.00%	0	30	0.00%	0	30	0.00%
SUM: Trained	5.88%	3	48				
SEG: / h /	0.00%	0	8	0.00%	0	7	0.00%
SEG: ASPIRATION	42.31%	22	30	13.51%	5	32	28.79%
SEG: COMPLEX √	80.95%	17	4	25.00%	2	6	55.95%
SEG:Obst.>Not complex				21.95%	9	32	28.05%
SEG: WI / t />not comp	50.00%	7	7				
SEG: SUM:Untrained	93.88%	46	3	20.78%	16	61	73.10%
SEG: TOT.- observ. fea	64.38%	47	26	10.32%	16	139	54.06%

APPENDIX 4. Table 1.2.--S1: Block 2 proportional match data							
	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
CATEGORY	BL. 1	BL. 1	BL. 1	ASSESSMENT			BL. 2 - BL. 1
/l/ (wi)	70.59%	12	5				55.59%
/l/ (siww)	100.00%	11	0				100.00%
/l/ CLUS.: Epen. √	100.00%	12	0				94.74%
SUM: /l/ (trained)	87.50%	35	5				73.21%
/l/ (sfww)	66.67%	2	1				66.67%
/l/ (wf)	14.29%	2	12				14.29%
/l/ TOTAL:Epen. √	62.90%	39	23				
/ʤ/	80.00%	12	3				80.00%
/ʃ/	73.91%	17	6				73.91%
/ʤ/ + /ʃ/ (trained)	76.32%	29	9				76.32%
/tʃ/	55.00%	11	9				55.00%
ʒ	0.00%	0	3				0.00%
ALVEOPAL.: TOTAL	65.57%	40	21				65.57%
SEG: SUM: TRAINED	82.05%	64	14				76.17%
COMPLEX √	72.00%	18	7				-8.95%
FRIC.>Not complex √	87.50%	14	2				
/h/	42.86%	6	8				42.86%
ASPIRATION	89.13%	41	5				46.82%
SEG:OBSERV. Untrain	74.38%	90	31				-19.50%
SEG: TOT. observ. feat	70.54%	158	66				6.15%
ʃ (si)	64.71%	11	6				64.71%
ʤ (si)	44.44%	8	10				80.00%
ʃ (wf)	37.50%	6	10				60.00%
ʤ (wf)	50.00%	4	4				50.00%
TYPE OF DIFFERENCE			% DIFF.				
SYL: TOT EPEN x (BL1 MAJ-ASSESS)			19.78%				
SYL: TOT EPEN √ (BL 1 MAJ-ASSESS)			31.65%				
SYL: TOT: BL2 - BL1 (MINOR PROBE)			-12.10%				
AVG. CHANGE: SYL:			13.11%				
SD			22.62%				
SEG: TOT BL 1 MAJOR - ASSESS			12.46%				
SEG: BL 2 MAJOR - BL1 MAJOR			51.13%				
AVG. CHANGE: SEG:			31.80%				
SD			27.34%				

APPENDIX 4. Table 2.1--S2: Proportional match data: Assessment and Block 1

CATEGORY	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% MATCH ASSESSMENT	MATCH ASSESSMENT	NONMAT ASSESSMENT	% Difference BL. 1-ASMT
SE: k (wi)	0.00%	0	25	0.00%	0	25	0.00%
k (siww)	0.00%	0	10	0.00%	0	17	0.00%
k (wf)	0.00%	0	17	5.88%	1	16	-5.88%
kl with ep	No examples			0.00%	0	4	0.00%
g (wi)	0.00%	0	6	0.00%	0	6	0.00%
g (siww)	0.00%	0	9	0.00%	0	9	0.00%
g (wf)	0.00%	0	8	0.00%	0	6	0.00%
gl with ep	0.00%	0	3	0.00%	0	5	0.00%
ŋ (all)	3.03%	1	32	0.00%	0	32	3.03%
f (wi)	6.25%	1	15	0.00%	0	15	6.25%
f (siww)	0.00%	0	1	0.00%	0	6	0.00%
f (wf)	0.00%	0	2	0.00%	0	4	0.00%
fl with ep	0.00%	0	2	0.00%	0	1	0.00%
v (wi)	33.33%	1	2	0.00%	0	1	33.33%
SE: v (siww)	37.50%	3	5	0.00%	0	5	37.50%
SE: v (wf)	16.67%	1	5	0.00%	0	8	16.67%
s (wi)	7.69%	1	12	0.00%	0	11	7.69%
s (siww)	0.00%	0	3	0.00%	0	9	0.00%
s (wf)	0.00%	0	13	0.00%	0	5	0.00%
SY: z (wi)	0.00%	0	4	0.00%	0	2	0.00%
z (siww)	0.00%	0	8	0.00%	0	5	0.00%
z (wf)	0.00%	0	20	0.00%	0	27	0.00%
ʃ (wi)	0.00%	0	4	0.00%	0	3	0.00%
ʃ (siww)	0.00%	0	3	0.00%	0	4	0.00%
ʃ (wf)	0.00%	0	2	0.00%	0	3	0.00%
ʤ (wi)	0.00%	0	6	0.00%	0	5	0.00%
ʤ (siww)	0.00%	0	3	0.00%	0	2	0.00%
ʤ (wf)	0.00%	0	3	0.00%	0	3	0.00%
tʃ (wi)	0.00%	0	5	0.00%	0	8	0.00%
tʃ (siww)	0.00%	0	2	0.00%	0	2	0.00%
tʃ (wf)	0.00%	0	3	0.00%	0	6	0.00%
SY: M: sp	0.00%	0	4	0.00%	0	1	0.00%
M: sp > C:	75.00%	3	1	0.00%	0	1	75.00%
SY: OR: st	0.00%	0	5	0.00%	0	7	0.00%
OR : st > t^h	100.00%	5	0	42.86%	3	4	57.14%
SY: OR: sl	0.00%	0	2	0.00%	0	2	0.00%
OR : sl > hl	50.00%	1	1	0.00%	0	2	50.00%
SY: M : sw	0.00%	0	2	0.00%	0	2	0.00%
sm	0.00%	0	1	0.00%	0	1	0.00%
sm > $_o$m	100.00%	1	0	0.00%	0	1	100.00%
sn	37.50%	3	5	0.00%	0	4	37.50%
sn > C:/CC	87.50%	7	1	50.00%	2	2	37.50%
sk	0.00%	0	2	0.00%	0	2	0.00%
sk > t^h	100.00%	2	0	50.00%	1	1	50.00%

Table 2.1 -- Continued

CATEGORY	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% MATCH ASSESSMENT	MATCH ASSESSMENT	NONMAT ASSESSMENT	% Difference BL.1-ASMT
SY: sC(targ) >	7.14%	1	13	0.00%	0	12	7.14%
SY: sC(all) > C	16.67%	4	20	0.00%	0	19	16.67%
SY: sC > CL/C€	81.48%	22	5	31.58%	6	13	49.90%
sCC > CC	42.86%	3	4	0.00%	0	5	42.86%
r (all)	2.04% *	1	48	0.00%	0	33	2.04%
Cr > CC	45.45%	10	12	0.00%	0	21	45.45%
p (wi)	45.00%	9	11	27.27%	3	8	17.73%
b (wf)	0.00%	0	3	100.00%	4	0	-100.00%
t (wi)	52.00%	13	12	46.15%	12	14	5.85%
t (wf)	46.94%	23	26	70.37%	19	8	-23.43%
θ (wi)	0.00%	0	2	0.00%	0	2	0.00%
θ (siww)	0.00%	0	1	0.00%	0	1	0.00%
θ (wf)	33.33%	1	2	0.00%	0	4	33.33%
ð (wi)	0.00%	0	14	33.33%	4	8	-33.33%
ð (siww)	0.00%	0	2	0.00%	0	3	0.00%
ð (wf)	0.00%	0	1	0.00%	0	1	0.00%

	$\bar{X}$	SD
X DIFF: SEG trained	18.06%	18.79%
X DIFF: SEG untrained (Dors, labiod)	2.83%	9.53%
X DIFF: SEG FEATURES (all Dors, all labiod)	5.68%	8.34%
X DIFF: SYL trained /s/- clusters	0.00%	0.00%
X DIFF: SYL untrained /s/-clusters	12.50%	21.65%
X DIFF: all /s/-clusters	5.36%	14.17%
X DIFF: SYL trained /s/-skeletal slots/CL	45.54%	32.13%
X DIFF: SYL untrained /s/-skeletal slots/CL/CC	62.50%	33.07%
X DIFF: SYL all cluster skeletal slots	52.81%	31.03%
X DIFF: SY: WI z	0.00%	0.00%
X DIFF: SY: Untrained WI coronal fricatives	-6.41%	18.31%
X DIFF: SY: All WI coronal fricatives	-5.13%	16.12%
X DIFF: All trained SYL as targets	0.00%	0.00%
X DIFF: All trained SYL as skeletal slots + WI z	36.43%	34.48%
X DIFF: All untrained SYL as targets	1.69%	20.64%
X DIFF: All untrained SYL as skeletal slots or coronal fric	23.12%	43.46%
X DIFF: SYL: Trained + untrained as targets	1.48%	19.12%
X DIFF: SYL: Trained + untrained as skeletal slot or WI cor fric	28.67%	40.14%

*WI

APPENDIX 4. Table 2.2--S2: Block 1 session data for syllabic condition

	S+E CVC/ CCVC	Ech s/z (M)	Ech s/z (M)	Ech #CC (OR)	Ech #CC (OR)	Ech #CC (OR)	Ech V(C)# (OR)	Ech V(C)# (OR)	Ech V(C)# (OR)	Ech CV-	Ech CV-	Ech C)CV(C	Ech C)CV	Ech C)CV
	% √	√	x	% √	√	x	% √	√	x	√	x	% √	√	x
SESS. 10: OR: #st	50.00%			71.43%	5	2	100%	7				50.00%	3	3
	Activity: Imitation of "waste" > "stay"; focusing of "st"-"ay" separately													
SESS. 11: OR: #st	76.98%			100%	10				Error: Glottal			80.33%	49	12
	Activity: Imitation of "st-ay", then whole wd (some sentence) imitation													
	Activity: Memory and "stop" games for spont. naming													
SESS. 11: OR: #sl	81.82%							Errors: /s/>[l]; /s/>				81.82%	9	2
SESS. 12: OR: #st	85.37%							Errors: /st/>[t]; t/d				85.29%	29	5
	Activity: Onset contrast game: /st/ versus /t, d/													
SESS. 12: OR: #sl	47.83%							3				64.71%	11	6
	Activity: "Slip through the slot": Imitation of sl-V(C) and then whole wd													
		with prolonged [l:]						Error: /sl/>[l;(h)l];/l/>[sl]-1						
SESS. 13: OR: #sl	65.38%							Error: /sl>[l], ([d				64.71%	22	12
	Activity: Onset contrast games (phrase, sentence). Best with eyes closed.													
SESS. 13: OR: #st	55.56%											50.00%	8	8
	Activity: Poem with /st/ words in phrases for imitation.													
SESS. 13: OR: #z	Stimulation with "Z-ip a dee doo dah" and "Z-ed" as home program													
SESS. 14: M: #sp	63.16%	2										86.67%	13	2
	Activities: Magic: [s] changes one word to another when added at them beginning													
SESS. 15: M: #sp	78.95%	3								1		83.33%	5	1
	Activities: Word "Spot" in story. Magic box - [s] changes /p/ words.													
SESS. 16:M: #sw	78.26%											92.86%	13	1
	Activities: Contrast ones with magic /s/ with ones without /s/ in whole wd													
	imitations													
SESS. 16:M: #sp														
SESS. 16:M: #st												100.00%	2	
REVIEW SESS. 1	Activity: Review activities for all targets based on activities of previous sessions													
SESS. 17: OR:#st	73.91%				1							68.42%	13	6
SESS. 17: OR: #sl	62.07%				1		Errors	5.00				58.82%	10	7
SESS. 17: M: #sp	100.00%	1										100.00%	1	
SESS. 17: M: #sw	61.11%											100.00%	3	
SESS. 17: M: #z	92.31%	1								3		90.91%	10	1
TOT: OR:st	75.77%											75.00%	102	34
TOT: OR: sl	62.61%											65.82%	52	27
TOT: OR: st, sl	71.35%											71.63%	154	61
TOT: OR:	71.35%											71.63%	154	61
TOT: MOR: WI z	92.31%											90.91%	10	1
TOT: MOR: sp	71.88%											86.36%	19	3
TOT: MOR: sw	70.73%											94.12%	16	1
TOT: MOR: sp, sw	71.43%											89.74%	35	4
TOT: MORAIC	73.73%											90.00%	45	5

Table 2.2.--Continued			
	Notes-Spontaneous responses*	Spont CCV(C) % √	S CCV- √	S CCV- x
SESS. 10: OR: #st				
SESS. 11: OR: #st		74.36%	58	20
		100.00%	1	
SESS. 11: OR: #sl				
SESS. 12: OR: #st		85.71%	6	1
SESS. 12: OR: #sl		0.00%	0	6
SESS. 13: OR: #sl		66.67%	12	6
SESS. 13: OR: #st		100.00%	2	
SESS. 14: M: #sp	Error: #/p/>[sp]-1 Errors: /sp/>[p]	47.83%	11	12
SESS. 15: M: #sp	Error:/p/>[sp]-3	76.92%	10	3
SESS. 16:M: #sw		55.56%	5	4
SESS. 16:M: #sp		66.67%	2	1
SESS. 16:M: #st				
REVIEW SESS. 17				
SESS. 17: OR:#st		100.00%	4	0
SESS. 17: OR: #sl	Errors: /sl/>[l]	66.67%	8	4
SESS. 17: M: #sp		100.00%	6	0
SESS. 17: M: #sw	Errors: /s/>[sw]-2;/sw/>[w]	53.33%	8	7
SESS. 17: M: #z		100.00%	2	0
TOT: OR:st		76.92%	70	21
TOT: OR: sl		55.56%	20	16
TOT: OR: st, sl		70.87%	90	37
TOT: OR:		70.87%	90	37
TOT: MOR: WI z		100.00%	2	0
TOT: MOR: sp		64.29%	27	15
TOT: MOR: sw		54.17%	13	11
TOT: MOR: sp, sw		60.61%	40	26
TOT: MORAIC		61.76%	42	26

*Spontaneous responses include self-echoic responses.

N.B. [s] are prolonged in clusters

APPENDIX 4. Table 2.3.--S2: Block 2 session data for syllabic condition								
	Sp+Ech	Echoic	Echoic	Ech	Ech	Echoic	Ech	Ech
	Whole w	#Cor#CC	#Cor#CC	VC#	VC#	Whole word		
	Target	(OR)	(OR)	(OR)	(OR)			
	% √	√	x	√	x	% √	√	x
SESS. 28: OR: #f-V(C(C))	65.63%	7		17		68.75%	33	15
	Activity: VC words into fVC words. Feed Garfield (phrases							
SESS. 29: OR: #fl						92.31%	12	1
	Activities: Song-"Old Lady and fly".							
	Contrast game (f/fl wd): imitation of whole wd							
	Activity: Find /f/ and /fl/ cards wtih flashlight - "I found a f-".							
SESS. 29: OR: #f	85.71%					100.00%	1	
SESS. 29: OR: #sp		Incidental teaching		spider		100.00%	5	
SESS. 29: OR: #s-VC(C)**		Incidental teaching				100.00%	2	
SESS. 30: OR: #s-VC(C)	64.10%	1				68.18%	15	7
	Activity: Onset contrast-whole wd, normal> prolonged [s]							
	(e.g., sit-hit-fit; sack-stack-tack-shack)							
	Errors for/s/: [h] -4; [st]-2;[f]-1							
	S-initiated sound play: '"am"-a-m							
SESS. 30: OR: #st	87.50%					100.00%	5	
SESS. 30: OR: #sl	75.00%					75.00%	3	1
SESS. 31: OR: #s-VC(C)	75.61%					88.46%	23	3
SESS. 31: OR: #sVV---		Incidental teaching				100.00%	4	
	Activities for s and st: (whole wd imitation-songs/stories)							
	Errors: /sV/>[hV]; /st/ > [st]; some /h/ > [s]							
SESS. 31: OR: #st	62.50%	1				61.54%	16	10
SESS. 31: OR: #sl	75.00%					81.82%	9	2
	Activity: slip things through a slot or flip them							
	S-initiated sound play: [b]-onset with rime(bip, bunny, bupid							
OR: SESS. 30+31 - #s-VC	70.00%					79.17%	38	10
SESS. 30+31: OR: #st	66.07%					67.74%	21	10
SESS. 30+31: OR: #sl	75.00%					80.00%	12	3
SESS. 32:M: zV-(C)	100.00%					100.00%	13	
	Zoom" story - well-liked word					Very long z for some		
SESS. 32:M: vV-(C)	89.29%					100.00%	18	
	Activity: Words from story + valentine + volleyball.							
	S-initiated sound play: "piano"-"viano", "wiano", "bandwich"							
SESS. 32: M: s-V(C)		Incidental teaching				91.67%	11	1
SESS. 32: M: s-VV(C)		Incidental teaching				100.00%	8	
SESS. 32: M: st		Incidental teaching				100.00%	2	
SESS. 32: M: sl		Incidental teaching				100.00%	2	
SESS. 32: M: sn		Incidental teaching				100.00%	1	
SESS. 32: M: sp		Incidental teaching				50.00%	1	1
SESS. 33: M: sVV(C)	79.63%					81.08%	30	7
	Activity: Grabbag with animals: See X; X say Y							
	Activity: "Snap" with sVV(C) wds					Error: [h, t, sp]		
SESS. 33: M: s-V(C)		Incidental teaching				100.00%	3	
SESS. 33: M: snap		Incidental teaching						
SESS. 33: M: sp	75.00%					100.00%	7	

Table 2.3.--Continued								
	S+E*	Ech	Ech	Ech	Ech	Ech	Ech	Ech
	Whole w	#Cor#CC	#Cor#CC	VC#	VC#	Whole word		
	Target	(OR)	(OR)	(OR)	(OR)			
	% √	√	x	√	x	% √	√	x
SESS. 34: M: sVV(C)	59.26%					100.00%	7	
	Activity: Signs, sights, sounds of camping conversation							
SESS. 34: M: sV(C)		Incidental teaching [ʃ]/ɑ				88.89%	8	1
SESS. 34: M: sw	87.30%		/sw/>[f,w]			92.00%	46	4
	Activity: Swim, swan, swim. Swap game							
SESS. 34: M: sp		Incidental teaching						
SESS. 34: M: st		Incidental teaching				33.33%	1	2
SESS. 34: M: z		Incidental teaching				100.00%	1	
SESS. 33+34: sVV(C)	84.09%					84.09%	37	7
REVIEW SESS. 35: OR: f	76.60%		N.B./ br/√			75.00%	24	8
	Activity: Review of all major activities and targets							
	S-initiated sound play: b-an, sp-an for tan-fan etc							
SESS. 35: OR: fl	100.00%					100.00%	10	
SESS. 35: OR: sVC	80.00%					80.00%	16	4
SESS. 35: OR: st	74.07%					75.00%	6	2
SESS. 35: OR: sl	50.00%					66.67%	2	1
SESS. 35: M: zV-C	100.00%					100.00%	2	
SESS. 35: M: vV-C	83.33%					75.00%	3	1
SESS. 35: M: sVV(C)	88.89%					100.00%	6	
SESS. 35: M: sp	80.00%					85.71%	12	2
SESS. 35: M: sw	100.00%							
TOT OVER SESS: OR: f*	73.38%					71.60%	58	23
TOT: OR: fl	83.33%					95.65%	22	1
TOT: OR: f, fl	80.95%					80.95%	34	8
TOT: OR: WI sV - all	72.00%					79.41%	54	14
TOT: OR: st	68.67%					69.23%	27	12
TOT: OR: sl	72.50%					77.78%	14	4
TOT: OR: st, sl	72.27%					77.36%	41	12
TOT: OR	73.98%					79.14%	129	34
TOT: MOR: WI sV V(C)	74.44%					86.00%	43	7
TOT: MOR: WI z	100.00%					100.00%	15	0
TOT: MOR: WI v	88.24%					95.45%	21	1
TOT: MOR: WI z, v	93.33%					97.30%	36	1
TOT: MOR: WI s, z, v	82.00%					90.80%	79	8
TOT: MOR: sp	76.92%					90.48%	19	2
TOT: MOR: sw	87.50%					92.00%	46	4
TOT: MOR: sp, sw	83.50%					91.55%	65	6
TOT: MORAIC	82.61%					91.14%	144	14

Table 2.3.--Continued								
	Spont	Spont	Spont	Spont	Spont	Spont	Spont	Spont
	#Cor#CC	#Cor#CC	VC#	VC#	VC#	Whole word		
	(OR)	(OR)	(OR)	(OR)	(OR)			
	√	x	% √	√	x	% √	√	x
SESS. 28: OR: #f-V(C(C))						56.25%	9	7
).	yellow">"fellow" in "funny yellow feet"						fat"=5 errors	
SESS. 29: OR: #fl			Errors: Ø, s			68.42%	13	6
SESS. 29: OR: #f			Errors: [h]			85.19%	23	4
SESS. 29: OR: #sp								
SESS. 29: OR: #s-VC(C)**								
SESS. 30: OR: #s-VC(C)			Errors: [h, f]			58.82%	10	7
SESS. 30: OR: #st						66.67%	2	1
SESS. 30: OR: #sl								
SESS. 31: OR: #s-VC(C)						53.33%	8	7
SESS. 31: OR: #sVV---	1			1		75.00%	9	3
SESS. 31: OR: #st						63.64%	14	8
SESS. 31: OR: #sl						71.43%	15	6
			Errors: /f/>Ø, (s) --			28.57%	2	5
OR: SESS. 30+31 - #s-VC						56.25%	18	14
SESS. 30+31: OR: #st						64.00%	16	9
SESS. 30+31: OR: #sl						71.43%	15	6
SESS. 32:M: zV-(C)						100.00%	11	
							Zoom"-9 √	
SESS. 32:M: vV-(C)			Error: b(s-1)			70.00%	7	3
SESS. 32: M: s-V(C)			Errors : "Santa"			54.55%	6	5
SESS. 32: M: s-VV(C)						50.00%	1	1
SESS. 32: M: st						100.00%	2	
SESS. 32: M: sl								
SESS. 32: M: sn						100.00%	1	
SESS. 32: M: sp								
SESS. 33: M: sVV(C)						76.47%	13	4
SESS. 32: M: s-V(C)			Error-[h, b]			50.00%	3	3
SESS. 33: M: snap		One rapid sequence of 15				37.50%	9	15
SESS. 33: M: sp						64.71%	11	6

Table 2.3.--Continued								
	Spont	Spont	Spont	Spont	Spont	Spont	Spont	Spont
	#Cor#CC	#Cor#CC	VC#	VC#	VC#	Whole word		
	(OR)	(OR)	(OR)	(OR)	(OR)			
	√	x	% √	√	x	% √	√	x
SESS. 34: M: sVV(C)						45.00%	9	11
SESS. 34: M: sV(C)						58.82%	10	7
SESS. 34: M: sw						69.23%	9	4
SESS. 34: M: sp						50.00%	1	1
SESS. 34: M: st						38.89%	7	11
SESS. 34: M: z						100.00%	1	
SESS. 33+34: sVV(C)								
REVIEW SESS. 35: OR: f						80.00%	12	3
SESS. 35: OR: fl								
SESS. 35: OR: sVC								
SESS. 35: OR: st			Error: /st/ > [t]			73.68%	14	5
SESS. 35: OR: sl			Error: /sl/ > [fl]			0.00%	0	1
SESS. 35: M: zV-C								
SESS. 35: M: vV-C						100.00%	2	0
SESS. 35: M: sVV(C)						66.67%	2	1
SESS. 35: M: sp						0.00%	0	1
SESS. 35: M: sw						100.00%	1	0
TOT: OR: f*						75.86%	44	14
TOT: OR: fl						68.42%	13	6
TOT: OR: WI sV - all						56.25%	18	14
TOT: OR: st						68.18%	30	14
TOT: OR: sl						68.18%	15	7
TOT: OR: st, sl						68.18%	45	21
TOT: OR						68.59%	107	49
TOT: MOR: WI sV						60.00%	24	16
TOT: MOR: WI z						100.00%	11	0
TOT: MOR: WI v						75.00%	9	3
TOT: MOR: WI z, v						86.96%	20	3
TOT: MOR: WI s, z, v						69.84%	44	19
TOT: MOR: sp						61.11%	11	7
TOT: MOR: sw						71.43%	10	4
TOT: MOR: sp+sw						65.63%	21	11
TOT: MORAIC						68.42%	65	30
*Totals do not include incidental teaching targets.								
** /s/=√ whether or not dental-about 80% without dentalization								

APPENDIX 4. Table 3.1.--S3: Proportional match data: Assessment and Block 1

	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
SIWW	BL. 1	BL. 1	BL. 1	ASSESSMENT			BL. 1 - ASMT
2-syll matches	94.78%	127	7	47.83%	55	60	46.95%
CVCV	85.37%	35	6	52.63%	10	9	32.73%
SIWW C	96.18%	126	5	33.33%	42	84	62.85%
M: ɪ - lax	91.67%	22	2	18.75%	3	13	72.92%
OR data: All	87.50%	21	3				63.24%
OR: n(ts V/diph_)	100.00%	12	0				56.82%
OR: t	75.00%	3	1	11.76%	2	15	8.04%
OR: d	75.00%	6	2	18.18%	2	9	16.67%
p	64.29%	9	5	56.25%	9	7	66.67%
b	66.67%	2	1	50.00%	3	3	60.00%
k	66.67%	10	5	0.00%	0	6	66.67%
g	60.00%	3	2	0.00%	0	4	50.00%
f	100.00%	3	0	33.33%	1	2	0.00%
v	50.00%	3	3	0.00%	0	5	50.00%
ð	0.00%	0	1	0.00%	0	1	
s	50.00%	1	1	0.00%	0	2	
z	0.00%						
WF	BLOCK 1-WF			ASSESSMENT -WF			BL. 1 - ASMT
CVC:no l, r	91.84%	90	8	58.41%	66	47	33.43%
CVC:including l, r	81.82%	90	20	49.26%	67	69	32.55%
p	100.00%	14	0	50.00%	2	2	50.00%
b	66.67%	4	2	0.00%	0	3	66.67%
t	61.90%	13	8	7.14%	1	13	54.76%
d	12.50%	1	7	0.00%	0	8	12.50%
k	82.35%	14	3	0.00%	0	9	82.35%
g	0.00%	0	3	0.00%	0	7	0.00%
f	100.00%	3	0	0.00%	0	3	100.00%
v	33.33%	1	2	0.00%	0	5	33.33%
θ	0.00%	0	4	0.00%	0	4	0.00%
ð	0.00%	0	1	0.00%	0	1	0.00%
s	95.45%	21	1	100.00%	8	0	-4.55%
z	0.00%	0	5	0.00%	0	11	0.00%

Table 3.1.--Continued

	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
	BL. 1	BL. 1	BL. 1	INITIAL ASSESSMENT			BL. 1 - ASMT
WI: l - √ E	18.18%	2	9	13.33%	2	13	4.85%
SIWW: l	25.00%	1	3	25.00%	1	3	0.00%
WI: h - √4/6 S	31.58%	6	13	9.38%	3	29	22.20%
SIWW: h	0.00%	0	1	50.00%	1	1	-50.00%
WI: p	28.57%	6	15	31.58%	6	13	-3.01%
WI: t	50.00%	14	14	40.74%	11	16	9.26%
WI: k	47.62%	10	11	35.29%	6	11	12.32%
r - not ɚ	0.00%	0	38	3.13%	1	31	-3.13%
ʃ - all	0.00%	0	9	0.00%	0	11	0.00%
tʃ - all	0.00%	0	9	0.00%	0	13	0.00%
ʤ - all	11.11%	1	8	0.00%	0	13	11.11%
WI: complex m √	33.33%	2	4	0.00%		Comp √	52.38%
SIWW: comp m √	50.00%	3	3				
WF: comp m √	66.67%	6	3				
TOT: complex m √	52.38%	11	10				
#sC	9.09%	2	20				
% DIFFERENCE BETWEEN BLOCK 1 AND ASSESSMENT							
2-syll matches	46.95%						
CVCV	32.73%						
All /n/ data	72.92%						
OR: t	63.24%						
OR: d	56.82%						
CVC:no l, r	33.43%						
p	50.00%						
l - √ E	4.85%						
h - √4/6 S	22.20%						
X - Syl slots-train.	33.08%						
SD - Syl slots	0.49%						
X - Syl targ -train.	60.75%						
SD - Syl targ-train.	9.75%						
X - Syl untr.(not l,r)	29.51%						
SD-Syl untr.(not l,r)	37.10%						
X - Seg trained	13.53%						
SD - Seg trained	12.27%						

APPENDIX 4. Table 3.2.--S3: Proportional matches in Block 1 and Block 2

WI	% MATCH BL. 2	MATCH BL. 2	NONMAT BL. 2	% MATCH BL.1	MATCH BL.1	NONMAT BL.1	% Difference BL.2-BL.1
SE:WI: 1 (8S)	100.00%	10	0	18.18%	2	9	81.82%
SE:SIWW: 1	25.00%	1	3	25.00%	1	3	0.00%
SE:WI:h-x SC	96.00%	24	1	31.58%	6	13	64.42%
SE:SIWW:h	0.00%	0	1	0.00%	0	1	0.00%
p	57.14%	4	3	28.57%	6	15	28.57%
t	73.33%	11	4	50.00%	14	14	23.33%
d	53.85%	7	6	92.86%	26	2	-39.01%
Cor/_ Dors(CVC)	71.43%	5	2	0.00%	0	2	71.43%
k	84.21%	16	3	47.62%	10	11	36.59%
g	100.00%	2	0	87.50%	7	1	12.50%
Dors/_Cor (CVC)	100.00%	5	0	0.00%	0	7	100.00%
v	50.00%	1	1	0.00%	0	2	50.00%
s/_V(V).	66.67%	2	1	0.00%	0	10	63.33%
s/_VC.	60.00%	3	2				
z(V.)	0.00%	0	2	0.00%	0	2	0.00%
Alveopalatals	0.00%	0	4	0.00%	0	9	0.00%
r	7.69%	1	12	0.00%	0	38	7.69%
ŋ	16.00%	4	21	2.27%	1	43	13.73%
CLUSTERS							
sm/_Vl>Ø	0.00%	0	1				0.00%
sm/_VC	0.00%	0	1				0.00%
sn/_V.	60.00%	3	2				25.00%
sn/_VC.	100.00%	3	0				(for all /sn/)
sp/_V	0.00%	0	2				0.00%
sp/_VC	0.00%	0	2				0.00%
st/_VC(OR)	0.00%	0	7				0.00%
st/_V(OR)	0.00%	0	2				0.00%
sk(VC#)	0.00%	0	1				0.00%
sl(VC#)	0.00%	0	2				0.00%
s w	0.00%	0	2				0.00%
TOT: #sC	21.43%	6	22	9.09%			12.34%
mp	60.00%	3	2				60.00%
nt	100.00%	5	0				100.00%
nd	100.00%	2	0				100.00%
n(d)z	25.00%	1	3				25.00%
nʤ	0.00%	0	2				0.00%
sk#	0.00%	0	1				0.00%
k s	100.00%	4	0				100.00%
bz	100.00%	1	0				100.00%
dz	0.00%	0	1				0.00%
gz	0.00%	0	1				0.00%
vz	0.00%	0	1				0.00%
TOT:WF CC (s/z & nas)	59.26%	16	11				59.26%

Table 3.2.--Continued

WI	% MATCH BL. 2	MATCH BL. 2	NONMAT BL. 2	% MATCH BL.1	MATCH BL.1	NONMAT BL.1	% Difference BL.2-BL.1
SY: X Diff.-trained	37.11%						
SD	41.03%						
SE: X Diff.-trained	36.56%						
SD	42.81%						
SE: X Diff-untrained	18.32%						
SD	13.67%						
SYL: untrained-CC#	59.26%						

APPENDIX 4. Table 4.1.--S4: Proportional matches: Assessment and Block 1

CATEGORY SIWW	%MATCH BL 1	MATCH BL. 1	NONMAT BL. 1	% MATCH SIWW ASSESSMENT	MATCH	NONMAT	% Difference BL. 1-ASMT
CVCV	83.87%	26	5	56.25%	18	14	27.62%
M: ɪr	81.82%	9	2	47.06%	8	9	34.76%
M:m-tokens	66.67%	10	5	89.47%	17	2	-22.81%
M:m-types	85.71%	6	1	66.67%	4	2	19.05%
M: All-tokens	73.08%	19	7	69.44%	25	11	3.63%
M: All-types	83.33%	15	3	52.17%	12	11	31.16%
OR: t	77.78%	7	2	10.00%	1	9	67.78%
OR: d	88.00%	22	3	33.33%	3	6	54.67%
OR: All	85.29%	29	5	21.05%	4	15	64.24%
p	100.00%	5	0	25.00%	1	3	75.00%
b	100.00%	7	0	54.55%	6	5	45.45%
k	60.00%	3	2	50.00%	4	4	10.00%
g	83.33%	5	1	87.50%	7	1	-4.17%
f	66.67%	2	1	0.00%	0	4	66.67%
v	42.86%	6	8	0.00%	0	3	42.86%
l	33.33%	2	4	10.00%	1	9	23.33%
h	0.00%	0	1	0.00%	0	0	0.00%
s	14.29%	1	6	0.00%	0	7	14.29%
z	16.67%	1	5	60.00%	3	2	-43.33%
tʃ	0.00%	0	2	0.00%	0	6	0.00%
ʤ	50.00%	1	1	0.00%	0	1	50.00%
				TRAIN+UNTRAIN		*X SIWW*	28.52%
						TOT SD	31.99%
WF	BL. 1	BL. 1	BL. 1	WF ASSESSMENT DATA			BL. 1 - ASS
C#/CVC:no l, r	71.60%	58	23	36.46%	35	61	35.15%
C#/CVC:with l, r	62.37%	58	35	30.97%	35	78	31.39%
OR:m	100.00%	10	0	33.33%	4	8	66.67%
M:n	55.56%	20	16	0.00%	0	25	55.56%
b	0.00%	0	4	0.00%	0	3	0.00%
t	50.00%	14	14	5.36%	3	53	44.64%
d	20.00%	2	8	0.00%	0	7	20.00%
k	77.78%	14	4	64.52%	20	11	13.26%
g	16.67%	1	5	0.00%	0	5	16.67%
f	100.00%	3	0	0.00%	0	4	100.00%
v	33.33%	2	4	0.00%	0	1	33.33%
l	13.33%	2	13	0.00%	0	7	13.33%
s	85.71%	6	1	50.00%	5	5	35.71%
ʃ	0.00%	0	3	33.33%	1	2	-33.33%
z	0.00%	0	19	0.00%	0	7	0.00%
tʃ	50.00%	1	1	0.00%	0	1	50.00%
ʤ	0.00%	0	3	0.00%	0	3	0.00%
				TRAIN+UNTRAIN		*X WF*	27.72%
						SD	32.76%
X: SY:TRAINED	40.49%	X:SK SL.	31.38%	(CVC,CVCV)			
SD:	27.43%		5.32%				
X:SY:UNTRAINED	22.95%						
SD:	32.32%						

Table 4.1.-- Continued							
CATEGORY	%MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
WF	BL. 1	BL. 1	BL. 1	WF ASSESSMENT DATA			BL. 1 - ASS
X:SY:ALL	28.14%						
SD	31.82%						
X:SE:TRAINED	41.60%	Without WF f		22.14%			
SD	38.96%			1.85%			
X:SE:WI UNTRAIN	13.91%						
SD	38.47%						
CATEGORY	%MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
WI	BL 1	BL 1	BL 1	ASSESSMENT			BL. 1 - ASS
l	23.08%	3	10	0.00%	0	5	23.08%
f	20.00%	3	12	0.00%	0	5	20.00%
r	0.00%	0	11	8.33%	1	11	-8.33%
v	100.00%	1	0	0.00%	0	1	100.00%
s	15.38%	2	11	0.00%	0	5	15.38%
z	0.00%	0	2	0.00%	0	2	0.00%
tʃ	33.33%	2	4	28.57%	2	5	4.76%
ʤ	0.00%	0	4	57.14%	4	3	-57.14%
p	76.92%	10	3	28.57%	4	10	48.35%
t	73.08%	19	7	65.38%	17	9	7.69%
k	68.75%	22	10	69.57%	16	7	-0.82%
h	68.18%	15	7	30.77%	4	9	37.41%
j	75.00%	3	1	71.43%	5	2	3.57%
						X	14.92%
						SD	35.87%

APPENDIX 4. Table 4.2.--S4: Proportional match data: Block 2							
CATEGORY	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
SIWW	BL. 2	BL. 2	BL. 2	BL. 1	BL. 1	BL. 1	BL. 2- BL. 1
f	75.00%	3	1	66.67%	2	1	8.33%
v	83.33%	5	1	42.86%	6	8	40.48%
l	100.00%	3	0	33.33%	2	4	66.67%
h	0.00%	0	1	0.00%	0	1	0.00%
s	44.44%	4	5	14.29%	1	6	30.16%
z	33.33%	2	4	16.67%	1	5	16.67%
tʃ	33.33%	1	2	0.00%	0	2	33.33%
ʤ	0.00%	0	2	50.00%	1	1	-50.00%
			TRAINED+UNTRAINED			*X DIFF*	18.20%
						SD	34.43%
WF	BL. 2	BL. 2	BL. 2	BL. 1	BL. 1	BL. 1	BL. 2- BL. 1
b	66.67%	2	1	0.00%	0	4	66.67%
d	44.00%	11	14	20.00%	2	8	24.00%
g	88.89%	8	1	16.67%	1	5	72.22%
f	64.71%	11	6	100.00%	3	0	-35.29%
v	42.86%	3	4	33.33%	2	4	9.52%
l	8.33%	1	11	13.33%	2	13	-5.00%
s	100.00%	8	0	85.71%	6	1	14.29%
z	20.00%	2	8	0.00%	0	19	20.00%
tʃ	66.67%	2	1	50.00%	1	1	16.67%
ʤ	25.00%	1	3	0.00%	0	3	25.00%
			TRAINED+UNTRAINED			*X DIFF*	20.81%
						SD	31.23%
WI	BL. 2	BL. 2	BL. 2	BL. 1	BL. 1	BL. 1	BL. 2- BL. 1
l	80.00%	8	2	23.08%	3	10	56.92%
f	64.71%	11	6	20.00%	3	12	44.71%
v	0.00%	0	1	100.00%	1	0	-100.00%
s	38.10%	8	13	15.38%	2	11	22.71%
z	50.00%	1	1	0.00%	0	2	50.00%
ʃ	100.00%	1	0	0.00%	0	2	100.00%
tʃ	28.57%	2	5	33.33%	2	4	-4.76%
ʤ	60.00%	6	4	0.00%	0	4	60.00%
p	75.00%	6	2	76.92%	10	3	-1.92%
t	100.00%	15	0	73.08%	19	7	26.92%
k	100.00%	20	0	68.75%	22	10	31.25%
h	61.90%	13	8	68.18%	15	7	-6.28%
			TRAINED +UNTRAINED			*X DIFF.*	23.30%
						SD	49.64%

APPENDIX 4. Table 4.3.--S4: DIPHTHONGS: BLOCKS 1 AND 2

S4: BLOCK 1 DIPHTHONG DATA							S4: BLOCK 2 DIPHTHONG DATA					
DIPHTHONG Child form	%Match	Mat	Non-mat	SUBST/ OR R:ø	Feature Types	#	%Match	Mat	Non-mat	SUBST/ OR R:ø	Feature Types	#
ɛɪ-c/u *	0.00%	0	3	æ	V2:Ø;V1:ht u	2						
				ɛ (ə)	V2:R:Ø	1						
ɛɪ-c/s	0.00%	0	9	æ/ɑ(ə)	V2:Ø;V1:ht u	7	0.00%	0	9	æ/ɑ(ə)	V2:Ø;V1:ht u	7
				ɛ	V2:R:Ø	2				ɛ		2
ɛɪ-o/u	0.00%	0	1	ɛ(ə)	V2:R:Ø	1	0.00%	0	2	ɛ(ə)	V2:R:Ø	0
										æ/ɑ(ə)	V2:Ø;V1:ht u	1
										i	V1:R:Ø	1
ɛɪ-o/s	0.00%	0	12	ɛ	V2:R:Ø-all	3	17.65%	3	14	ɛ	V2:R:Ø-all	3
				æ/a(ə)	-hi u	8		e		æ/a(ə)	V2:Ø;V1:ht u	3
				i	V1:R:Ø	1				i	V1:R:Ø	1
										ɑ/æ ɪ	V1:-hi u	7
sum-ɛɪ	0.00%	0	25				10.71%	3	25			way-(
ɑɪ-c/s	0.00%	0	2	ɑ	V2:R:Ø	2	12.50%	1	7	a	V2:R:Ø	1
										æ	V2:R:Ø	5
										ʌɪ	Inapp raising	1
ɑɪ-o/u	50.00%	2	2	ɑ	V2:R:Ø	2	100.00%	2	0			
ɑɪ-o/s	41.67%	10	14	ɑ(ə)	V2:R:Ø	9	70.83%	17	7	ɑ/a(ə)	V2:R:Ø	4
		1-sy		æ((ə))	V1:-bk m,	8			1-sy	æ((ə))	V1:-bk m,	2
									+2sy	ʌ(ə)	V2:Ø,V1:-lo	1
sum-ɑɪ	40.00%	12	18				58.82%	20	14			
ɑʊ-c/s	0.00%	0	5	ɑ((ɔ))	V2:R:Ø	5	100.00%	5	0			
ɑʊ-o/u							0.00%	0	1	a(ə)	V2:R:Ø	1
ɑʊ-o/s	0.00%	0	3	ɑ(ə)	V2:R1/2	2	66.67%	2	1	ɑ/a((ə))	V2:R1/2	1
				a		1					2-syll	
sum-ɑʊ	0.00%	0	8				77.78%	7	2			
ʌɪ-c/u	0.00%	0	1	æ	V1:-bk m	1						
					V2:R:Ø							
ʌɪ-c/s	0.00%	0	1	æ	V1:-bk m	1	0.00%	0	3	æ(ə)	V1:-bk m	3
					V2:R:Ø						V2:R:Ø	
ʌɪ-o/u	0.00%	0	1	ɔ(wə)	V2:glide syll	1						
					(-bk u)							

Table 4.3.--Continued

DIPHTHONG Child form	%Match	Mat	Non-mat	SUBST/ OR R:ø	Feature Differen Types	#	%Match	Mat	Non-mat	SUBST/ OR R:ø	Feature Differenc Types	#
ʌI-o/s	0.00%	0	1	æ		1						
sum-ʌI	0.00%	0	4				0.00%	0	3			
ɔI-c/s	0.00%	0	1	ɔwɪ	Add syll	1	0.00%	0	1	ɔwɪ	Add syll	
										o	V2:R:Ø	
												1
ɔI-o/s	0.00%	0	4	o(wə)	Add 1/2 syll	1	50.00%	1	1	o(wə)	Add 1/2 syll	
				ɔ	V2:R:Ø	1				o	V2:R:Ø	1
sum-ɔI	0.00%	0	5	ʊ	V1:-lo u	1	33.33%	1	2			
					V2:R:Ø	1						
oʊ-c/s	11.11%	1	8	o ˇ,O^	V2>Ø-all x	3						
				o		2						
				ʌ	LAB u	2						
				ʌ(ʊ)	LAB-glide	1						
				ɑ	LAB u, ht u	1						
				ʊʔoʊ		1						
oʊ-o/u	0.00%	0	3	ɑ/ʌ(ə)	LAB u,ht u	1						
				o		1						
oʊ-o/s	45.00%	9	11		V2:R:Ø	4						
	close eyes=[koAI].				V2:R:Ø	7						
sum-oʊ	31.25%	10	22		Not [o]	6						
ʌʊ-c/u							0.00%	0	1	a	V2:R:Ø	1
ʌʊ-c/s							100.00%	1	0			
ʌʊ-o/s	0.00%	0	1	ɑ(ə)	V>long		0.00%	0	1	ɑ(ə)	V>long	
					V2:R:Ø						V2:R:Ø	
										ʌ(ʊ)	V2:R:1/2	1
sum, ʌʊ	0.00%	0	1				50.00%	1	1			
TOTALS											% DIFF.	
OPEN,STR	22.22%	10	35				48.94%	23	24		26.71%	
OPEN,UNST	33.33%	2	4				33.33%	2	4		0.00%	
SUM:OPEN	23.53%	12	39				47.17%	25	28		23.64%	
CLOSED,STR	0.00%	0	18				25.93%	7	20		25.93%	
CLOSED,UNS	0.00%	0	4				0.00%	0	1		0.00%	
SUM:CLOS.	0.00%	0	22				25.00%	7	21		25.00%	
OVERALL	16.44%	24	122				42.54%	57	77		26.10%	

*C=closed, o=open, s=stressed, u=unstressed

**Single parentheses indicate offglide. Double brackets indicate optional offglide.

Note:lax -bk/ vowelsin mid space sometimes inaccurate for height and -bk;

APPENDIX 4. Table 5.1.--S5: Proportional match data: Assessment /Block 1							
CATEGORY	% MATCH	MATCH	NONMAT	% MATCH	MATCH	NONMAT	% Difference
	BL. 1	BL. 1	BL. 1	ASSESSMENT			BL. 1-ASMT
#CC	17.72%	14	65	26.88%	25	68	-9.16%
#CC with ep	46.84%	37	42	37.63%	35	58	9.20%
.CC	0.00%	0	5	0.00%	0	7	0.00%
.CC with ep	20.00%	1	4	0.00%	0	7	20.00%
#sC-2 CC	48.00%	12	13	42.31%	11	15	5.69%
#sC-With ep	56.00%	14	11	42.31%	11	15	13.69%
#Cl-CC	6.25%	1	15	19.05%	4	17	-12.80%
#Cl-With ep	62.50%	10	6	22.73%	5	17	39.77%
#Cr-2 CC	9.68%	3	28	15.56%	7	38	-5.88%
#Cr-With ep	58.06%	18	13	26.67%	12	33	31.40%
#st-CC	16.67%	2	10	8.33%	1	11	8.33%
#tw	0.00%	0	3	No examples			
pr&pr>CC,no ep	0.00%	0	2	0.00%	0	1	0.00%
OR:pr-CC with ep	50.00%	1	1	0.00%	0	1	50.00%
M:br	12.50%	1	7	0.00%	0	8	12.50%
br-With ep	37.50%	3	5	0.00%	0	8	37.50%
br-CC, no ep	12.50%	1	7	12.50%	1	7	0.00%
br-CC with ep	87.50%	7	1	25.00%	2	6	62.50%
M: tr	0.00%	0	4	0.00%	0	7	0.00%
tr-With ep	25.00%	1	3	0.00%	0	7	25.00%
tr-CC, no ep	0.00%	0	4	50.00%	3	3	-50.00%
tr-CC with ep	100.00%	4	0	83.33%	5	1	16.67%
OR: dr	20.00%	1	4	0.00%	0	11	20.00%
dr-With ep	40.00%	2	3	0.00%	0	11	40.00%
dr-CC, no ep	40.00%	2	3	9.09%	1	10	30.91%
dr-CC with ep	100.00%	5	0	9.09%	1	10	90.91%
kr	0.00%	0	7	0.00%	0	6	0.00%
kr-CC	0.00%	0	7	33.33%	2	4	-33.33%
kr-CC-With ep	100.00%	7	0	83.33%	5	1	16.67%
gr	0.00%	0	3	0.00%	0	3	0.00%
gr-CC	0.00%	0	4	33.33%	1	2	-33.33%
gr-CC-With ep	75.00%	3	1	100.00%	3	0	-25.00%
kr+gr-CC	0.00%	0	11	33.33%	3	6	-33.33%
kr+gr-CC-+ep	90.91%	10	1	88.89%	8	1	2.02%
pl-With ep	25.00%	1	3	0.00%	0	6	25.00%
bl-With ep	25.00%	1	3	0.00%	0	2	25.00%
kl-With ep	66.67%	2	1	0.00%	0	7	66.67%
gl-With ep	25.00%	1	3	0.00%	0	1	25.00%
fl-With ep	0.00%	0	1	0.00%	0	0.2	0.00%
l (wi)	80.00%	8	2	5.56%	1	17	74.44%
l (siww)	37.50%	3	5	0.00%	0	9	37.50%
l (sf)	0.00%	0	23	0.00%	0	24	0.00%
l (si-all)	61.11%	11	7	3.70%	1	26	57.41%
l (trained)	54.55%	12	10	3.45%	1	28	51.10%
l (all)	26.83%	11	30	1.96%	1	50	24.87%
ʃ (wi)	50.00%	1	1	0.00%	0	9	50.00%
ʃ (siww)	0.00%	0	3	0.00%	0	9	0.00%
ʃ (wf)	33.33%	2	4	0.00%	0	6	33.33%

Table 5.1.-- Continued

CATEGORY	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% MATCH ASSESSMENT	MATCH	NONMAT	% Difference BL. 1-ASMT
ʃ (all)	27.27%	3	8	0.00%	0	24	27.27%
tʃ (wi)	33.33%	2	4	0.00%	0	7	33.33%
tʃ (siww)	0.00%	0	3	0.00%	0	5	0.00%
tʃ (wf)	0.00%	0	4	0.00%	0	1	0.00%
tʃ (all)	15.38%	2	11	0.00%	0	13	15.38%
ʤ (wi)	25.00%	3	9	0.00%	0	11	25.00%
ʤ (siww)	25.00%	1	3	0.00%	0	2	25.00%
ʤ (wf)	0.00%	0	8	0.00%	0	4	0.00%
ʤ (all)	16.67%	4	20	0.00%	0	17	16.67%
ʃ+ʤ	20.00%	7	28	0.00%	0	41	20.00%
ʃ+ʤ+tʃ	18.75%	9	39	0.00%	0	48	18.75%
WI: Stops	52.38%	33	30	59.66%	71	48	-7.28%
WF: Stops	42.11%	8	11	65.79%	25	13	-23.68%
t (siww)	71.43%	10	4	68.97%	20	9	2.46%
d (siww)	64.71%	11	6	63.64%	14	8	1.07%
r (wi)	5.88%	1	16	0.00%	0	19	5.88%
r (siww)	9.09%	1	10	4.17%	1	23	4.92%
r (sf)	55.56%	10	8	37.93%	11	18	17.62%
r (si-all)	7.14%	2	26	0.00%	0	42	7.14%
r (all)	26.09%	12	34	16.67%	12	60	9.42%
						$\bar{X}$	SD
X DIFF: SEG: TRAINED						30.03%	23.23%
X DIFF: SEG: UNTRAINED (l, alveop)						25.93%	23.88%
X DIFF: SEG: (l, alveop)						28.10%	23.87%
X DIFF: SYL: TRAINED: #Cr-epen						25.63%	18.30%
X DIFF: SYL: TRAINED: #Cr-no epen						8.13%	9.87%
X DIFF: SYL: TRAINED: #Cr>CC with epen						55.02%	30.77%
X DIFF: SYL: TRAINED: #Cr>CC - no epen						-4.77%	33.49%
X DIFF: SYL: UNTRAINED: #CC-no epen (#sC, Cl, kr+gr)						-13.48%	19.52%
X DIFF: SYL: UNTRAINED: #CC-epen (#sC, Cl, kr+gr)						18.50%	19.33%

APPENDIX 4. Table 5.2.-- S5: Proportional match data: Block 2

CATEGORY	% MATCH BL. 2	MATCH BL. 2	NONMAT BL. 2	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% Difference BL. 2-BL. 1
#CC	22.35%	19	66				4.63%
#CC with ep	56.47%	48	37				9.64%
.CC	10.00%	1	9				10.00%
.CC with ep	30.00%	3	7				10.00%
#sC-2 CC	31.91%	15	32				-16.09%
#sC-With ep	44.68%	21	26				-11.32%
#sC-CC, no st	25.64%	10	29	76.92%	10	3	-51.28%
#sC-CC,no st,ep	41.03%	16	23	92.31%	12	1	-51.28%
#Cl-CC	0.00%	0	16				-6.25%
#Cl-With ep	66.67%	14	7				4.17%
#Cr-2 CC	10.34%	3	26				0.67%
#Cr-With ep	41.38%	12	17				-16.69%
OR:#st-CC	62.50%	5	3				45.83%
M:#tw	60.00%	3	2				60.00%
pr&pr CC, no ep	0.00%	0	1				0.00%
pr - CC with ep	100.00%	1	0				100.00%
br	0.00%	0	9				-12.50%
br-With ep	10.00%	1	9				-27.50%
br-CC, no ep	11.11%	1	8				-1.39%
br-CC with ep	100.00%	9	0				12.50%
tr& tr-CC, no ep	0.00%	0	3				0.00%
tr-With ep	0.00%	0	3				-25.00%
tr-CC with ep	100.00%	3	0				0.00%
dr	0.00%	0	2				-20.00%
dr-With ep	0.00%	0	2				-40.00%
dr-CC, no ep	0.00%	0	2				-40.00%
dr-CC with ep	100.00%	2	0				0.00%
kr-With,withoute	0.00%	0	5				0.00%
M:kr-CC	40.00%	2	3				40.00%
M:kr-CC-With ep	100.00%	5	0				0.00%
gr	0.00%	0	3				0.00%
gr-With ep	33.33%	1	2				33.33%
gr-CC	0.00%	0	3				-75.00%
gr-CC-With ep	100.00%	3	0				100.00%
fr-With,withoutep	0.00%	0	2				0.00%
OR:fr-CC, no ep	0.00%	0	2				0.00%
OR: fr-CC with ep	100.00%	2	0				100.00%
pl-With ep	16.67%	1	5				-8.33%
bl-With ep	100.00%	2	0				50.00%
M:kl-With ep	66.67%	2	1				0.00%
gl-With ep	14.29%	1	6				-10.71%
OR:fl	0.00%	0	5	0.00%	0	1	0.00%
fl-With ep	80.00%	4	1	0.00%	0	1	80.00%
fl-CC, no ep	0.00%	0	5	100.00%	1	0	-100.00%
fl-CC with ep	100.00%	5	0	100.00%	1	0	0.00%
l (wi)	100.00%	10	0				20.00%
l (siww)	100.00%	5	0				62.50%
l (sf)	7.69%	1	12				7.69%
l (si-all)	100.00%	15	0				38.89%

Table 5.2-- Continued

CATEGORY	% MATCH BL. 2	MATCH BL. 2	NONMAT BL. 2	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% Difference BL. 2-BL. 1
l (all)	57.14%	16	12				30.31%
ʃ (wi)	33.33%	2	4				-16.67%
ʃ (siww)	0.00%	0	2				0.00%
ʃ (wf)	33.33%	3	6				0.00%
ʃ (all)	29.41%	5	12				2.14%
tʃ (wi)	66.67%	2	1				33.33%
tʃ (siww)	71.43%	15	6				71.43%
tʃ (wf)	25.00%	2	6				25.00%
tʃ (all)	59.38%	19	13				43.99%
ʤ (wi)	36.36%	4	7				11.36%
ʤ (siww)	100.00%	2	0				75.00%
ʤ (wf)	0.00%	0	3				0.00%
ʤ (all)	37.50%	6	10				20.83%
ʃ+ʤ	33.33%	11	22				13.33%
ʃ+ʤ+tʃ	46.15%	30	35				27.40%
WI: Stops	66.67%	26	13				14.29%
WF: Stops	75.00%	15	5				32.89%
r (wi)	3.23%	1	30				-2.66%
r (siww)	11.11%	1	8				2.02%
r (sf)	57.14%	12	9				1.59%
r (si-all)	5.00%	2	38				-2.14%
r (all)	22.95%	14	47				-3.14%

	$\bar{X}$	SD
X DIFF: SEG: TRAINED	19.02%	32.61%
X DIFF: SEG: UNTRAINED (l, alveop)	34.36%	26.92%
X DIFF: SEG: (l, alveop)	24.14%	30.52%
X DIFF: SYL: TRAINED: st, tw	52.92%	10.02%
X DIFF: SYL: TRAINED: #Cr(fr,kr with ep)	0.00%	0.00%
X DIFF: SYL: TRAINED: #Cl (kl,fl with ep)	40.00%	56.57%
X DIFF: SYL: TRAINED: All	30.97%	35.62%
X DIFF: SYL: UNTRAINED: #Cr, Cl	-2.95%	21.76%
X DIFF: SYL: UNTRAINED: #CC-epen (#sC, Cl, Cr)	26.87%	60.75%

APPENDIX 4. Table 6.1--S6: Proportional match data: Assessment and Block 1

CATEGORY	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% MAT ASSESSMENT	MATCH ASSESSMENT	NONMAT ASSESSMENT	% Difference BL. 1-ASMT
SIWW C: No clus	37.30%	47	79	21.43%	9	33	15.87%
IWW C SLOT:no LN	46.83%	59	67	30.95%	13	29	15.87%
WF C: No clus, liq	26.45%	73	203	7.69%	7	84	18.76%
WF C SLOT: No LN	29.71%	82	194	7.69%	7	84	22.02%
OR: m (siww)	83.33%	5	1	50.00%	2	2	33.33%
m (wf)	85.71%	18	3	60.00%	3	2	25.71%
M: n (siww)	83.33%	5	1	50.00%	1	1	33.33%
n (wf)	83.78%	31	6	33.33%	4	8	50.45%
ŋ (all)	0.00%	0	25	0.00%	0	1	0.00%
p (wi)	13.64%	3	19	100.00%	1	0	-86.36%
M: p (siww)	60.00%	3	2	25.00%	1	3	35.00%
M: p (wf)	38.46%	5	8	0.00%	0	4	38.46%
b (siww)	77.78%	7	2	100.00%	1	0	-22.22%
b (wf)	0.00%	0	3		No examples		0.00%
SE:t (wi)-types	41.67%	5	7	16.67%	1	5	25.00%
SE: t (wi)	55.56%	10	8	16.67%	1	5	38.89%
OR: t (siww)	62.50%	10	6	25.00%	1	3	37.50%
OR: t (wf) -type	23.33%	7	23		Irrelevant		23.33%
OR: t (wf)	7.14%	9	117	0.00%	0	18	7.14%
OR: d (siww)	20.00%	3	12	0.00%	0	2	20.00%
d (wf)	0.00%	0	11	0.00%	0	7	0.00%
SE: k (wi)	13.64%	3	19	0.00%	0	4	13.64%
k (siww)	10.00%	1	9	0.00%	0	3	10.00%
k (wf)	0.00%	0	30	0.00%	0	12	0.00%
g (wi) - types	22.22%	2	7	25.00%	1	3	-2.78%
g (wi)	50.00%	7	7	50.00%	3	3	0.00%
g (siww)	0.00%	0	2	0.00%	0	3	0.00%
g (wf)	0.00%	0	8	0.00%	0	5	0.00%
f (wi)	100.00%	17	0	80.00%	8	2	20.00%
f (siww)	40.00%	2	3	0.00%	0	1	40.00%
M: f (wf)	66.67%	6	3	0.00%	0	4	66.67%
v (siww)	33.33%	3	6		No examples		33.33%
v (wf)	50.00%	2	2	0.00%	0	7	50.00%
θ (wi)	0.00%	0	1		No examples		0.00%
θ (siww)	0.00%	0	2		No examples		0.00%
θ (wf(ʰ)	50.00%	1	1	0.00%	0	1	50.00%
ð (wi)	7.69%	5	60	0.00%	0	11	7.69%
ð (siww)	0.00%	0	3	0.00%	0	1	0.00%
ð (wf)		No examples			No examples		0.00%
SE: s (wi)	0.00%	0	25	0.00%	0	3	0.00%
s (siww)	0.00%	0	8	0.00%	0	5	0.00%
s (wf)	6.82%	3	41	0.00%	0	5	6.82%
z (wi)	33.33%	1	2	0.00%	0	2	33.33%
z (siww)	0.00%	0	2		No examples		0.00%
z (wf)	0.00%	0	24	0.00%	0	2	0.00%
ʃ (wi)	0.00%	0	4	0.00%	0	5	0.00%
ʃ (siww)	0.00%	0	3		No examples		0.00%
ʃ (wf)	0.00%	0	10	0.00%	0	3	0.00%

Table 6.1. Continued

CATEGORY	% MATCH BL. 1	MATCH BL. 1	NONMAT BL. 1	% MATCH ASSESSMENT	MATCH ASSESSMENT	NONMAT ASSESSMENT	% Difference BL. 1-ASMT
ʤ (wi)	0.00%	0	5	0.00%	0	1	0.00%
ʤ (siww)	0.00%	0	2		No examples		0.00%
ʤ (wf)	0.00%	0	3		No examples		0.00%
tʃ (wi)	0.00%	0	5	0.00%	0	4	0.00%
tʃ (siww)	0.00%	0	1		No examples		0.00%
tʃ (wf)	0.00%	0	3	0.00%	0	1	0.00%
CC (wi)	1.67%	1	59	0.00%	0	14	1.67%
(C)CC>C/CC*	61.29%	38 +	24	42.86%	6	8	18.43%
CC (wf)**	13.16%	5	33	0.00%	0	12	13.16%
h (wi)	90.91%	40	4	100.00%	15	0	-9.09%
l (wi)	95.65%	22	1	76.92%	10	3	18.73%
l (siww)	14.29%	1	6	0.00%	0	3	14.29%
b (wi)	100.00%	48	0	80.00%	8	2	20.00%
r - all	0.00%	0		0.00%	0		0.00%

*Not glottal or [h]

**No liquid clus.

+13/38=/br/ clusters

APPENDIX 4. Table 6.2.--S6: Proportional match data: Block 2							
CATEGORY	% MATCH BL. 2	MATCH BL. 2	NONMATCH BL. 2				% Difference BL 2 - BL 1
SIWW C: No clus	53.49%	69	60				16.19%
IWW C SLOT: No LI	73.64%	95	34				26.82%
WF C: No clus, liq	44.12%	105	133				17.67%
WF C SLOT: No LN	75.21%	179	59				45.50%
m (siww)	83.33%	5	1				0.00%
m (wf)	100.00%	13	0				14.29%
n (siww)	80.00%	4	1				-3.33%
n (wf)	100.00%	17	0				16.22%
ŋ (all)	8.16%	4	45	√ in cluster only			8.16%
p (wi)	9.09%	2	20				-4.55%
p (siww)	100.00%	10	0				40.00%
p (wf)	100.00%	8	0				61.54%
b (siww)	87.50%	7	1				9.72%
b (wf)	0.00%	0	1				0.00%
t (wi)-types	62.50%	10	6				20.83%
t (wi)	62.50%	15	9				6.94%
t (siww)	56.25%	9	7				-6.25%
t (wf)-ty.	56.52%	13	10				33.19%
t (wf)	42.05%	37	51				34.90%
d (siww)	37.50%	6	10				17.50%
d (wf)	56.25%	9	7	SE: k (wi)√			56.25%
SE: k (wi)	13.79%	4	25	cowboy-PR SE√		+	0.16%
SY: M: k (wi)	32.43%	12	25	can-E-2√	cat-E√	++	18.64%
SE: M: k(siww)	57.14%	4	3	One error - can>[ank		+	47.14%
SY:M: k (siww)	100.00%	10	0			++	42.86%
MINIPROBE:k(wf	77.78%	7	2			+	77.78%
k (wf)	69.23%	18	8			++	-8.55%
MINIPR. #kC>k	25.00%	2	6	#kw only > [k],			25.00%
#kC > k	75.00%	6	2	(others glottal)			50.00%
SE: g (wi)	0.00%	0	13		Types: no gum	+	-22.22%
SY: OR: g (wi)-ty	9.09%	1	10		(1 gum)	++	9.09%
SY: OR: g (wi)	16.67%	2	10			++	16.67%
MINIPR: g (siww)	66.67%	4	2			+	66.67%
g (siww)	40.00%	2	3			++	-26.67%
MINIPR: g (wf)	50.00%	5	5			+	50.00%
g (wf)	50.00%	4	4			++	0.00%
f (siww)	75.00%	3	1				35.00%
f (wf)	50.00%	1	1				-16.67%
v (siww)	25.00%	1	3				-8.33%
v (wf)	58.33%	7	5				8.33%
θ (wi)	0.00%	0	1				0.00%
θ (siww)	66.67%	2	1				66.67%
θ (wf)	100.00%	4	0				50.00%
ð (wi)	24.32%	9	28				16.63%
ð (siww)	No examples						0.00%
ð (wf)	0.00%	0	1				0.00%

Table 6.2.--Continued

CATEGORY	% MATCH BL. 2	MATCH BL. 2	NONMATCH BL. 2		% Difference BL 2 - BL 1
SE: s (wi)	4.17%	1	23		4.17%
SE:PLACE N s-wi	22.73%	5	17		22.73%
s (siww)	0.00%	0	8		0.00%
SE: s (wf)	0.00%	0	15		-6.82%
SE:PLACE N s-wf	86.67%	13	2	BL1 - 4/44=9.09%	77.58%
SE: z (wi)	0.00%	0	1		-33.33%
SE:PLACE N z-wi	100.00%	1	0		66.67%
z (siww)	0.00%	0	5		0.00%
z (wf)	0.00%	0	11		0.00%
ʃ (wi)	0.00%	0	2		0.00%
ʃ (siww)	0.00%	0	3		0.00%
ʃ (wf)	75.00%	6	2		75.00%
ʤ (wi)	0.00%	0	9		0.00%
ʤ (siww)	0.00%	0	2		0.00%
ʤ (wf)	0.00%	0	3		0.00%
tʃ (wi)	0.00%	0	2		0.00%
tʃ (siww)	100.00%	2	0		100.00%
tʃ (wf)	0.00%	0	2		0.00%
CC (wi)	6.00%	3	47		4.33%
M: fl>CC	20.00%	1	4		20.00%
OR: bl>CC	25.00%	1	3		25.00%
(C)CC>C/C*	84.00%	42	8		22.71%
CC (wf)**	57.78%	26	19		44.62%
h (wi)	94.87%	37	2		3.96%
l (wi)	94.44%	17	1		-1.21%
l (siww)	28.57%	2	5		14.29%
l (sf)	8.33%	1	11		8.33%
r - all	0.00%	0	42		0.00%

*Not glottal or [h]

**No liq. clus.

+Difference between BL 1 major probe - Block 2 Miniprobe

++Difference between Bl 2 Miniprobe - BL 2 major probe

APPENDIX 5

SAMPLES OF MAJOR PROBE TRANSCRIPTIONS*

*Approximately 20% of the major probe data is presented for each subject. The entire data set is available conditionally from the author.

APPENDIX 5

SAMPLES OF MAJOR PROBE TRANSCRIPTIONS

General Coding

1. All adult IPA forms are phonemic, with exceptions made in the case of inflectional morphology and [ŋ], in which the phonetic forms are given in most cases. All child forms are phonetic. Offglides from [i] and [u] are disregarded in the syllable shape encoding, although they may be indications of tenseness, and hence, length.

2. The adult forms include the orthographic target, the phonemic target, and the word shape in terms of consonants, vowels and syllable boundaries.

3. In addition to the transcription and the word shape for the child, the utterance is identified by its Revox tape counter number.

4. Unless designated by the following codes, utterances were spontaneous single words:

S: Spontaneous
E: Echoic
DE: Delayed echoic (intervening utterance between the adult and child word)
SE: Self-echoic
DSE: Delayed self-echoic (intervening utterance between the adult and child word)
C: Connected speech
PR: Prompted for correct production

5. From the second to the fourth probe dates, two codes relate to changes in the child forms. If no change occurs, the Revox tape number plus NC (no change) are included. If a significant change occurs, the utterance is marked with an asterisk beside the counter number. Vowel variations between /ɑ/ and /ɔ/ and /æ/ and /a/ as well as variations in transitional gliding or relative vowel position (< or > or height) are disregarded in most cases. Many of these vowel variations are within the range of transcription error.

6. Variations from IPA necessitated by lacks in the available fonts are:

[ɚ] for both stressed and unstressed variants
[T], [D], [S], [Z], [L], and [N] for dental (or interdental) alveolar consonants
[ˇ] for a "pop" release on an unaspirated stop or lowering on a vowel
GF for glottal fry
Subscript [w] = rounding on previous consonant
Superscript [w] = trace of glide following consonant
Subscript "v" prior to a consonant = prevoicing.

7. Because of the tendency for VV to appear as a W in printing, a space has been inserted between the V's. A space also appears around the length marker, for printing clarity, i.e.,
[o ː pən]

Subject 1

AGE:	5;10	6:0	6;2	6;4

N.B. For this subject, a tongue thrust during speech results in a [θ/ð] transcription for interdental sibilants. Occasionally, this sibilant was produced with stridency, particularly in single words, or was a combination of [S-θ] as the tongue passed through the alveodental to interdental position. This is not noted in the transcriptions below.

Adult Forms

Vowel initial

icecubes	443 - E	393*		
ʌɪs#kjub+z	ʌɪθkub$_o$θ	ʌɪθkjubð		
V VC#C^{C}VC +C	V VC.CVCC	V VC.C^{C}VCC		
itchy	1198 - E	362	392 - E	790*
ɪʧ+i	ɪTθiʲə			ɪʧɪʲ
VC^C+V	VC^{C}V.^{cv}	NC	NC	V.C^{C}V

/m/

mouth	1032	332	58 - T. 2	649
mʌuθ	mʌuf			
CV VC	CV VC	NC	NC	NC
musician				238, 239- E
mjuzɪʃəŋ				mjudɪʃə̃n
C^{C}V.CV.CVC				C^{C}V.CV.CVC
musician				240 - SE
				mjumɪʃə̃n
				C^{C}V.CV.CVC
"musicwriting"	707	540*		
mjusik#rʌitiŋ	muðɪkwʌiɾin	myðikwʌɪɾĩn		
C^{C}V.CVC#	CV.CVC.	CV.CVC.		
CV VCVC	CV V.CVC	CV V:.CVC		

/n/

noisy	948	727	1224	428
nɔɪz+i	nɔɪðiʲə			nɔɪʒ ː iʲ
CV VC+V	CV V.CV.^{cv}	NC	NC	CV V.C:V

/p/

pages		717		842*
pɛɪʤ+əz		$p^hɛɪd^ðɛð$		$p^hɛɪʤɛ^əð$
CV VC^C+VC		CV V.C^{C}VC		CVV.C^{C}V^{V}C
pig	648	442 - C	1048*	274 - S 277 - E, C*
pɪg	bɪg	pɾg	$p^hɪg$	
CVC	CVC	NC	CVC	CVC
plum	627	483	479 - T. 2	592, 593 - C*
plʌm	pɹʌm	pwɑ̃m	pəlɑ̃m	plɑ̃m
CCVC	CVC	CCVC	C^V.CVC	CCVC

/b/

ball	1151	152 - C	1076, 1165- C	387 - C
bɑl	bɑʊ		bɑ^ə	bɔː
CV/l/	CV V	NC	CV^V	CV:
balla				391 - C
bɑlə				bɔləː
CV.CV				CV.CV:
black	863	97*	387 - T. 2 - C*	1 - C*
blæk	bɹæk	bwæk^h	b^{ʊ}læk	blæk
CCVC	CVC	CCVC	C^V.CVC	CCVC
bread	391 - C		346 - T. 2	566
brɛd	bwʌd^ə		b^{ʊ}wɛ^{ə}d	
CCVC	CCV.C^v		C^V.CV^{V}C	NC
bread			350 - T. 2 - E*	
			b^{ʊ}ɰ̣ɛd	
			C^V.C2VC	
brush	545	574*	1068*	
brʌʃ	vwʌθ	bwʌθ	b^{ʊ}wʌʃ	
CCVC	CCVC	CCVC	C^V.CVC	
brushing	640 - C	405 - C*		
brʌʃ+ɪŋ	bʌθɪn	bwʌθ̃ɪn		
CCVC+VC	CV.CVC	CCV.CVC		

/t/

teeth	1045	334	55 - T. 2*	652*
tiθ	^{T}θiθ	θif	$t^hiθ$	t^hi^Is
CVC	^{C}CVC	CVC	CVC	CVC

teeth		405 - C θiθ CVC	245, 247 - T. 2 t^{h}if CVC (x 3, C)	
toothbrush tuθ+brʌʃ CVC+CCVC	638 ʈuθbɑᵊθ CVC.CVᵛC	401* ʈθuθbwɔᵊθ ᶜCVC.CCVᵛC	251 - T. 2 - DE* t^{h}uθb^{ʊ}wʌθ CVC.Cᵛ.CVC	715 - C NC
toothbrush			258 - T. 2 - DE* t^{h}uθb^{ʊ}wʌʃ CVC.Cᵛ.CVC	716 - DSE, PR, C NC
trailer trɛɪlə˞ CCV V.CV/r/	672 - C vwɛɪjɔ CCV V.CV			
train trɛɪn CCV VC	988 dəwɛ̃inᵊ CV.CV V.Cᵛ			
Transformer trænzfɔrmə˞ CCVCC.CV/r/.CV/r/			331 - T. 2 - C twænðfɔmə CCVCC.CV.CV	
treasure trɛʒə˞ CCV.CV/r/				492 t^{h}əwɛʤɔᵊ CV.CV.C^{C}Vᵛ
truck trʌk CCVC	668 fwʌk˞ CCVC	437* dowʌk^{h} CV.CVC	1057* d^{ʊ}wʌk^{h} Cᵛ.CVC	715 - C* t^{hʊ}wʌk Cᵛ.CVC
twelve twɛlv CCV/l/C		570 - C fwɛʊv CCV VC		
twenty twɛnti CCVC.CV	905 - C fwɛntiᴵ CCVC.CV	490 - C NC		
twenty	905 - SE,C fwʌ<nɾi CCVC.CV			
twenty	88 (X6, S, SE) wɛ̃nʈiᴵ CVC.CV			
twin twɪn CCVC		10 - C* dəwĩn CV.CVC		

twins		16, 809 -C*		
twɪn+z		tᵊw{ɛ/ɪ}nð		
CCVC+C		Cᵛ.CVCC		

/d/

dressed	1159		460 - T. 2*	
drɛs+t	vwʌθT		dʊwɛʃtʰ	
CCVC+C	CCVCC		CV.CVCC	

/k/

calling		731	1183*	107 - C
kal+ɪŋ		kʰɔːjɛ̃n	kʰɑːlĩn	
CV/l/+VC		CV:.CVC	CV:.CVC	NC
clay	239 - C (X2)			
klɛɪ	kɛɪ			
CCVC	CV V			
clock			256 - T. 2 - DE*	603, 605 - C
klɑk			kᵘlɔkʰ	
CCVC			Cᵛ.CVC	NC
crayon	826	71	226 - T. 2 - C*	
krɛɪjɑn	kəwɛɪjɔ̃n	kɛwɛ̃n	kᵘwɛɪjɑ̃n	
CCV V.CVC	CV.CV V.CV ᵛC	CV.CVC	Cᵛ.CV V.CVC	
crayon	829 - DSE	72 - SE*	226*	
	kɛɪwɑ̃n	kwɛwɛ̃n	kwɛɪjɑn	
	CV V.CVC	CCV.CVC	CCV V.CVC	
crayons	854 - C	73 - PR		
krɛɪjɑn+z	fwɛɪjɔ̃nð	θkwɛwənð		
CCV V.CVC+C	CCV V.CVCC	CCCV.CVCC		
"Q"		771 - C		
kju		kju		
CᶜCV		CᶜCV		
quarter	1141	282	366 - T. 2	
kwɔrtə˞	kʷɔɾoʊː	kʰɔᵊdɔᵊ		
CCV/ɾ/.CV/ɾ/	CV.CV V:	CVᵛ.CVᵛ	NC	
quarter			371 - T. 2 - PR*	
			kʰwɔɪdɔᵊ	
			CCV VCVᵛ	
queen		503	575 - T. 2 - C*	
kwin		kᵊwːĩːn	kwĩn	
CCVC		Cᵛ.C:V:C	CCVC	

quiet	1134 - C	132*		
kwɑijət	fwɑijɛt	kᵊwɑɪjɛt		
CCV V.CVC	CCV V.CVC	Cᵛ.CV V.CVC		
quiet	1134 - C,SE			
	waijət			
	CV V.CVC			

/g/

glove	566	144 - C*	1022, 1023 - C*	
	446 - C			
			596 (x 3), 598	
glʌv	vwʌbᵊ	gᴵjʌv	gᵊlʌv	
CCVC	CCVCᵛ	Cᵛ.CVC	Cᵛ.CVC	NC
glove		179 - C*		
		gʌv		
		CVC		
grey	610			
grɛɪ	gəwɛɪjᵊ			
CCV V	CV.CV Vᵛ			
grin			58 - T. 2 - C	
grɪn			gᵊwĩn	
CCVC			Cᵛ.CVC	
gross		814		
grɔʊs		gʊwoθ		
CCV VC		CV.CVC		

/f/

father	1105 - C	608 - C*		909 - E, C
fɑðəɹ	fadoʊ	faðoʊ		
CV.CV/ɪ/	CV.CV V	CV.CV V		NC
feather	859	245	218 - T. 2 - C	484
fɛðəɹ	fadɔːᵊ	fɛdʊ	fʌdoʊ	fʌdɑᵊ
CV.CV/ɪ/	CV.CVːᵛ	CV.CV	CV.CV V	CV.CVᵛ
fish	388	342	1079*	521*
fɪʃ	fɪθ		fɪ^ʃ	fɪç
CVC	CVC	NC	CVC	CVC
fishing	386	587	1078*	521
fɪʃ+ɪŋ	fɪθĩn	fɪθʔɛ̃n	fɪʃː ɪᵊn	fɪʃĩn
CVC+VC	CV.CVC	CVC.?VC	CVC:. VᵛC	CV.CVC

flower flauwə˞ CCV.CV/ɾ/	793 fawɔᵊ CV.CVᵛ	553 fæwɔᵊ CV.CVᵛ	1080* fᵊlawɔᵊ Cᵛ.CV.CVᵛ	544 NC
friends frɛnd+z CCVCC+C	1123 fwẽndð CCVCCC			866 - C, E NC
frogs frɑg+z CCVC+C		47 - C fɾ ɑᵊgθ C:VᵛCC		
from frʌm CCVC		506 - C fʷʌ̃m CᶜVC		896 - E, C NC
front frʌnt CCVCC	550 - C fʌᵊnt CVᵛCC			
/v/				
van væn CVC	492 - C væ̃n CVC			783* væ̃ŋ CVC
/θ/				
thin θɪn CVC		219 - C fɪn CVC		
thing θɪŋ CVC	438 θĩŋ CVC			
think θɪŋk CVCC				289 - C θɪŋk CVCC
three θri CCV	775 fwiᴵ CCV	99 (x2) NC	321 fʊwiː CV.CV:	396, 541 NC
throw θroʊ CCV V			413 - T. 2 - C fᵘwo Cᵛ.CV	448 - C* fwɔ CCV
thumb θʌm CVC	624 fʌ̃m CVC	482 fʌᵊm CV VC	420 - T. 2 fʌ̃m CVC	384 * sʌ̃m CVC

/ð/

that	973 - C	5, 10,16 - C	257, 687 - T. 2 - C	812 - C
ðæt CVC	Dæt CVC	Dæt CVC	Dæt CVC	
that			1023, 1052, 1072, 1165, 252 - T. 2, 277, 521, 635 - C	777 - C 939 - E, C
			dæt CVC	dæt
that		5, 10, 16		587-S,C, 936-E, C
		ðæt CVC		ðæt CVC

/s/

screwdriver	838	274	1059*	1212
skrudraɪvə˞ CCV.CCV V. CV/ɾ/	fuvʷaɪvɔᵊ CV.Cᶜv V.CVᵛ	fuvwaɪvʷaᵊ CV.CCV V. CᶜVᵛ	tᵘwudwaɪvɔᵊ Cᵛ·CV.CCV V. CVᵛ	tʰᵘwudᵘwaɪvʊ Cᵛ·CV.Cᵛ.CV V. CV
screwdriver			1063* Stᵊwudᵘwaɪvə CCᵛ.CV.Cᵛ. CV V.CV	1214 - E* Skᵊwuðᵘwaɪvʊ CCᵛ.CV.Cᵛ.CV V.CV
see ("C")	553, 1113 - C	256, 263, 289,* 291 - C	25 - T. 2 - C 100 - T. 2 - C	175, 179 - C
si CV	ᵀθi ᶜCV	θi CV	NC	NC
sewing machine sowɪŋ#məʃin CV.CVC#CV. CVC	760 θowĩnməθĩn CV.CVC.CV. CVC	590 (2) NC	1101* θowĩnməʃĩn CV.CVC.CV. CVC	540 θoᵊnməʃin CVᵛC.CV.CVC
sleep slip CCVC	722 fwip CCVC	584* ljip CCVC	1114* θəlip CV̇.C̣VC	673* Səlip CV.CVC
sleeping slip+ɪŋ CCVC+VC	350 fʷipĩn CᶜV.CVC	583* θəjipɛᵊ̃n CV.CV.CVᵛC	1113* θəlipʰɛ̃n CV.CV.CVC	673 θəlipʔĩn CV.CVC.ʔVC
smooth smuð CCVC	1171 mu:v CV:C	824* θmuv CCVC	397* Smu : v CCV:C	

snake	667	629 - C	1130*	570
snɛɪk	θnːɛɪk	θnɛɪk^{h}	Snɛɪk^{h}	
CCV VC	CC:V VC	CCV VC	CCV VC	NC
snowing	412	586*	1090*	
snow+ɪŋ	nowẽn	θno ː wĩn	Snowẽn	
CCVC+VC	CV.CVC	CCV:.CVC	CCV.CVC	
spoon	794	86*	163 - T. 2 - E 158, 160 - C*	
spun	pumᵊ	θɸỹ ː m	θpũm	
CCVC	CVC^{v}	CCV: C	CCVC	
spring	683	256	3643 - T. 2*	725*
sprɪŋ	vwĩŋ	pwẽŋ	Stᵊwĩŋ	Spʊwĩŋ
CCCVC	CCVC	CCVC	CC^{V}.CVC	CCV.CVC
star	816	426, 429 (DE)	373, 376 - T. 2	
star	θau^{wə}	θa ː ʊ		
CCV/r/	CV V.^{CV}	CV: V	NC	
star			378 - E, 383 - PR*	1214
			Stau	
			CCV V	NC
string	798	245, 254, 257*	1164	400*
strɪŋ	fwĩŋ	t^{ʊ}wẽŋ		θʊwĩŋ
CCCVC	CCVC	C^{V}.CVC	NC	CV.CVC
string		231 - C	1165*	
		f ː wɛ^ŋ	Stʊwẽŋ	
		C:CVC	CC^{V}.CVC	
sweater	433		132 - T. 2*	1217
swɛtə˞	fwʌdɔ		t^{hʊ}wɛrɔʔ	θʊwɛdɔᵊ
CCV.CV/r/	CCV.CV		C^{V}.CV.CV	CV.CV.CV^{V}
/z/				
zoo	945	721	1222	421*
zu	ðu^{wə}			zu^{wə}
CV	CV.^{cv}	NC	NC	CV.^{cv}
/ʃ/				
shoe	633		118 - T. 2*	823*
ʃu	θu ː		ʃu ː	ʧu ː
CV	CV:		CV:	CV:

/ʧ/

chair ʧɛr $C^{C}V/r/$	809 - C θɛɔ CV^{V}	75 θɛːᵘ $CV:^{V}$	198 - T. 2* ʃɛᵘ CV^{V}	714 - C NC
chair			199 - T. 2 - E* ʧɛɔʔ $C^{C}V^{V}$	715 - DSE, PR, C ʧɛᵘ $C^{C}V^{V}$
church ʧəˑʧ $C^{C}V/r/C^{C}$	1007 ᴛθ ɔəᴛθ $C^{C}V^{V}C^{C}$	737 θɔəᴛθ $CV^{V}C^{C}$	437 - S* ʧɔəᴛθ $C^{C}V^{V}C^{C}$	120* ʤɔəʃ $C^{C}V^{V}C$
church			437 - SE* ʧɔəʧ $C^{C}V^{V}C^{C}$	122 - DSE ʧɔəʔʃ $C^{C}V^{V}C_{C}$

/ʤ/

"G" ʤi $C^{C}V$	954 θiᴵː CV:	742 - S, 769 - C NC	1190 - DE* ʤi $C^{C}V$	140 NC
jump ʤʌmp $C^{C}VCC$	1028 - SE ðɐ̃mp CVCC	318 NC	25 - T. 2 - S, C ʤɐ̃mp $C^{C}VCC$	642 NC

/r/

roar rɔr CVC	997 wɔː CV:	755 wɔə CV^{V}	1209 NC	776, 779 - E NC
roar				777 - E, PR* rːɔə $C:V^{V}$

/l/

laugh læf CVC	937 jæf CVC	762* læːəf $CV:^{V}C$	390 - T. 2* lːæf C:VC	212* læəf $CV^{V}C$
laughing læf+ɪŋ CVC+VC	935 jæfẽn CV.CVC	760 ᵘlæːfɪn ^{V}.CV:.CVC		202* læːfɪə̃n CV:.$CV^{V}C$

like	631, 938, 971 - C	16, 33, 121 - C	201 - T.2 - C*	
lʌɪk CV VC	jʌɪk CV VC	NC	lʌɪk CVC	
Lyle	1188 - E	751 - E*	1208*	215 - E
laɪjəl CV V.CV/l/	ljaɪjɔ $C^{C}V$ V.CV	ʊlaɪjɔᵊ ^{V}.CV V.CV^{V}	lː aɪjɔ C:V V.^{CV}	laɪjoʊ CV V.CV V
/w/				
watch	805	653, 658 - C	257 - T. 2 - C	
watʃ CVC^{C}	wɔTθ CVC^{C}	NC	waTθ CVC^{C}	
watch		78	260 - T. 2 - E*	
		waᵊTθ CV $^{V}C^{C}$	watʃ CVC^{C}	
/j/				
yellow	827	94	224 - T. 2 - S*	418 - C
			226 - T. 2 - C	
jɛloʊ CV.CV V	jɛjɔʊ CV.CV V	NC	jɛ ː loʊ CV:.CV V	jɛloʊ CV.CV V
yellow		812*		
		ljʌɪjoʊ $C^{C}V$ V.CV V		
/h/				
hair	1063	324	47 - T. 2 - C*	508 - C
hɛr CV/r/	ʔɛjɔ CV.CV	ʔɛᴼ^ CV^{V}	hɛᵊ CV^{V}	hɛɔ CV V
hanger	423	224	1044	1217*
hæŋəˠ CVCV/r/	ʔãŋoᵊ CVC.V^{V}	ʔæŋõʊ CVC.V V	ʔãŋɔᵊ CVC.V^{V}	hæ̃ŋɔᵊ CVC.V^{V}

Subject 2

AGE:	4;2 2 sessions 3 days apart: 2nd Tape 1, 1099 ff.	4;4	4;6 (slightly denasal)	4;9

N.B. All utterances marked as 'oral mech.' were echoic.

Adult forms

Vowel Initial:

egg	977, 978 (DSE)	957	153, 159 (PR DSE);917	
ɛg	ɛ$^{(ɪ)}$d	ɛ ː d		
VC	V$^{(v)}$C	V: C	NC	
egg			161 - PR E*	521*
			a ː $^{ɪ}g_o{}^h$	$ɛg_o$
			V:^{v}C	VC
itch		273 - T. 2 - C		939
ɪʧ		iᵊtθ		ʌ<tθ
VC^{C}		V^{v}C^{C}		VC^{C}
itchy	1076 - C, E	275 - T. 2*	942*	938
ɪʧ+i	it?i?	ɪT?i	ɪ?i·	ɪtθ?i·
VC^{C}+V	VC?V?	VC?V	V?V:	VC^{C}?.V·
/m/				
mouth	1074 - E	834	48 - E*	
mʌʊθ	mʌʊ?	maʊ⟨t⟩	mʌʊf	
CV VC	CV V?	CV V<C>	CV VC	
mouth		835 - PR SE*		
		maʊθ		
		CV VC		
music	1180 - E	990 - E*	284 - E*	533*
mjuzɪk	mᵊjudɛᵊ?	mᵊju^{d}ðɛ?	mʲjõ^{ʊ}ðɪᵊ?	mʲuza?
C^{C}V.CVC	C^{v}.CV.CV^{v}?	C^{v}.CV.^{C}CV?	C^{C}V.CV^{v}?	C^{C}V.CV?
/n/				
noisy	1125(DE)	239 - T. 2*	679 - E (GF)*	
nɔɪz+i	nɔɪɾi	nʌɪðɪ ː ʒː ː	nɔɪdɾ^{i}?	
CV VC+V	CV V.CV	CV V.CV: C::	CV V.CV?	

/p/

page	1186	197*	685 - E*	479 - C; 883*
pɛɪʤ	pɛɪd3_o	pɛ>$ɪ_v$ts ː	pɛɪdð$_o$	pɛɪd(ð)
CV VC^C	CV VC^c	CV VC^{C}ː	CV V.C^C	CV VC$^{(c)}$
piggy	716 - C, E; 719 - C, DSE	1148 - C, E*	495 - E*	749 - E;750(DSE)
pɪg+i	pɪdi	p^{h}ɪ^di	p^{h}ɪgɪ^i	
CVC+V	CV.CV	CV.CV	CV.CV	NC

/b/

bathtub	1163	144 - T. 2*	272*	844
bæθ#tʌb	b^{w}æ ^{l} tʌb	bæθtʌd^ə_o	bæftʌ^{ə}b	bi̯ɛ˘θʔtʌb
CVC#CVC	C^{c}V^c.CVC	CVC.CVC^v	CVC.CV^{v}C	C^{c}VCʔ.CVC
beef	(oral mech)	1149		
bif	biθ(open θ)	biθ		
CVC	CV<C>	CVC		
black	807,1172 - C	26 , 30(DE)-140 (E), T. 2	489	804
blæk	bəl{ɑ/æ}ʔ	b{ɛ/ə(2)} l{a(2)/æ<}ʔ	bəlæʔ	bəlæ ː ^{ə}
CCVC	CV.CVʔ	CV.CVʔ	CV.CVʔ	CV.CV : ^{v}
black				806 bəlæk^h CV.CVC
boots	1162	1024*	245*	345
but+s	but^s>	bu ː ts	butθ	⟨but⟩
CVC+C	CVC^c	CV :CC	CVCC	<CVC>
brush			743 - C	414*
brʌʃ			bɣwʌθ	bwʌ^{ə}θ
CCVC			CV.CVC	CCV^{v}C
brushing	807 - C			417*
brʌʃ+ɪŋ	bʌfĩ⟨n/ŋ⟩			bʊwʌθĭn
CCVC+VC	CV.CVC			CV.CV.CVC
buzzing	1197 - E	371 - T. 2 - C	558*	375*
bʌz+ɪŋ	bʌfĩ⟨ŋ/n⟩	bʌđĭn	bʌðĭn	bʌz̆ĭn
CVC+VC	CV.CVC	CV.CVC	CV.CVC	CV.CVC

/t/

take	715 - C	1071 - C	749, 781 - C	756
tɛɪk	tɛɪʔ			tɛɪk
CV VC	CV Vʔ	NC	NC	CV VC

teeth	688 - C	838	51*	616*
tiθ	$t^hiθ$		t^hif	$t^hiθ$
CVC	CV^C	NC	CVC	CVC
toothbrush	638	842*	754*	863
tuθ+brʌʃ	$t^huɸbʌθ$	$t^hu^θbʌ^əθ$	tuθbʊwʌθ	
CVC+CCVC	CVC.CVC	$CV^C.CV^vC$	CVC.CV.CVC	NC
toothbrush	687			
	$t^hu:bʌ^θ$			
	$CV:CV^C$			
truck	626			754*
trʌk	$Tʌ^əʔ$			$təwʌk^h$
CCVC	$CV^vʔ$			CV.CVC
try		1084 - C	474 - C*	673*
traɪ		$t^haɪ$	təwaɪ	$t^haɪ$
CCV V		CV V	CV.CV V	CV V
tub		146, 147- T. 2 E, DE		
tʌb		$t^hʌvɑ^ə$ (1=labiodent.stop)		
CVC		$CV.CV^v$		
tubby	1167 - C, E	155 - T. 2 - E*		905, 906(3)
tʌb+i	$T^hʌbi$	Tʌbi		t{ʌ/a}bi·(')
CVC+V	CV.CV	CV.CV		CV.CV·('-1)
T.V.	1143,1144-C	124 - T. 2	298, 299(DSE)	834 - C
	(DSE)		-C*	
tivi	t^hidi		$t^hi\{v/v^{(stop)}\}i:j^ə$	$t^hivi·$
CV.CV	CV.CV	NC	$CV.CV:^{cv}$	CV.CV·
/d/				
dive	1131	1098*	845; 847 - C	
daɪv	daɪd	daɪv		
CV VC	CV VC	CV VC	NC	
diving	1127	1094* (after swimming)	851 - E, C*	305*
daɪv+ɪŋ	daɪðɪŋ	s :daɪðĭn	daɪvĩn	$daɪv^wĩn$
CV VC+VC	CV V.CVC	C:CV V.CVC	CV V.CVC	$CV\ V.C^cVC$
diving		1096 - E*		
		daɪðɪn		
		CV V.CVC		

dollhouse	931	1194 - E*	827 - E	873 - E*
dɑl+hʌus CV/l/+CV VC	dɑᵘhʌʊ ˢ CVᵛ.CV Vᶜ	dɑᵘhʌʊtθ CVᵛ.CVᵛᶜᶜ	dɑ⟨ʊ/l⟩hʌʊ⟨ ⟩ CV<V/C>.CV V	dɑlhʌʊs CV[l].CV VC
dress drɛs CCVC	1221 - T. 2 - C ð j ʌθ CᶜVC	851 s·fɛᵊʔ C·CVᵛʔ		
dress	160 - C dɑS CVC	853 - DE f^ː ɛᵊʔ C:Vᵛʔ		
dress		906 - E dəwʌθ· CV.CVC·		566 - C dəwɑS CV.CVC ‿
dress		912 - C dɑθ CVC		

/k/

cagey	1126 - E	170(E), 172 -DSE - T. 2	597-E; 600 (DSE)*	222 - E*
kɛɪʤ+i CVVCᶜ+V	tʰɛɪdʔi CV VCʔV	tʰɛɪd(ɪʔ)i CV V.C(Vʔ)V	tʰɛɪᵈðɪⁱ CV V.ᶜCV	kʰɛɪdðiː₀ CV V.CᶜV:
candle kændəl CVC.CV/l/	942 Tæᵊndoʊ CVᵛC.CVᵛ	1019 tʰæ̃ndɑᵘ CVC.CVᵛ	162* ʤændʌʊ CCVC.CV V	262* kændʌʊ₀ CVC.CV V
coffee kɑfi CV.CV	1142 tʰɑhi CV.CV	1016 - E* tɑtʰi CV.CV	244* kɑfiʲᵊ CV.CV.ᶜᵛ	349 NC
cookie kʊki CV.CV	366 tʊᵊti CVᵛ.CV	55 - T. 2 - C* tʰɰᵊʔtʰi CVᵛʔ.CV	919 - E; 920-SE 920 - C, DSE* kʰ⁽⁻¹⁾ʊkiː CV.CV	
quarter kwɔrtə˞ CCV/r/.CV/r/	969 tʰɑᵊDɔʔ CVᵛ.CVʔ	1087* tʰɑɾɛᵊ CV.CVᵛ	883, 885(DSE) -E* kʰ⁾ɑdɛᵊ CV.CVᵛ	923 NC

/g/

glove glʌv CCVC	487, 497(DSE)-C dəlʌd CV.CVC (2)	1108<*> dəlʌ⟨bₒʰ⟩ CV.CVC	954* dəlʌvᵊ CV.CVCᵛ	880 - C* gɪlʌv-v CV.CVC-C

glovey glʌv+i CCVC+V	504 - E dəlʌbli? CV.CVC.CV	343 - T. 2 - E* dəlʌvi CV.CV.CV		
girls gəˑl+z CV/rl/+C			931 - E* gɪwɔ^ð CV.CVC	
gonna gʊnə CV.CV	677 - C dʊnə CV.CV		651 - C dʌnə CV.CV	678, 889 - C* gɪˀnə CV.CV
/f/				
feather fɛðəˑ CV.CV/r/	1075 hadɛᵊ CV.CVᵛ	1144 NC	177* fawɪᵘ˂ CV.CVᵛ	
fish fɪʃ CVC	807 çjɪᵊʔ ᶜCVᵛʔ	1088* hɪᵊθ CVᵛC	485* fɪᵗθ CVᶜC	287, 684* f{ɪᵊ/ʌ}θ CVᵛC
five faɪv CVVC	736 - C hʌɪd CV VC	1182 - PR E* faɪd CV VC	855 - E* faɪv CV VC	214 NC
flower flauwəˑ CCV.CV/r/		959 (2) l{a·ɑ·/ʌᵘ}wɛᵊ C{V.V./Vv}CVᵛ	787* flaʊjɔᵊ CCV V.CVᵛ	518* fˡaʊwɛᵊ ᶜCV V.CVᵛ
fly flaɪ CCV V	1084 laɪ CV V		354, 443 f(ᵊ)laɪ C(ᵛ).CV V	
fume	(oral mech) hju CCV			
/v/				
van væn CVC	908 - E hãn CVC	1003 - E* væᵊn CVᵛC	229 - E NC	850 NC
/θ/				
throw θroʊ CCVV	1158 - C wo CV	298 - T. 2 - C NC	645 - E; 978(C) woʊ CV V	497 - C* fwɔʊʔ CCV Vʔ

thumb	886	1064	77, 344(E);992(C)	
θʌm	hʌ$^{\tilde{ə}}$m			
CVC	CV^{v}C	NC (3)	NC	
thumb			83,495 - DE*	47, 624
			{⟨θ/f⟩/f}ʌ^{ə}m	fʌ$^{\tilde{ə}}$m
			CV^{v}C	CV^{v}C
/ð/				
that	677 - C	1119, 1171 - C	814, 816(2)-C*	307 - C, E*
ðæt	dæʔ		ðæʔ	dæ^{ə}
CVC	CVʔ	NC	CVʔ	CV
that	1150, 1166 1204, 1210 - T. 2 - C	1061 - C*	535, 959 - C	658(2), 746 825 - C
	w{æ/a-1}$^{(ə-1)}$t	v^{w}æt	{^{w}/v}æʔ	dæʔ
	CV$^{(v-1)}$C	C^{c}VC	CVʔ	CVʔ
that		1196 - C	168, 814, 961-C	659 - C*
		wa^{ə}ʔ	waʔ	Dæ^{ə}t
		CV^{v}ʔ	CVʔ	CV^{v}C
that		476, 503, 505 -T. 2 - C	644; 924, 975-C*	680 - C
		w{a/æ$^{-2}$}t	ðæ{ʔ/t^{-1}}	ðæʔ
		CVC	CVʔ	CVʔ
this	475 - C	1078*	482*	527 - C
ðɪs	hɪθ	hɪ^{ə}T^{h}	dʌθ	dɛ^^{ə}S
CVC	CVC	CV^{v}C	CVC	CV^{v}C
this	1187 - C	1118, 1148 - C	806 - C	497, 738 - C
	^{hj}ɪS	h(j)ɪθ	jɪθ	jɛ$^{(ə)}$θ
	^{cc}VC	C(C)VC	CVC	CV$^{(v)}$C
this		359 - T. 2 - C	846 - C	662, 697, 818-C
		hjɛ^θ	j$_{I}^{ə}$θ	hɪ(˘)^{ə}θ
		CCVC	^{c}V^{v}C	CV^{v}C
this			924, 997 - C	368, 553 - C
			h{ʌ/ɪ^{ə}}θ	hɪ$^{(ə)}$s
			CV^{v}C	CV$^{(v)}$C
this				674 - C
			ɪ^{ə}s	
			V^{v}C	

/s/

Santa Claus	1157 - PR DSE	1029 - E*	265 - PR SE*	404 - C*
sæntə+klɑz	hæ̃nTə Təlɑᵊ	hæ̃ntə təlɑᵊθʌ	Sæ̃ntə təlɑᵊð	sænkɑð- tə⟨t/k⟩lɑð
CVC.CV+CCVC	CVC.CV.CV. CVᵛ	CVC.CV CV.CVᵛC	CVC.CV CV CVᵛᶜ	CVC.CVC- CV.CCVC
scarf	1109 - E	976, 977(SE)*	802*	232, 238*
skɑrf	Tʰɑᵊ	tʰɑ(ʌ)ᵊf	Tɑᵊf	skɑ·ᵊf
CCV/r/C	CVᵛ	CVᵛC	CVᵛC	CCV·ᵛC
screwdriver	550	930 - DE*	766*	665 - C*
skrudraɪvə˞	Tudaɪrə	tʷʰuʔʰəₒ dɛwʌĩ ː dɛᵊ	təwᴵ ʊdʊwɑɪ vj̇ə	skɪ-tudəwɑɪ vɛᵊ
CCCV.CCVV. CV/r/	CV.CV V.CV	CVʔ.ᶜᵛ.CV. CV V: CVᵛ	CV.CᵛV.CV. CV V.CᶜV	CCV-CV.CV. CV V.CVᵛ
sewing machine	834 - E	284 - T. 2*	793*	267*
sowɪŋ#məʃin	howĩn məʔhĩn	hʌᵘbɛhj̃ĩn	sowĩn ⟨b/v⟩j̇aʔsĩn	sowĩn bəθĩn
CV.CVC#CV. CVC	CV.CVC.CV.ʔ CVC (whisper)	CVᵛ.CV.CCVC	CV.CVC CᶜVʔ.CVC	CV.CVC CV.CVC
sleeping	701 - SE	968*	65*	
slip+ɪŋ	lipʔin	hlipʔin	slipĩ̯n	
CCVC+VC	CVCʔ.VC	CCVCʔ.VC	CCV.CVC	
slipper(s)		1113 (sg)		630 (pl)*
slɪpə˞(+z)		lˑɪˇpΦᵘᵊ		θlɪpʔɛᵊð
CCV.CV/r/(+C)		CˑVCᶜVᵛ		CCVCʔVᵛC
smooth	1180 - E	189 - T. 2 - E*		899*
smuð	mut	ₒmudᵊₒ		smᵘuv
CCVC	CVC	ₒCVCᵛₒ		CCᵛVC
snake	1153 - E	940*	334	338
snɛɪk	nˑɛɪʔ	s ː ː nɛɪʔ	sˑnɛɪʔ	Sᵊnɛɪk
CCVVC	CˑVVʔ	C::CV Vʔ	CˑCV Vʔ	Cᵛ.CV VC
snake		947 - DSE*		
		n ː ɛɪʔ		
		C: V Vʔ		
snake		948 - PR SE*		
		s ː nlɑᵊ		
		C:CCVᵛ		
snake		949 - E*		
		nˑʌɪʔ		
		CˑV Vʔ		

snakey	1154 - E	944(E), 945(SE)*		338*
snɛɪk+i	n·ɛɪʔi	s·nɛɪʔi		snɛɪki·
CCV VC+V	C·V V?V	C·CV V?V		CCV V.CV·
spider		1060	355*	
spaɪdə·		$p·^{h}aɪdɛ^{ə}{}_{o}$	spaɪdɛ^{ə}	
CCV V.CV/r/		C·V V.CV$^{v}{}_{o}$	CCV V.CV^{v}	
spoon	635	1052*	194*	108, 779*
spun	pun>	p^{h}ʊæ̃ŋ ː	pɪ-spɪ^{ʊ}n	sp^{hl}ʊ(ː)n
CCVC	CVC	CVV^{v}C:	CV-CCV^{v}C	CC^{v}V):)C
spoon		1161 - C*		
		bʊ^{ʊ}n		
		CV^{v}C		
spring	954 - E	1079 - E*	470 - E*	24 - C
sprɪŋ	p^{h}ɪ̃n	p^{h}ɛwĩŋ (√)	Spʊ<wĩn	
CCCVC	CVC	CV.CVC	CCV.CVC	NC
star	693	892*	724, 746*	856
star	θɑ·ə	t^{h}ɑ^{ə}	{ST/st}ɑ^{ə}?	stɑ^{ə}
CCV/r/	CV·^{v}	CV^{v}	CCV^{v}?	CCV^{v}
string	520	51 - T. 2	522*	523*
strɪŋ	ðĩn	t^{h}ɛʊwĩ·ŋ·	Tˇɔwĩn	sʔtəwĩn
CCCVC	CVC	CV^{v}.CV·C·	CV.CVC	C?CV.CVC
string			538*	685*
			dəwi ː ː ɾ̃ n ː	stəwĩɳ
			CV.CV:::C:	CCV.CVC
sweater	448 - E	866 - E	121 - E*	576
swɛtə·	war·ɛ^{ə}	warɛ$^{ə}{}_{o}$	swɛrɪ^{ə}	
CCV.CV/r/	CVC.V^{v}	CV.CV$^{v}{}_{o}$	CCV.CV^{v}	NC

/z/

zipper	661	1123, 1124 - E*	670 - DE*	695 - E*
zɪpə·	hjɪpɛ^{ə}	jɪ($_{o}$)pʔɛ^{ə}	zʌ<bɪ^{ə}	zɪpʲɑ^{ə}
CVCV/r/	C^{c}V.CV^{v}	CV.Cʔ.V^{v}	CV.CV^{v}	CV.C^{c}V^{v}
zoo	1113 - E	230 - T. 2*	674*	508*
zu	hju	ʤ·u ː	zjuʷ^{ə}	zʲʊ ː
CV	CCV	C^{C}.V:	C^{c}V.^{cv}	CV^{v}V:
zoo		231 - T. 2 - SE*		
		z> ːu·		
		C:V·		

/ʃ/

sheep		1057 - E	366*	69 - E*
ʃip		hip⟨ʰ⟩	spip	Sip
CVC		CVC	CCVC	CVC
sheep			366 - E*	
			ʃ(blade)ip	
			CVC	
shoe	552		167, 705*	788
ʃu	hj_ou^u		sjᴵu(wə)	θjᴵu
CV	C^cV^v		CC^vV.(cv)	C^cV

/ʧ/

chicken	1103 - T. 2	1157	715 - E*	726, 728 (DSE)*
ʧɪkən	$T^hɪʔɛn$	$t^hɪʔi$: n'	$t^hɪt^hə̃n$	{tθ/t^h}ɪkɛə̃n
C^CV.CVC	CVʔ.VC	CVʔ.V:C	CV.CVC	C^CV.CV^vC

/ʤ/

"G"	1095	209, 212-T. 2-E*	580 - E (clenched teeth)	434 - E*
ʤi	$d_o{}^hi$	dɛwi (ː)	dəw iː	di·
C^CV	CV	CV.CV(:)	CV.CV:	CV·

/r/

roar	1208	325(E), 331* (DE) - T. 2 (GF)		451
rɔr	ᵊʁɑʁ	w(ː)ɑᵊ		wɑᵊ
CVC	ᵛ.CVC	C(:)V^v		CV^v
roar		326 - E*		
		rɑᵊᵕ		
		CV^{vv}		

/l/

laughing	1140		608 - E*	443*
læf+ɪŋ	lahɪn		læf(stop)ɪn	læfin
CVC+VC	CV.CVC		CV.CVC	CV.CVC
laughing			609 - C, DSE	
			læfin	
			CV.CVC	
leaf	1089 - T. 2	1139*	515*	783
lif	liʔ	l·i⟨f⟩(stop?)	lif	
CVC	CVʔ	C·VC	CVC	NC

/w/

wagon	1175	1180*	834*	269*
wægən	wædən	wɛɪD^{h}ɛ̃^{ə}n	wæ ɪdən	wægən
CV.CVC	CV.CVC	CV V.CV^{v}C	CV V.CVC	CV.CVC
watch	1106, 1107(DE) -C		299, 465- C	824;825 - C
watʃ	w{ɑ/ʌ}t^{θ}		watθ	
CVC^{C}	CVC^{C}		CVC^{C} (2)	NC
waving	996	848*		
wɛɪv+ɪŋ	wɛ̃ɪɾɾ⟨ʔ⟩(quiet)	wɛɪɗɪŋ		
CVVC+VC	CV V.CV<ʔ>	CV V.CVC		

/j/

yellow(y)	764	135-T. 2 (yellowy)		
jɛlou (wi)	halo	hʌlowi		
CV.CV V (CV)	CV.CV	CV.CV		
yellow		100 - T. 2 - C	481 - DE*	801 - C,E
		^{h}jɛlo	lʌlʌu	jɛlɔ
		^{c}CV.CV	CV.CV V	CV.CV

/h/

have	635, 646, 715 - C;T. 3 -44-C	1071, 1156, 273 - T. 2 - C	289, 295, 704 862, 936(for 'has') -C*	297 - C
hæv	hæ		hæ{v/v(stop-1)}	hæv
CVC	CV	NC	CVC	CVC
hanger	484 - E	908	695	819*
hæŋə˞	hæ^{ɹ} nʌu	hæn ː ɛ^{ə}	hænɪ^{u}	hæŋɟɑ^{ə}
CVCV/ɹ/	CV^{v}.CV^{v}	CVC:.V^{v}	CVC.V^{v}	CVC.^{c}V^{v}
hanger		911 - E		
		hæn>ɛ^{ə}		
		CVC.V^{v}		
hanging'		914 - E(low confid)	149 - C	274 - E
hæŋ+ɪŋ'		<hæŋ̃ɪŋ'>	hæŋ̃ɪŋ	
CVC+VC'		CVC.VC	CVC.VC	NC
hanging		912 - C		
		hæñ̃ɪn		
		CV.CVC		

Subject 3

AGE:	3:4	3:6	3:8	3:10
	3 sessions 4 days apart: 2nd Tape 1, 1067 ff.; 3rd = Tape 2, 480 ff.	2 sessions 2 days apart: 2nd Tape 2, 691 ff.	2 sessions 1 day apart: 2nd=Tape 2	2 sessions 2 days apart: 2nd=Tape 2

N.B. During the first probe, S3 frequently produced voiceless coronal sibilants in WF position. Whenever he produced WF [s] as a mismatch with the adult target, the word shape is designated with [s] rather than C, e.g., CVC > CVs.

Adult forms

Vowel Initial

all	497-T. 2-PR E	691-T. 2-PR E*	834 -T. 2-PR E	396-T. 2-E, C*
ɑl	ɑʊ	aˤʔ		al
V /l/	V V	V ^{v}(ʔ)	NC	VC
eating	1155 - PR E	1180 - E*	1021-T. 2-E*	1011- C*
it+ɪŋ	ĩhĩs$^{>}$	i^{n}t^{h}ɪn	it^{h}in	
VC+VC	Ṽ.CṼs	V^{c}.CVC	V.CVC	NC
egg	278 - T. 2	905 - T. 2*		748 - E*
ɛg	ɛ^{I}s	ɛ$_{V}$k^{h}		ɛɪ$_{V}$k^{h}
VC	V vs	VC		V VC
Ernie	75		26- E, 53*	646 - T. 2 -E
ɚni	ʊ̃^{w}i		ʊ̃ni^{ʔ}	
V/r/.CV	V.^{c}V		V.CV^{v}	NC
icecubes	443 - PR E	806-T. 2-PR E*	1061-T. 2-E*	610 - E*
ʌɪs#kjub+z	ʌ̃bɪs	ʌɪkup^{h}	ʌɪskjubz$_{o}$	a^{I}skjubz$_{o}$
V VC#C^{C}VC+C	V.CVs	VV.CVC	V VC.C^{C}VCC	V VC.C^{c}VCC
icecubes				627*
				ʌɪt^{s}kjub$_{o}$ts
				V VC^{C}.C^{c}VCCC
icy	445 - PR E	809-T. 2-PR E*	1060-T. 2-E, C*	630 - E, C
ʌɪs+i	ɪs$^{>}$	ɑɪt^{h}jiʔ	ʌɪsi	
V VC+V	Vs	V V.C^{c}V	V V.CV	NC
icy	1089 - PR E			
	əsʔɪs$^{>}$			
	VCʔVC			

itchy	772-T. 2-PR E	634-T. 2-C, E*	1144-T. 2-PR E*	483 - PR E*
ɪʧ+i	ɪᵊs	itˢ>iˈ	ʊtˢ>iː	ɪʧiː
VC^{C}+V	V^{v}C	V.C^{c}Vˈ	V.C^{C}V:	V.C^{C}V:
up	558 - PR DE 561 - DSE	1062	241	61 - T. 2 - C*
ʌp	ap		ɑᵊp	ʌp
VC	VC	NC	V^{v}C	VC
/m/				
mad	606 - S, 945 - C	754 - T. 2*		
mæd	mæ̃ᵊ	mæ̃nt^{h}		
CVC	CṼ^{v}	CVCC		
man	608 - DSE	121, 896, 234 T. 2	572	1048 - C
	mæ̃ᵊn			
	CV^{v}C	NC	NC	NC
man	612, 943 - S 702, 908 - C mæ̃ᵊ(ʔ) CV$^{\tilde{v}}$			
mask	627 - T. 2 - E, C	1011 - T. 2 - E	1156 - T. 2 - E*	847 - E*
mæsk	$_{v}$mɛs	mʌs	mʌks	mæks
CVCC	$_{v}$CVs	CVC	CVCC	CVCC
milk	72 - PR E	1026 - T. 2*		365, 366(SE) - T. 2
mɪlk	ɲʌs	$_{v}$ŋʌk^{h}		$_{v}$nɑk^{h}
CV/l/C	CVs	$_{v}$CVC		$_{v}$CVC
milk	106 - PR E			373 - PR E* (mI: : k)
	ɲ^{m}ãᵊs			miː ː k
	C^{C}V^{v}C			CV:: k
mommy	759 - DE	1046, 1183, 1176 - T. 2 - C		
	mʌmi			
	CV.CV	NC		
money	524 - S 525 - E	288, 870 - T. 2*		590 - E
mʌni	mʌɪ	mʌniː		
CV.CV	CV V	CV.CV		NC

monkey	582 - PR E			
mʌŋkɪ	mãŋ.ɾɪs			
CVC.CV	CVC.CVC			
monkey	583 - SE			
	mãɪ			
	C$\tilde{V}$ V			
more	612, 892 - DSE 892 - C	1114 - C		
	mɔ̃	mɔ		
	C$\tilde{V}$	CV		
music	287 -T. 2 - E	980 - T. 2 - E*	1120 - T. 2 - E*	851 - DE
mjusɪk	myˇs	muʰɪˇkʰ	mʊsɪkʰ	
C^{C}V.CVC	CVs	CV.^{c}VC	CV.CVC	NC
musicbox		983 - PR E*	1129-T. 2-PR E*	852 - PR E*
mjusɪk+bɑks		mugibɑ^s	mʊkɪsʔbɑks	mudjɪtʰ bɑ<ks
C^{C}V.CVC+CVCC		CV.CV.CVC	CV.CVC. CVCC	CV.C^{C}VC.CVCC
/n/				
noisy	648-T. 2-PR E	785 - T. 2*	967 - T. 2 - E*	
nɔɪz+i	nõᵊsː	nɔɪdiˈʔ	noʊsiᴵ	
CV VC+V	C$\tilde{V}^{v}$s:	CV V.CVˈ	CV V.CV	
/p/				
page	482 - T. 2	1048 - T. 2*		522 - T. 2*
pɛɪʤ	bɛᵊs	pʰɛɪtˢ>		pᵘlɛɪts
CVVC^{C}	CV^{v}s	CV VC^{C}		C^{v}.CV VC^{C}
pages		1050 - T. 2*		524 - T. 2 - E*
pɛɪʤ+əz		pʰʊtʰtʰ		pʰɛɪts
CV VC^{C}+VC		CVC^{h}C^{h}		CV VC^{C}
pages		1051-T. 2-PR E		525-T.2-PR E*
		pœdʊˈᵊʔs		pʰɛɪdz$_{o}$ɛᵊs
		CV.CV^{v}ʔC		CV V.C^{C}V^{v}C
pig	266	829 - T. 2 -PR E*	499*	765, 768*
pɪg	pʰɪ^s	pʰɪkʰ	bɪg$_{o}$	pɪg$_{o}$
CVC	CVs	CVC	CVC	CVC
piggy	283 - PR E	829 - T. 2*		770 - PR E*
pɪg+i	piˇs	pɪgiːʔ		pʰᵊᵒgiˈ
CVC+V	CVs	CV.CV:		C^{v}.CVˈ

pipe		1013 - S* 1013, 1014, 1015, 1024 - PR E	672 - T. 2 -E*	
pʌɪp CV VC		t^{h}aɪp CV VC	p^{h}ʌɪp CV VC	
play plɛɪ CCV V		1073 - T. 2 - C pɛɪ CV V		989 - T. 2 -C NC
playing plɛɪ(j)+ɪŋ CCV V(C)+VC				975-E;987-T. 2* plɛ̃ĩn CCV VC
playing				989-E,C;1005-T. 2-C p^{h}ɛ̃(ɪ)n CV (v)C
pop pɑp CVC		1104 - S 1161 - T. 2 - C pɑ^{ə}p(^{h}) CV^{v}C		
pop		403 - T. 2 - C p^{h}ɑp^{h} CVC		

/b/

basket bæskət CVC.CVC	505 - T. 2 - E bæs CVs	705 - T. 2 - E* bʌt:^{h}ɛs$^{>}$ CVC:VC		
basket		707 - PR E* bakɛʔs CV.CVʔC	842 - T. 2 - E bʌkəs CV.CVC	606 - E* basɪk' CV.CVC'
Bert bə˞t CV/r/C	53 - E bʊt CVC		56 - E bøt^{h} CVC	643 - T. 2 -E NC
bib bɪb CVC	57 - E bɪs CVs	594 - T. 2 - E* dib$_{o}$ CVC	863 - E* bɪb CVC	23 - T. 2 NC
black blæk CCVC		264 - T. 2 bak^{h} CVC	850 NC	813 - E* b^{ʊ}lak C^{v}.CVC

bread brɛd CCVC	1156 bɛᵊs CVᵛs			200 - T. 2* bᵘladₒ Cᵛ.CVC
broke				1085 - C* bouk CV VC
broke				485 - T. 2 - E* bulouk CV.CV VC
brush brʌʃ CCVC	470 bãʃ˂ CVC			649* bwʌs CCVC
/t/				
take tɛɪk CV VC		1088-C-PR E* kʰɛɪkʰ CV VC	1067-T. 2-E,C* sakʰ CVC	621-T. 2-DE* tʰɛɪk CV VC
take			1075-T. 2-DE,C* sɛɪk CV VC	
tape tɛɪp CV VC		1145 - E tɛɪpʰ CV VC		
top tɑp CVC	960 - T. 2 - PR E daᵊs CVᵛs			
truck trʌk CCVC	458 - E gʌʃ˂ CVs	76-T. 2-PR E* tʌtʰ CVC	483* tˢʌkʰ CᶜVC	1158 - C(2)* sʌkʰ CVC
truck	481 gɑː ʃ˂ CV: s	77 - T. 2 - PR E kʰʌs CVs		
truck		138 - T. 2- PR E gʌkʰ CVC		
T.V. tivi CV.CV	1145 - S 1146, PR DE tʰitʰi CV.CV	965 - T. 2 - E tʰivₒijᵊ CV.CV.ᶜᵛ	1113 - T. 2 NC	379 - T. 2 NC

/d/

daddy	169 - C			
dædi	dædi			
CV.CV	CV.CV			
desk	636 - E			
dɛsk	gʌs			
CVCC	CVC			
diving	1234 - E	171-T. 2-PR E*	1038-T. 2-E*	109 - T. 2*
daɪv +ɪŋ	^{b}vaɪ' s	daɪvĩn	dʌifĩn	daɪvĩn
CVVC+VC	cCV V's('=stress)	CV V.CVC	CV V.CVC	CV V.CVC
dog	1202		655 - T. 2*	960 - PR E*
dɑg	gas		dzak	dɑ^{ə}g$_{o}^{h}$
CVC	CVs		CCVC	CV ^{v}C
dog	241 - T. 2		655 - T. 2*	
	da^{ə}s		gak	
	CV ^{v}s		CVC	
doll	260-T. 2 -E			
dɑl	gɑ			
CV/l/	CV			
dolls		1187 - E	?1001 - T. 2 - E	
dɑl+z		dʊʔs>	dɑ^{ə}ts	
CV/l/+C		CVʔC	CV^{vc}C	
dolly(ies)	263- T. 2 - E	1190(dolly)*	1002 - T. 2 - E	
dɑl+(ɪ)+(z)	da-ɪ˘s	daji'^{jə}	dɑis	
CVC+V+C	CV.Vs(2 beats)	CV.CV'.^{cv}	CV.VC	
dress	145 - DE	612 - T. 2		465 - E*
drɛs	dɛs>	das		dzæ^{ʌə}s
CCVC	CVC	CVC		^{C}CV^{v}C

/k/

cake	1218 - PR E	322 - T. 2*	633 -C	679
kɛɪk	k^{h}ɛɪs>	k^{h}ɛɪk^{h}		
CV VC	CV ^{v}s	CVC	NC	NC
call	525 - T. 2 - E	1018 - T. 2	868 - T. 2 - E	418 - T. 2 - E, C
kɑl	k^{h}a^{ə}	k^{h}ɑ^{ə}		
CV/l/	CV^{v}	CV^{v}	NC	NC

calling	528 - T. 2 - E (singsong)	1017 - T. 2	864 - T. 2 - E	420 - T. 2
kal+ɪŋ	$k^{n}{}_{o}\tilde{a}\,\tilde{\imath}n^{ə}$	kɑ ɛ̃n	$k^{h}ɑɛ^{\wedge}n$	$k^{h}ɔl\tilde{\imath}n$
CV/l/+VC	$CV.VC^{v}$(2.5 beats) CV.CVC		CV.VC	CV.VC
clean	1138 - C			
klin	đĩn			
CCVC	CVC			
climb				1166 - C
				$k^{h}\tilde{a}\tilde{\imath}m$
				CV VC
climb				1167 - E*
				$k^{hʊ}l\tilde{a}\tilde{\imath}m$
				C^{v}.CV VC
clock	182 - T. 2	1051*	556 - E	923
klɑk	$k^{h}aç$	$k^{h}ɑk^{h}$		
CCVC	CVs	CVC	NC	NC
combing	474 - E*****	862 - T. 2*	1029 - T. 2 - C	634
koʊm+ɪŋ	kom̃ĩn	$k^{h}om\tilde{\imath}n^{ə}$	$k^{h}oʊm\tilde{\imath}n$	
CV VC+VC	CV.CVC	$CV.CVC^{v}$	CV V.CVC	NC
combing	1085 - E*****			
	bõw̃ĩn			
	CV.CVC			
key	490	292 - T. 2		
ki	$t^{h}i$	$t^{h}i\!:j^{ə}$		
CV	CV	$CV.^{cv}$		
key		366-T. 2-PR E*		586
		$k^{h}i$		
		CV		NC
queen	152 - T. 2	1080	758 - T. 2	473 - T. 2 - E
kwin	$k^{h}\tilde{\imath}n$	$k^{h}i\tilde{ə}n$		
CCVC	CVC	$CV^{v}C$	NC	NC
/g/				
go	706	1054 - E		933
goʊ	goʊ			
CV V	CV V	NC		NC
glove	420	1208*	1180-T. 2-E*	547 - T. 2*
glʌv	$gʌ^{ə}s$	dʌɪf	$gʌ^{ə}v_{o}$	$g^{ʊ}lʌv_{o}$
CCVC	$CV^{v}s$	CV VC	$CV^{v}C$	C^{v}.CVC

green	20 - T. 2 - E	868-T. 2-PR E*		803*
grin	gĩn	$k^{h}im^{ə}$		gĩn
CCVC	CVC	CVC^{v}		CVC

/f/

finger(s)	690 - T. 2 - E	460 - T. 2*	129*	505
fɪŋgə-+(z)	fɪs	fidʊ^{ə}	fɪŋgʊs	
CVC.CV/r/+(C)	CVs	$CV.CV^{v}$	CVC.CVC	NC
flower	279 - T. 2	902 - T. 2*	1024 - T. 2	732*
flauwə-	fa^{ə}ʃ<	fʌɪjʊʔ	faʊwɛ^{ə}	faʊwʊ^{ə}ʔ
CCV.CV/r/	CV ^{v}s	CV V.CV	$CV.CV^{v}$	$CV V.CV^{v}$
friends			921, 926 - C	395 -T. 2-E, C
frɛnd+z			fɛ̃n ː ts	
CCVCC+C			CVC:CC	NC
funny	417 - E (2)	1149*		1048 - C
	fɑɪ	fʌ<nɪjə		fʌ^{n}i
	CV V	CV.CV.^{cv}		CV.^{cv}
funny	667 - C			
	^{p}fʌɪ			
	^{c}CV V			
funny	887 - S*****			
	fɐ̃n (Rising)			
	(Pause)ni(Rising)			
	CVC.(PAUSE) CV			

/v/

van	38 - T. 2- C, DE	328 - T.2*	787, 791, 807, 808 - T. 2	
væn	væ̃s	dæ̃m^{ə}	væ̃n$^{(ə)}$	
CVC	CVs	CVC^{v}	CV $C^{(v)}$	

/θ/

think				1070;457-T. 2(E)*
θɪŋk				θɪ ŋk
CVCC				CV:CC
three	321	1188;307;309 314, 315 - T. 2(C) - T. 2	675 - T. 2 - E	
θri	fi			
CCV	CV	NC	NC	

three	611	113 - T. 2	853 - T. 2	928;534,543 -T.2
	pfi	føiː	f_wi	fʊliᴵ
	^{c}CV	C^{v}V:	CV	CV.CV
thumb	248 - T. 2	987	135, 635(T. 2)*	508, 512(DSE), 934
θʌm	pã̃^{ə}m	t^{h}ʌ^{ə}m	f^{w}ʌ^{ə}m	fʌ^{ə}m
CVC	CV^{v}C	CV^{v}C	C^{C}V^{v}C	CV^{v}C
/ð/				
that		1038 - T. 2 - E	249(S), 762 - C*	
ðæt		gʌf	dæt^{h}	
CVC		CVC	CVC	
that		1040 - PR E		
		dæf		
		CVC		
there	195 - E	848, 1078, 1087 T. 2 - C	302	960, 1118 - C
ðɛr	dɛ^{ə}			
CV/r/	CV^{v}	NC	NC	NC
/s/				
Santa Claus	1131 - PR E (singsong)	1025 - T. 2*	1086 - T. 2 - E*	780 - E*
sæntə+klɑz	h^{ə}ngɑs	d^{ʊ}ækɑ^{ʔ}s	sãnkʊkɑ^{ə}s	sæ̃nɾək^{l}ɑz
CVC.CV+CCVC	CVC.CVs	C^{v}V.CV^{ʔ}C	CVC.CV.CV^{v}C	CVC.CV.C^{C}VC
scarf	1196 - E	126 - T. 2 - E*	1011 - T. 2 - E	138 - T. 2 - E
skɑrf	kʊs	gʌf	kɑ^{ə}f	
CCV/r/C	CVs	CVC	CV^{v}C	NC
screwdriver	171 - PR E		540	696 - E*
skrudrɑɪvə˞	nãs$^{>}$		t^{h}ugɑɪv$_{o}$ɛ^{ə}^{ʔ}	skufkɑɪv$_{o}$ʊ^{ə}
CCCV.CCVV. CV/r/	CVs		CV.CV V.CV^{v}	CCVC.CV VCV^{v}
screwdriver	175 - PR E	843 - T. 2 - SE*		
	nũwʌ^{ə}ʃ	tugʌf		
	CV.CV^{v}s	CV.CVC		
see	398 - DE	1199 - C	1119 - T. 2 - C*	
si	t^{h}ji	t^{h}ijə	si	
CV	CV	CV.^{cv}	CV	

see	555, 584, 587, 670, 674, 679, 718, 832, 885, 906, 953, 972, 988 - S, 399, 714 - C di(most have rising int.) CV			
sewing machine sowɪŋ#məʃin CV.CVC#CV.CVC	1102 - PR E mʌ̃ndɪᵊs>ᵛ CVC.CVᵛs		1056 - T. 2 - E* soĩn tsĩnᵊ CV.VC.ᶜCVCᵛ	321 - T. 2-E* NC
sis	954-T. 2-PR E		1153-T. 2-PR E*	516 - T. 2 - E
sɪs CVC	tʰɪs>ᵛ CVC		sɪs CVC	 NC
sleep slip CCVC		333 - T. 2 tʰip CVC	150(S), 152(SE,C)* siː pʰ CV:C	
sleep		579 - T. 2 tˢipʰ CᶜVC		
sleeping slip+ɪŋ CCVC+VC	507 - E mɪs CVs	511 - T. 2 - E* tʰiᵊmitʰ CVᵛ.CVC		
sleeping	1105 - PR E bɛɪsᵛ> CV ᵛs	512 - T. 2 - PR E* tʰɪ̃ntʰɪ̃n CVC.CVC		
sleeping	1107 - PR E (singsong) bøɪʔɪs CVᵛʔVs	513 - T. 2 - PR E* tʰɪ̃ptʰɪ̃n CVC.CVC		
sleeping		514 - T. 2 PR E* tʰɪ̃npʰiʔᵊn CVC.CVʔᵛC		
slipper slɪpəˠ CCV.CV/ɾ/				758 - E sᵛɪpʊᵊ CV.CVᵛ
small smɑl CCV/l/			1127-T. 2-E,C maᵊʔ CVᵛ	1137 - C* sːmɑᵊ C:CVᵛ

smooth	800 - T. 2 - E	7 - T. 2*	1136 - T. 2 - E*	
smuð	$mu^{U}s$	muv	muv_{o}	
CCVC	CVs	CVC	CVC	
snake	1141	1029 - T. 2*	382 - E*	362 - T. 2*
snɛɪk	nis>	$snɛɪk^{h}$	$sn\,\text{ː}\,i\check{}k^{h}$	snɛɪk
CCV VC	CVs	CCV VC	CC:VC	CCV VC
sneezing			945 - T. 2 - E	
sniz+ɪŋ			nisĩn	
CCVC+VC			CV.CVC	
snip			938 - T. 2 - E	
snɪp			snɪp	
CCVC			CCVC	
snow	1188	120 - T. 2	1006 - T. 2*	
snoʊ	$no\text{ː}^{\upsilon}$		snoʊ	
CCV V	$CV\text{:}^{V}$	NC	CCV V	
snowing	1189 - E*****	116 - T. 2	1008 - T. 2 - DE	123 - T. 2*
snow+ɪŋ	nowĩn			snowĩn
CCVC+VC	CV.CVC	NC	NC	CCV.CVC
spoon	207 - T. 2	1039	584(spoonie?)	
spun	$p^{h}ʊ^{ə}n$		bũn^{ɪ}ʔ	
CCVC	$CV\,\tilde{}^{v}C$	NC	$CV.C^{v}$	
spoon			685 - T. 2 - C	664*
			$p^{h}uũ<n$	spun^{ɪ}ʔ
			$CV\,^{v}C$	$CCVC^{v}$
spring	300-T. 2-PR E	1112 - PR E	278 - E	64 -T. 2 - E*
sprɪŋ	bɛ̃^{ɪ}s	$p^{h}ø^{ɪ}n$	$p^{h}ĩn^{ə}$	spĩŋ
CCCVC	$CV^{v}s$	$CV^{v}C$	CVC^{v}	CCVC
squirrel	87 - T. 2 - E	959	1128 - T. 2 - E	336 - T. 2-E*
skwə˞l	$k^{h}ʊ$	$gu^{wo}ʔ$	s>ʊwə	$^{s}kɔ^{ə}$
CCCV/rl/	CV	$CV.^{cv}ʔ$	CV.CV	cCV^{v}
star(s)	672 - T. 2 - E	834 - T. 2(star)	1162 - T. 2*	813*
star+(z)	tas	$dɑ^{ə}ʔ$	$sɑ^{ə}$	$stɑ^{ə}$
CCV/r/+(C)	CVs	CV^{v}	CV^{v}	CCV^{v}
starry	674-T. 2 -PR E	836 - T. 2*	1163-T. 2-E, C*	836-PR E, C*
stari	dɔ ɪs	tɑi	sɑi	
CCV/r/+V	$CV.Vs^{(2\ beats)}$	CVV	CVV	NC
sting		695 - T. 2 -C	846(S); 849(C) - T. 2*	876*
stɪŋ		$ʔɪŋ^{kh}$	$k^{h}ɪŋ$	stĩŋ
CCVC		$ʔVC^{c}$	CVC	CCVC

string			672*	792 - E*
strɪŋ			si^n	s̃ĭ˘ŋ
CCCVC			CVC	CVC
sweater	162 - PR E	575 - T. 2*	33 - E*	448 - E
swɛtə˞	wɛ˘ʔɪs>	wedʊəʔ	sɔ^tɛə	sat^{h}ɛəʔ
CCV.CV/r/	CV.ʔVs	CV.CV^{v}	CV.CV ^{v}	CV.CV^{v}

/z/

"Z"	644 - T. 2 - E	780 - T. 2 - PR E		
zɛd	dæət^{h}	dæt^{h}		
CVC	CV^{v}C	CVC		
zipper		44-T. 2-PR DE	960 - T. 2 - E*	858*
zɪpə˞		Dɪp^{h}ʊə	z$_{o}$ɪpɛə	zɪpʊə
CVCV/r/		CV.CV^{v}	CV.CV^{v}	CV.CV^{v}
zipper		47 - T. 2 - SE bido'ʔ CV.CV'		
zipper		48 - T. 2 - PR E dzɪpʔʊʔ C^{C}VC.ʔVʔ		

/ʃ/

shoe(s)	1138 - S	1196(shoe) - C		467, 1091 - E, C
ʃu+(z)	tus>	t^{h}u		s>uz$_{o}$
CV+(C)	CVs	CV		CVC

/ʧ/

chair	812, 820 - T. 2	474	764 - T. 2 1085* - E	873*
ʧɛr	tɛ$^{(ə)}$s		t^{s}ɛə	sɛʔə
CCV/r/	CV$^{(v)}$s	NC	C^{C}V^{v}	CVʔV
cherries	275 -T. 2 - E		1041 - T. 2 - E*	52 - T. 2*
ʧɛɪn+z	gʊɪs		sɛwi^{t}s	tsɛɪz$_{o}$
C^{C}VCV+C	CV Vs(1 syl)		CV.CV^{C}C	C^{C}V VC
chicken	396 - E	10-T. 2-PR E*?	351*	869*
ʧɪkən	tɪs	ʔʊ^{t}s	^{d}zɪkə̃n	ʤɪkɛ̃n
C^{C}V.CVC	CVs	V^{C}C	^{C}CV.CVC	C^{C}V.CVC

chicken		11-T. 2-PR E* tĩnk^{h} CVCC	352 - SE* sɪkə̃n CV.CVC	

/ʤ/

"G" ʤi C^{C}V	551 - T. 2 - E dis CVs	768 - T. 2* ʤiˇː C^{C}V:	882 - T. 2 - E ʧiː C^{C}V:	439 - T. 2 - E NC
jump ʤʌmp C^{C}VCC	736 - T. 2 - E da^{ə}s CV^{v}s		59, 689(T.2) - E* d$_{o}$z$_{o}$>ʌ$^{(ə)}$mp CCV $^{(v)}$CC	1008 NC
jump			517 - C, DE* zʌp CVC	560* ʤʌp^{h} C^{C}VC
jump			680(S), 681(E) - T. 2* dzʌ$^{(ə)}$p CCV$^{(v)}$C	

/r/

rabbit ræbɪt CV.CVC	239 - PR E wɛ^{ɛ}ʌs CV^{v}s		229 - PR DE* ʔæbɪt^{h} ʔV.CVC	755 - E* wæbɪt^{h} CV.CVC
raining rɛɪn+ɪŋ CV VC+VC		337(2), 339(2), 341, 906(2); 342, 360 - C - *T.2 winĩn CV.CVC		
rub rʌb CVC	804- T. 2-PR E ʔʌ^{ə}p ʔV^{v}C	995 - T. 2* $_{v}$lʌf $_{v}$CVC		
rub		996-T. 2-PR E* lʌb CVC	1139 - T. 2 - E* wa^{ə}p CV^{v}C	

/l/

la (la la) la CV	559 - T. 2 - E la (la la) CV (CV CV)	1004-T. 2-PR E NC

lamb	183 - E			
læm	mæ̃n			
CVC	CVC			
laugh	563 T. 2-PR E	728 - T. 2 - E*		
læf	ʔʌᴵs	ʔæf		
CVC	ʔVᵛs	ʔVC		
laughing	565-T. 2-PR E	728 - T. 2 - E*	898 - T. 2 - E	450 - T. 2*
læf+ɪŋ	ᵘwɛ̃>ᵊs	ʔæfin	lafin	læfin
CVC+VC	ᵛCVᵛs	ʔV.CVC	CV.CV	CV.CVC
leaf	113	351 - T. 2*	357	710
lif	wiʃ<	ʔif	lif	
CVC	CVs	ʔVC	CVC	NC
line	798		715, 67 725 - C*	
laɪn	ʔaɪn		laɪn	
CV VC	ʔV VC		CV VC	
Lyle	572 -T. 2-PR E		902 - T. 2 - E*	455 - T. 2-E*
laɪjəl	læʳɔᵘ		laɪjæᵊ	læl̥oʊ
CV VCV/l/	CV. C*V V (*Transition r)		CV V.CVᵛ	CV.ÇV V
/w/				
one	150 - E 167, 169, 170 272, 354 - C (+18 more C)			
wʌn	wÃn			
CVC	CVC			
/j/				
yeh	31		36	
jɛᵊ	jɛᵊ			
CVᵛ	CVᵛ*		NC	
*Many eg of "yeh"				
yellow		238 - T. 2*	199 - C	1184 - E, C*
		lɛˇloʔ	lalʊ	lɛloʊ
		CV.CV	CV.CV	CV.CV V
yucky		268, 484, 485 - T. 2-C*		
jʌki		lʌkʰi		
CV.CV		CV.CV		

/h/

hanger	189 - E	622 - T. 2 - E*		55 - T. 2*
hæŋɚ	hæ̃s>	ʔæŋgʊʔ		hæŋʊᵊ
CVC.+V/r/	CṼs	ʔVC.CV		CVC.Vᵛ
happy	505, 942 - C	236 - T. 2-PR E	896 - T. 2(2)*	
hæpi	ʔæbi	ʔaʔpiʔ	hæpiː	
CV.CV	ʔV.CV	ʔVʔ.CV	CV.CV:	
happy	602 - C			
	ʰæpi			
	ᶜV.CV			
happy	608, 909, 913, 936 - C	234 - T. 2 - C		
	ʔæpi			
	ʔV.CV	NC		
heehee ("horse sound")	340			
hihi	hihi			
CV.CV	CV.CV			
home	167, 319, 618, 662, 1007, 1118, - S, C	1176, 1141 - C	708, 870- T. 2*	
	287 - E			
	288 - DSE			
houm	ʔõm		hoũm	
CV VC	ʔVC	NC	CV VC	
hug	780 - T. 2	456 - T. 2 - E*	148 - E*	649 - T. 2*
hʌg	ʔaᵊs	ʔʌᵥkʰ	hʌg	hakʰ
CVC	ʔV ᵛs	ʔVᵥC	CVC	CVC

Subject 4

AGE:	3;6 2 sessions 1 week apart: 2nd session Tape 1, 860 ff.	3;8 2 sessions 1 week apart: 2nd=Tape 2	3;10 2 sessions 2 days apart: 2nd=Tape 2	4;0 2 sessions 2 days apart: 2nd=Tape 2

N.B. Many items were produced with strong glottal fry (expression of anger or excitement). This may have affected the transcription of vowels as well as perception of glottals. Glottal fry is indicated with (GF).

Adult forms

Vowel
Initial:

eat	1021 1024 - C	1211; 331 - T. 2*		330 - T. 2
it	ʔiː	ʔitʰ		
VC	ʔV :	ʔVC		NC
eating		1213 - PR E	835 - T. 2*	773
it+ɪŋ		ʔitʰ	ʔitʰᵊinᵊ	
VC+VC		ʔVC	ʔV.CVCᵛ (s/b eat)	NC
"M"	1192(GF) 1194 - C, E			
ɛm	ʔæᵊp			
VC	ʔVᵛC			
itch	419 - T. 2 - E	989 - T. 2 - E*	1092 - T. 2 - E*	
ɪʧ	jɪʃ	ʔitʲ	ʔɪtsˀ	
VCᶜ	ᶜVC	ʔVCᶜ	ʔVCᶜ	
itchy	419 - T. 2 - E	988 - T. 2 - E, C*	1093 - T. 2 - E*	
ɪʧ+i	ʔæʒəʔ	ɪzɪⁱ	ʔitʰjɪːˈjəʔ	
VCᶜ+V	ʔV.CV	ʔV.CV	ʔV.CᶜVːˈᶜV	
up	687 - C	1103 - PR E; 1104 - C*		374 - T. 2 - C
	ʌpʰ	ʔʌpʰ		
	VC	ʔVC		NC

/m/

mad	1148 - E	778; 548 - T. 2	598 - T. 2 - C*	972 - C*
mæd	mæᵊ	532 - T. 2 - C	mædʌ	mæːD
CVC	CVᵛ	NC	CV.CV	CV: C

man	928 - DE, C; 929 - E, C	895*	443 - T. 2 - C	520 - T. 2 - C
mæn	mæ̃(ə̃)	mæ̃n		
CVC	CV(v)	CVC	NC	NC
man		253, 964 - T. 2-C		525 - T. 2 - C
		mæə		
		CVv		NC
mask	1197 - E	719 - T. 2 - E	912-T. 2;992-T. 2	492*
mæsk	mæəs>	mækh	- C	mæks
CVCC	CVvC	CVC	NC	CVCC
mom	674, 676, 688 704 - C	784 - C		
mʌm	mʌ̃(ə̃ -1)m			
CVC	CV (v - 1)C	NC		
mommy	733, 851;734 -DE, C; 714, 769, 852, 854			
mʌmi	mʌ (ə)(ː)m(ɪ)i (1 each of variants)			
CV.CV	CV(: - 1).CV			
mouth	58 - T. 2 - E(GF)		1112	556 - T. 2 - E*
mʌʊθ	maəs>		mɔəs>	mʌʊf
CV VC	CVvC		CVvC	CV VC
mouthy	449 - T. 2 - E	1029 -T. 2-PR E*	1084 - T. 2 - E	556 - T. 2 - E*
mʌʊθ+i	maʒiˈ	maʊfɪi	mʌʊfɪəʔ	mʌʊfiʔ
CV VC+V	CV.CV	CVv.CV	CVv.CVv	CV V.CV
musicbox	443 - T. 2 - E, C	918 -T. 2 -PR E*	971 - T. 2*	138 - PR E*
mjusɪk+baks	mugibak	mubakh	mugimbakh	smʊgibak
CCV.CVC. CVCC	CV.CV.CVC	CV.CVC	CV.CVC.CVC	CCV.CV.CVC
/n/				
night			777 - T. 2 - DE, C	129 - T. 2 - E, C*
nʌɪt			næth	naɪth
CV VC			CV:	CV VC
night-night	997 - C(GF)	930; 165 - T. 2*		30 - T. 2*
nʌɪt+nʌit	nanɑɪ	næʔnæ(ə)th		nʌɪtnʌit
CV VC+CV VC	CV.CV V	CVʔ.CV (v)C		CV VC.CV VC
nine	590		1087 - T. 2 - E	540 - T. 2*
nɑɪn	nɑɪ		nʌ̃ĩn	nɑ̃ĩn
CV VC	CV V		CV VC	CV VC

noise	100 - T. 2 - E	499 - T. 2 - E*	680 - T. 2*	977*
nɔɪz CV VC	nɔɛ^s CV VC	no˘wɪʃ CV.CVC	nos^{ə}ʔ CVC^{v}	nɔɪz$_{o}$ CV VC
noisy	105 - T. 2 - E	500 - T. 2 - E*	680 - T. 2*	979 - E*
nɔɪz+i CV VC+V	nɔ^{wə}zɪ^{ə} CV.^{cv}.CV ^{v}	no^{wə}ʒi$_{o}$ CV.^{cv}.CV	nosi^{jə} CV.CV.^{cv}	nɔʊz̃ĩn CV V.CVC
/p/				
page	1156	389 - T. 2*	1103 - T. 2 - E	449 - T. 2*
pɛɪʤ CV VC^{C}	pas CVC	p^{h}æ^{ə}ʃ< CV^{v}C	p^{h}ɛdɪ^{ə}ʔ CV.CV^{v}	p^{h}ɛ>ɪdz> CV VCC
pages		391 - T. 2 - E	1104 - T. 2 - E	451 - T. 2-E(GF)*
pɛɪʤ+əz CV VC^{C}+VC		pɛzi˘ʔ CV.CV	p^{h}æsi^{d}z$_{o}$ CV.CV^{C}C	p^{h}ʊdzɛĩ CV V.CCV V
pie	162, 167-T. 2-E	581 -PR E(GF)*	1110 - T. 2 - E*	263 - T. 2 -E
	267 - T. 2			
pɑɪ CV V	p(^{h})ɑ ː ^{ə} CV: ^{v}	p^{h}æ^{ə} CV^{v}	p^{h}ɑɪ CV V	NC
plum	224 - T. 2-E(GF)	584 - PR E*	1112 - T. 2 - E*	267 - T. 2 - E*
plʌm CCVC	p^{h}ɑ^{ə} CV^{v}	p^{h}ʌ$^{ə̃}$m CV^{v}C	pʟæ^{ə}m CCV^{v}C	p^{ʊ}lʌ̃m C^{v}.CVC
pouring	1212 - E	473 - T. 2	1205*	862
pɔr+ɪŋ CV/r/+V C	bɔdi̯ɛ^{ɪ}> CV.C^{c}V ^{v}	p^{h}ɔwi^{ɪ} CV.CV	p^{h}ɔwĩn CV.CVC	p^{h}ɔ. ĩn CV.VC
present	1085 - E	1226*	833 - T. 2*	718*
prɛzənt CCV.CVCC	paz>ɪ˘^{i} CV.CV	pʊ^{w}ɛ^{ɪ} CV.cV^{v}	p^{h}ɛsæ^{ə}n CV.CV^{v}C	p^{h}ɛi̯ɪʔ CV.^{C}V?
present		1227 - PR E	834 - T. 2 - E*	719 - E*
		pazɛ^^{ə}ʔ CV.CV ^{v}	p^{h}ɛzæ^{ə} CV.CV^{v}	p^{h}ɛzit^{h} CV.CVC
/b/				
baby		705 - T. 2 - C 857 - T. 2 - E	949 - T. 2	624 - C
bɛɪbi CV V.CV		bibɪ^{ə} CV.CV^{v}	NC	NC

baby			633 - T. 2 - C* beˈbɛˈʔ CV^{v}.CV ^{v}	
baby			635 - T. 2 - C* bebiˈʲˈʔ CV.CV.^{cv}	
basket bæskət CVC.CVC	1159 - E bægɪ^{i} CV.CV	407 - T. 2* bækʰɪʔ CV.CV		109* bægɛt CV.CVC
Bert bə˞t CV/r/C	131 b$_{w}$ɔʃ CVC	1181-DE;1193 - C* bʊtʰ CVC	1133 - C NC	565(3) - T. 2 NC
bib bɪb CVC	141 - E bɪb$_{o}$ CVC	1167 - PR E;* 1170 - SE 1172 - E bɛpʰ CVC	1185 - E bɛbᵊ CVC^{v}	67 - T. 2 - E* bɪb CVC
big bɪg CVC	145 - C 917 - E, C(GF) 1139 - E, C bægi CV.CV	279 - T. 2 bagiː CV.CV:	435, 463- T. 2-C bægi CV.CV	484 - T. 2 - C* 369 bɪg CVC
black blæk CCVC	365 - E ^{ʊ}wækʰ ^{v}CVC	623 - T. 2 - E bækʰ CVC	702 - T. 2 - PR E NC	254 - E* bᵊlæk C^{v}.CVC
blue blu CCV	745 buː CV:		1152 - T. 2 - C NC	776 - T. 2 - C* bᵊlu C^{v}·CV
boat boʊt CV VC	729 boʊ CV V	536 - T. 2 - E, C* boˇʧ CVC^{C}	646 - T. 2 - C* boˇtʰ CVC	
boat boʊt CV VC	776 - C bɔʔ CV			
boots but+s CVC+C	890 - E, C bʊp CVC	418(2, 1 C)-T. 2* butʃ CVC^{C}	1044, 1036-T.2-C buts CVCC	808 NC
boots			1044 - T. 2 - C butʰ CVC	809 NC(2 boots)

boy	1021		46 - T. 2 - C*	161 - T. 2 - C
bɔɪ	bouʔ		bɔ^ɪ	273 - T. 2
CV V	CV V		CV V	NC
boy	1029	56 - T. 2 - C*		
	bɔᵊ	pɔ^ʔ		
	CVᵛ	CV		
broke	625, 627-DSE, C	838 - DE	112 - T. 2 - C*	492(2) - T. 2 - C
	bɔ^kʰ		bwok	bwɔk
	CVC	NC	CCVC	CCVC
broke	720;788-DSE, C			786, 787, 788*
	790 - SE, C			
	boˇkʰ			bʷokʰ
	CVC			CVC
broom	1013		851 - T. 2 -PR E*	747
brum	buɔː		bj̇ũm	bj̇umᵊ
CCVC	CV V:		CᶜVC	CᶜV.Cᵛ
brush	528, 543(DSE)-C	1095 - C*	59 - T. 2 - C	107 - T. 2 - C
brʌʃ	b(w)aːᵊ	bʌᵊs		baʃ<
CCVC	CV: ᵛ	CVᵛC	NC	CVC

/t/

tall			1172 - DE	
tɑl			tʰɑːʔ	
C V /l/			CV:	
teeth	525 - E	1078 - DE;1095-C	1111; 59-T. 2-C	106 - T. 2 - C
tɪθ	tʰis			
CVC	CVC	NC	NC	NC
teeth	543 - C	1122 - C*		
	tʰiᵊ	dis		
	CVᵛ	CVC		
tent		794 - T. 2 - E	458 - T. 2	
tɛnt		tʰɛtʰ		
CVCC		CVC	NC	
tie			1195 - C	
tɑɪ			tʰæᵊ	
CV V			CV ᵛ	
time			826 - T. 2 - C	716 - C*
tɑɪm			tʰæ̃m	tʰɑ̃ĩm
CV VC			CVC	CV VC

toothy			1084 - T. 2 - E	
tuθ+i			$t^hufi^jə?$	
CVC+V			CV.CV.^{cv}	
tub	904 - E	858 - T. 2 - E*		
tʌb	tap	$t^hʌ^əp$		
CVC	CVC	CV^{v}C		
tubby	905 - E	859 - T. 2 - E*	951 - T. 2 - PR E	107 - T. 2 - E
tʌb+i	tap^hi	$t^hʌbɪ^i$		
CVC+V	CV.CV	CV.CV	NC	NC
T.V.	938	847 - T. 2	818 - T. 2 - C	218 - T. 2
tivi	ʔiː	$t^hivi^ɪ$		
CV.CV	ʔV:	CV.CV	NC	NC

/d/

daddy	855 - C	1229	468 - T. 2 - C	
dædi	dædɛ^ɪ	dædiɪʔ		
CV.CV	CV.CV v	CV.CV	NC	
diving	616 - E;617-DSE	1220*	896 -T. 2 - PR E*	758*
daɪv+ɪŋ	waʒɛ^ɪ	da^{ə}vɪːʔ	davĩn	daɪvĩn
CV VC+VC	CV.CV^v	CV^v.CV:	CV.CVC	CV V.CVC
dog		35 - T. 2	434, 435(2), 437 - T. 2 - C*	277 - T. 2
dɑg		gɑk^h	dɑg	
CVC		CVC	CVC	NC
doll	990, 991(GF) - E		900 - T. 2*	
	dɑ$^{(ə)}$		dɑʔɑl	
	CV$^{(v)}$		CV?V[l]	
dollhouse		1007 - T. 2-PR E	902 - T. 2-PR E*	167 - T. 2 - E*
dɑl+hʌus		dɑ^{ə}ʔɑ^{ə}s	dɑlʔlɑ^{ə}s	dɑhʌʊs'
CV/l/+CV VC		CV ^{v}.ʔV^{v}C	CV[l]ʔCV^{v}C	CV.CV VC'
down	946	661, 919;849 138 - T. 2 - C*	746 - T. 2** 55, 84(3)-T. 2-C	308 - T. 2
daʊn	ta^ə	dɑ (ː) $^{ə(ː}$)n	daũn	
CV VC	CV ^{v}	CV(:)^v(:)C	CV VC	NC
dream		539 - PR E	649 - T. 2 - PR E*	
drim		z>im^ə	dimə?	
CCVC		CVC^v	CV.CV	

dress drɛs CCVC	220 bɔːᵊs CV:ᵛC	562 - PR E* dɛs CVC	1161 - E NC	423 - T. 2 - E NC
/k/				
call kɑl CV/l/		465 - E* kʰɑl CV[l]	533 - T. 2 - E NC	840* kʰɑᵊ CVᵛ
calling kal+ɪŋ CV/l/+V C	1176 - E(GF) kʰɑjɪⁱ CV.CV	458 - E* kʰɑliᴵ CV.CV	530, 532(PR E) - T. 2* kʰɑl̃ĭn CV.CVC	838* kʰɑ. ĭn CV.VC
camel		448, 449, 450 - T. 2 - C kʌbʌ(ə) CV.CV (v)		837(2)* kʰamɔᵊ CV.CVᵛ
candle kændəl CVC.CV/l/	1064 - E(GF) kʰɑɛᴵ CV V	632(GF)* gɑdoʊʔ CV.CV V	830 - T. 2* kʰæᵊndoˇʔ CVᵛC.CV	469 - T. 2* kʰænɔʊ CV.CV V
candle		1232* kʰædʌᵊ CV.CVᵛ	831 - T. 2* kʰæ̃ᵊdoʔ CVᵛ.CV	730* kʰæ̃ndɔʊ CVC.CV V
clock klɑk CCVC		656 - PR E tʰɑkʰ CVC		455 - T. 2* kʰʊlɑk Cᵛ.CVC
close clown klaʊn CCV VC		205 - T. 2 - C go CV		985 - C kʰo CV 377 - T. 2* ᵏlɑ ː ʊ̃n ᶜCV: VC
coffee kɑfi CV.CV	895 - E(GF) kʰɑjɛːˆ CV.ᶜV:	815 - T. 2-E* kʰɑfiˈ CV.CVˈ	411 - T. 2-PR E* kʰɑfi CV.CV	812 NC
comb	549 - E kʰɔˆ: CV:	1084 - PR E kʰo ː mᵊ CV:Cᵛ		
combing koʊm+ɪŋ CV VC+VC		805 - T. 2 - E kʰoʊ̃miʔ CV V. CV	803 - T. 2-PR E* kʰowĩm CV.CVC	848* komɛ̃ⁿn CV.CV ᵛC

crayon kɾɛɪjɑn CCV V.CVC		822 $k^haja^ə$ CV.CV ^{v}		
crayons kɾɛɪjɑn+z CCV V.CVC+C			733 - T. 2 - E* $k^hæla^{\tilde{ə}}n$ CV.CV^{v}C	241* $k^hɛʔ\tilde{a}n$ CVʔ.VC
cry kɾɑɪ CCV V			608 - T. 2 - DE, C $k^hʌ^əʔ$ CV^v	
quarter kwɔɾtə˞ CCV/ɾ/.CV/ɾ/	395 - T. 2 - E $k^xwowɛ'^ə$ CCV.CV^v	648 - T. 2 - E* gouwɛ^ɪ CV^v.CV^v	1105 - T. 2 - E* $k^hɔdo^{\wedge}ʔ$ CV.CV'	
/g/				
glove glʌv CCVC	467 - T. 2 - E gɑːs$^>$ CV:C	1137 - PR E* gɔ^{ɾ}ləʔ CV.^{c}CV		
glove		1138 - E* gɔlç CVCC	1116 - T. 2 - E* $gʌ^əv_o$ CV^{v}C	1183 - T. 2 - E* g^{ə}lʌv C^v.CVC
glove		1139 - E* gɑɾp^f CV[r]C^C		
glovey glʌv+i CCVC+V		1140 - E $gadi_o$ CV.CV	1117 - T. 2 - E* gʌviː CV.CV:	
glovey		1141 - E gɑɾliʔ CV[r].CV		
glovey		1142 - E gɑɾiɪʔ CV.CV		
go gou CV V	354 gɔ$^{\wedge ə}$ CV^v			
go	147, 338(DE) 774, 1128 - C gou(ʔ) CV V	994(GF) NC		579 - T. 2 - C NC

green	299 - T. 2 -E(GF)	621 - T. 2 - E*	385 - T. 2*	243*
grin	gæᵊs	gĩ˞ m	ginᵊʔ	gĩn
CCVC	CVᵛC	CV:C	CVCᵛ	CVC
green	300 - T. 2-E(GF)			
	gɛᵊ			
	CVᵛ			

/f/

feather	638 - E	1025 -T. 2-PR E*	357 - T. 2*	53 - T. 2 - PR E*
fɛðəˑ	hɛᵊwi	havʊᵊ	hɛːᵊzɪʔ	fɛᵊ
CV.CV/r/	CVᵛ.CV	CV.CVᵛ	CV:ᵛ·CV	CVᵛ
feather		1026 -T. 2-PR E*	374 - T. 2**	
		ha<fɑᵊ	fɛsɛᵊʔ	
		CV.CVᵛ	CV.CVv	
feet		715 - C	1081;1145 - C*	
fit		wit	fitʰ	
CVC		CVC	CVC	
finger	423 - T. 2 - E	979 - T. 2-PR E*	1075 - E(GF)*	374
fɪŋgəˑ	ʔæjɛᵊ	ʔægʊᵊ	fɛgʊᵊʔ	fɪgə
CVC.CV/r/	ʔV.CVᵛ	ʔV.CVᵛ	CV.CVᵛ	CV.CV(s/b plural)
fire		635 - E		
faɪjəˑ		haldæᵊ		
CV V.CV/r/		CV[l].CVᵛ		
fire		925		
		wɑɛɪ ː		
		CV V. V:		
fire		926 - PR E*		
		fajɛᵊʔ		
		CV.CVᵛ		
fish	1029 - E		241, 782 - T. 2*	
fɪʃ	ʔaʃ-s		fɛᵊs	
CVC	ʔVC		CVᵛC	
fish			781 - T. 2*	694
			fɪ˘s	fɪs
			CVC	CVC
fishing		57 - T. 2 - PR E	899 - T. 2*	686*
fɪʃ+ɪŋ		ʔæziː	fæs̃in	fɪs̃in
CVC+VC		ʔV.CV:	CV.CVC	CV.CVC

five faɪv CV VC		179 - T. 2-PR E* pfaᵊ $^{C}CV^{v}$	815 - T. 2* fæᵊv_{o} $CV^{v}C$	538 - T. 2 - E* fɔ<ɪv CV VC
fix fɪks CVCC				1020 - T. 2 -C fɪk CVC
flower flauwəɾ CCV.CV/r/	1089- E hɑjɛ^ɪ $CV.CV^{v}$	81 - T. 2 ʔavɛɪʔ $ʔV.CV^{v}$	874 - T. 2* faʔkoʔ CVʔ.C:V	884 - T. 2* fɛʊ CV V
fume fl̃um $C^{C}VC$	521 - T. 2 - E ^{h}jup ^{c}CvC			
funny fʌni CV.CV		481 - T. 2 hʌniᴵ CV.CV	231 - T. 2 ʔaᵊni $ʔV^{v}.CV$	
funny		486 - T. 2 - PR E* pfʌni $^{C}CV.CV$		
/v/				
van væn CVC	1093 - E hæ ː ᵊs(weak s) CV: ^{v}c	790-T. 2 - PR E* væ̃n $CV^{v}C$	479, 481(2)-T. 2 S, DE, SE* fæᵊn $CV^{v}C$	202 - T. 2 v_{b}æ̃n $CV^{v}C$
/θ/				
three θri CCV	586 (2)(GF) wiː CV:	1189 NC		158 - T. 2 - PR E* $f_{w}I^{i}ʔ$ CV
throw θroʊ CCV V			898 - T. 2 - C foʔ CV	941 - C fwoʊ CCV V
throwing θrow+ɪŋ CCVC+VC	26 - T. 2 (quiet) ʔʌᵊzɪ^{i} $ʔV^{v}.CV$		671 - T. 2(GF)* ʔowĩn ʔV.CVC (s/b throw)	
throwing	31 - T. 2 - E, C ʔɔʤi $ʔV.C^{C}V$		897 - T. 2** fowĩn CV.CVC	939* floʊʔĩn CCV V.ʔVC

thumb	222 - T. 2-E(GF)	583(GF)*	1076*	265 - T. 2
θʌm	hɑːᵊ	ʔʌᵊm	fʌ̃m	
CVC	CV:ᵛ	ʔVᵛC	CVC	NC
thumb			1111; 1126(C) - T. 2	
			hɑ̃ᵊm	
			CVᵛC	

/ð/

that	(Most common wd) 365;365, 898,	(Still common) 388, 663;975;136	(Still common) 1226; 1021 - T. 2*	48; 518(C)-T. 2 596 - T. 2
	1106, 1107, 1108, 1168 - C (with [n]) (S or SE)	- T. 2 - C	1070, 1113 - C 142, 169, 245 - T. 2-C	
ðæt	dɑᵊ		dæ(ə)tʰ	
CVC	CVᵛ	NC	CV (ᵛ)C	NC
that	364, 665, 724-C; 383, 793, 1095 1101, 1182 , 1076 - DSE, C (with [n])	371 - T. 2;1043-C		941 - C*
	dæᵊ			ðæt
	CVᵛ	NC		CVC

/s/

Santa Claus	919	934 - T. 2 - DE	550 - T. 2(GF)*	190(2)*
sæntə+klɑz	ʔægɑɪ		ʔækʰɑlɪʔ	ʔæklɑᵊ
CVC.CV+CCVC	ʔV.CV V	NC	ʔV.CV.CV	ʔV.CCVᵛ
scarf	1016 - E	216 - T. 2-PR E*	848 - T. 2*	746 (4) - E(1)
skɑrf	kɑs>	kɑᵊf	kʰɑf	
CCV/r/C	CVC	CV ᵛC	CVC	NC
screwdriver	382 - T. 2 - E	606 - T. 2 - E*	766 - T. 2(GF)*	
skrudrɑɪvəˠ	gʊdgɛᵊ	kʰʊkədɑɪ	gʊdæɪ	
CCCV.CCV V. CV/r/	CVC.CVᵛ	CV.CV.CV V	CV.CV V	
screw-dri-ver		607 - T. 2-PR E*	766 - T. 2 - PR E*	
		kʰudɑɪjɪʔ	kʰʊdɑɪvʊᵊʔ	
		CV.CV V.CV	CV.CV V.CVᵛ	
see, "C"	1199 - E	453 - T. 2 - E*	354(2) - T. 2*	503 - T. 2 - C*
si	hɪⁱ	siː ʔ	hɪⁱ	siʔ
CV	CV	CV:	CV	CV

sleep		800 - T. 2	1122 - PR E*	398*
slip		ʔip^{h}	^{hɬ}sip^{h}	slip
CCVC		ʔVC	^{c}CVC	CCVC
sleeping	1002 - E	165 - T. 2 - PR E	1124 - PR E*	399*
slip+ɪŋ	ʔipɪ^{i}	j ː ip^{h}iʔ	lip	slipʲin
CCVC+VC	ʔV.CV	C:V.CV	CVC	CCV.CVC
small				485, 904-T. 2-C*
smal				smɑ$^{(ə)}$
CCV/l/				CCV $^{(v)}$
smooth		705 - T. 2 - E;* 706 - T. 2 - DSE, C	1090 - T. 2*	
smuð		mũ ː v	muv$_{o}$	
CCVC		CV:C	CVC	
snake	956 - E(GF)	944 - T. 2*	33 - T. 2*	804*
snɛɪk	næk^{h}	snæk^{h}	^{t}snæk^{h}	sn ː ɛɪk
CCV VC	CVC	CCVC	^{c}CCVC	CC:V VC
snakey	957	951 - T. 2 - E*	1103 - T. 2*	806 - E*
snɛɪk+i	nægɪ˘^{i}	snaᵊk^{h}ɪ^{i}	neɪk^{h}ijᵊʔ	snɛɪk^{h}ɪ^{i}
CCV VC+V	CV.CV	CCV^{v}.CV	CV^{v}.CV.^{cv}	CCV V.CV
snowman	1006;1012-DSE, C (GF - 1012 on V_2)	209 - T. 2*	842, 843(E)-T. 2*	
snoʊ#mæn	no(^)mæ ː	domæᵊ ː	nomædᵊʔ	
CCV V#CVC	CV.CV:	CV.CV^{v}	CV.CVC^{v}	
snowman			843(E), 844(SE) - T. 2*	739 - C*
			nomæ̃nᵊ	nomæ̃n
			CV.CVC^{v}	CV.CVC
spoon	202 - T. 2 - E	642 - PR E*	1239	462*
spun	p^{h}u˘^{ʊ}	p^{h}ũ ː nː		spũn
CCVC	CV	CV: C:	NC	CCVC
spring	265 - T. 2-E(GF)	1044 - E(GF)*	387 - T. 2*	377 - T. 2 - E(GF)*
sprɪŋ	bɛᵊs	pɛ'gɑᵊʔ	p^{h}ɪ$_{o}$sʲin	p^{h}ʲɪŋ
CCCVC	CV^{v}C	CV'.CV^{v}	CV$_{o}$.CVC	CVC
squirrel	934 - E(GF)	831 - T. 2 - E	955 - T. 2*	816 - E*
skwəˠl	gʊwɛ		k^{h}walːoʔ	k^{h}ʊwəl
CCCV/rl/	C^{v}.CV^{v}	NC	CCV.C:V	CV.CV[l]
squirrel				817 - PR*
				skʊwəl
				CCV.CV[l]

star	411 - T. 2 - E	610 - T. 2 - E*	601 - T. 2 - DE*	119 - T. 2
star	$t_w{}^h$ɔː	tɑᵊ	dɑᵊʔ	tɑᵊ
CCV/r/	CV:	CV^v	CV^v	CV^v
star				125 - T. 2 - DE*
				stɑᵊ
				CCV^v
starry	426 - T. 2 - E	587 - T. 2 - PR E, C	777(2)- T. 2 - C*	128 - T. 2 - E, C*
stari	tɔ^wɛᵊ<	$t^hɑᵊ$	dɑɪ	stɔ<i
CCV/r/+V	CV.CV^v	CV^v	CV V	CCV V
sun		254 - T. 2 - E	860 - T. 2- DE*	676 - E*
sʌn		hɐ̃nᵊ	saᵊn	sɐ̃n
CVC		CVC^v	CV^vC	CVC
sun			857 - T. 2 - C	
			ɐ̃ᵊn	
			V^vC	
sweater		1160	1175 - E*	74 - T. 2*
swɛtəˠ		wɛdʌˈᵊ	wɛˡdzəʔ	wɛᵊbʊᵊʔ
CCV.CV/r/		CV.CVˈ^v	CV^v.C^CV	CV^v.CV^v
sweater		1162 - SE		76 - T. 2 - E*
		$b^vʌɪ$^dʌᵊʔ		wɛ-^{t}sw$ɛt^hʊ$
		C^cV V.CV^v		CV-^{C}CV.CV
swim				759*
swɪm				swɪ^{ə}m
CCVC				CCV^vC
swimming			364 - T. 2 - C*	495 - T. 2(GF)*
swɪm+ɪŋ			mæm̃in	wɪm̃in
CCVC+VC			CV.CVC	CV.CVC
/z/				
zipper	(no number)	803 - E*	755 - T. 2-E(GF)*	
zɪpəˠ	ʔæzi	ʔɪpɔʔ	zæpo˘ʔ	
CVCV/r/	ʔV.CV	ʔV̆.CV	CV̆.CV	
zoo	92 - T. 2 - E	497 - T. 2	678 - T. 2*	969*
zu	ʔʊᵘ	hu ː	zjuʷᵊʔ	zuᵘ
CV	ʔV	CV:	C^cV.^{cv}	CV
/ʃ/				
shirt		388 - T. 2		
ʃəˠt		hʊtˢ		
CV/r/C		CVC^c		

shoe		808 - C(GF)	1084 - C*	231 - T. 2 - DSE
ʃu		zju?	ʃu	
CV		C^CV	CV	NC
/ʧ/				
chair		860	1076 - T. 2 - C	322 - T. 2
ʧɛr		$t^hɛ?$	dæ?	$t^hɛ^ə$
C^CVC		CV^v	CV	CV^v
chair		896 - E	56 - T. 2	
		tʃɛ	tʃæ?ə	
		C^CV^v	C^CV^v	
chair			1077 - T. 2 - C	
			ʧɛ?ə	
			C^CV^v	
church	1178 - E	1021 - T. 2-PR E*	550 - T. 2 - PR E*	844 - E
ʧəʧ	$_vt^hʊʃ$	ʧʊt	$t^hʊʧ$	
$C^CV/r/C^C$	CVC	C^CVC	CVC^C	NC
church			558 - T. 2 - C*	
			$t^hʊwəʧ$	
			$CV.CVC^C$	
/ʤ/				
"G"	1185 - E	397 - T. 2	563 - T/ 2 - PR E*	871 - E*
ʤi	dji		dʲis ɪ	dʲiː
C^CV	C^cV	NC	C^cVC:	C^cV:
judge	465 - T. 2 - E	1035 -T. 2-PR E*	1086 - T. 2 - E*	536 - T. 2 - E
ʤʌʤ	da^{t}ʃ	da^{ə}s	dʒʌʤə?	
C^CVC^C	CV^cC	CV^vC	C^CVC^Cv	NC
jump	1185 - DE	1182 - PR E*	1055; 1057 (1057 s/b jumping)	468 - T. 2*
ʤʌmp	dɑ^ə	dʌp^h	dɑp^h	dʒɑp
CCVCC	CV v	CVC	CVC	C^cVC
/r/				
radio	884 - E(GF)	884 - T. 2 - E*	1045 - T. 2 - DE*	224 - T. 2(GF)*
rɛɪdijo	wɑzɛ^ə	wɛdɑ^ə	wɛdo?	wɛɔ^ʊ
CV V.CV.CV	CV.CV^v	CV.CV^v	CV.CV	CV. V^v

radio				226 - T. 2(GF) - E* wɛdæʊ CV.CV V
read rid CVC	970 wiː CV:	80 - T. 2 - PR E NC	811, 813 - T. 2-C NC	682* wiː d CV: C
/l/				
laugh læf CVC	1139 - E jæᵊs ᶜVᵛC		615 - T. 2 - E* ʔæf ʔVC	
laughing læf+ɪŋ CVC+VC	1137 - E hæ ziː CV.CV:	687 - T. 2 - PR E* ʔæfɪˉⁱn ʔV.CVC	612 - T. 2 - PR E* ʔæziʲᵊʔ ʔV.CV.ᶜᵛ	890, 891* læfin CV.CVC(N.B. - 891 - for laugh)
laughing			619 - T. 2 - E** læfin CV.CVC	
leaf lif CVC		1093 - PR E jif CVC	1235 - E* liː f CV:C	601* lʲif CᶜVC
leafy lifi CVC+V	465 - T. 2 - E ʔizɪⁱ ʔV.CV		1088 - T. 2* lifiˡʔ CV.CV	604 - E NC
/w/				
way wɛɪ CV V	630, 451, wæ (ː)ᵊ(ʔ) CV(:)ᵛ	950, 1030(2) 689(GF), 693-C NC	1124, 1200; 387 1031, 1125,1129 wæ ɪ CV V	843 - T. 2 - C 859 - T. 2 - C NC
way			859 - T. 2 - C wæₒ CV	
/j/				
yeh jɛ CV	150, 237, 250 jɛ ː (ʔ) CV (ʔ)	680 - T. 2 NC		23 - T. 2 NC

yeh (Many other "yeh's" -not counted)	234, 283(GF) jæ (ː)ə CV (:) V		1083 NC
yellow SE(C)* jɛlou CV.CV V	83 - T. 2 - E jɪʌlɔə CV.CVV ([l]-coloring on [j])	819 rː loh C:cV ([l]-colored flap)	781-T. 2-E, lalou CV.CV V
you ju CV	426 - T. 2 - E hwjuː cCV:	1210 - C* ju CV	931, 943, 977 -1038 - T. 2-C* hju CCV
/h/			
hanger hæŋə CVCV/ɾ/	230 - E ʔægjuʊʔ ʔV.CcV	565 - T. 2 -PR E* hægʌə CV.CVV	645, 646 hæ̃ŋʌə CVC.VV
hang hæŋ CVC		116-T. 2-PR E ʔæəⁿ ʔVVC	
hang		565 - T. 2 - C* hɑ̃ĩ>n CV VC	
hanging hæŋ+ɪŋ CVC+VC	1056 - E hægi CV.CV	114-T. 2-PR E* ʔæg̃ĩn ʔV.CVC	647 - E, C* hæg ːĩŋ CVC:VC
hungry hʌngri CVC.CCV		1212(GF)* hʌgɾi CV.CCV	975 - E* hʌŋkwɪi CVC.CV

Subject 5

AGE:	6;2 3 sessions, first two 1 day apart, third (cassette tape) 11 days later: 2nd 718 ff. Cassette tape=C.T.	6;4	6;6	6;8 2 sessions 1 day apart: 2nd=Tape 2 (Had "cold")

N.B. S5 tended to articulate with slight drooling from time to time. His voice was slightly tremulous. I have not noted these tendencies in the transcriptions, but the vowel variability may partially reflect voice factors.

Adult forms

Vowel Initial:

all ɑl V/l/	369 - T. 2 - E ɪʊ V V	1211 ɑᵘ Vᵛ	228 - C, E* ɑl V[l]	
all	1080 - C ʌʊ V V	1201 - C NC		690 - C (2) NC
alone əloʊn V.CV VC		1211 - C* əʔloʊ̃n Vʔ.CVᵛC	228 - C NC	430 əʔᵥloᵘn VʔCVᵛC
egg ɛg VC	941 ak^{h} VC	1083 æᵊk^{h} VᵛC	45;45-PR SE* ɑɪ{k/g̬} V VC	
egg	636 - T. 2 - E ɛᴵg VᵛC		47, 1030 - PR E ɛ.ɪ(.)k(/ʰ) VᵛC	693 ɛɪk^{h} V VC
icecube(s) ʌɪs#kjub(+z) V VC#C^{C}VC(+C)	155 ʌɪθkɑ^b$_{o}$θ VVC.CVCC	788* ʌɪθkob$_{o}$θ V VC.CVCC	36* ʌɪθkᵘwob̬ V VC.CᵛCVC	
icecubes	625 ʌɪθkopθ VVC.CVCC			368 - E* ʌɪθkʊb$_{o}$θ V VC.CVCC
itch ɪʧ VC^{C}	276 - T. 2 - E itθ VC^{C}			840 - PR E* ɪʧ VC^{C}

orange	691	1107*	869	104
ɔr(ə)nʤ	õr̃ndð	ɔr$_{w}$ĩndð	ɔ·rnDʒ$_{o}$	ɔrnᵗθ
V.C(V)CC^{C}	VrCC^{C}	V.CVCC^{C}	V·[r]CC^{C}	V[r]C^{C}C
orange	692-SE			105 - PR SE*
	oẉəndð			ɔrntʃ
	VCVCC^{C}			V[r]CC^{C}

/m/

mask	355 - T. 2	982*	382;383 - PR E	506
mæsk	maθk	ma^{ə}kθ	ma$^{(ɪ)}$kθ(·)$^{ə}{}_{o}$	ma^{ə}kθ
CVCC	CVCC	CV^{v}CC	CV^{v}CC	CV^{v}CC
mask			386*	
			maθk^{h}	
			CVCC	
milk	675 - T. 2 - C		889	391, 399 - DE*
mɪlk	mɪjok^{h,}		mɪ^{ʊ}k	mɪlo^{ʊ}k^{h}
CV/l/C	CV.CVC'		CV^{v}C	CV.CV^{v}C
milk				397 - E*
				m ː l̈ʊk^{h}
				C : C^{C}VC
milk				398 - PR E*
				m ː jʊk^{h}
				C : CVC
music	434 - E	1141 - E*	599 (PR E-σ1)	124*(quiet)
mjuzik	moʔθɪ(?)	mʌ^{ʊ}gðɛ^{ɪ}k	mo^{ʊ}ʔgi^{ɪ}	mʊd̄ðik
CCV.CVC	CVʔ.CV	CV^{v}C.CV^{v}C	CV^{v}ʔ.CV	CVC.CVC
music			600 - E*	129 - SE*
			mo^{ʊ}ðɪk	$_{v}$mu^{ˇ}ðik
			CV^{v}.CVC	CV.CVC
music				133-SE(E-syl 1)*
				$_{v}$mʊθgɛ^{ɪ}k
				CVC.CV^{v}C
music				975*
				mʊkθɛ^{ɪ}k
				CVC.CV^{v}C

/n/

noise	262, 264 - T. 2	47 - T. 2*	555*	552
nɔɪz	nɔɪð	nɔɪ^{t}θ	nɔɪð	
CV VC	CV VC (2)	CV V^{C}C	CV VC	NC

noisy	267 - T. 2	50 - T. 2	558	555 (E-syl 1)*
nɔɪz+i	nɔɪðɪʔ	nɔɪð^ɪiç	nɔɪ^{d}ʒiɪ$_{o}$	nɔɪʃɟɪ^ʔ
CV VC+V	CV V.CV	CV V.CV^{vc}	CV V.^{c}CV	CV V.C^{c}V
/p/				
pages	294 - T. 2	72 - T. 2 - (SE)*	894*	862*
pɛɪʤ+əz	p^{h}ɛɪd^{ð}ɪθ	p^{ʊ}i˘d^{ð}ɪð	p^{h}iʤɪʒ	p^{h}idðɛɪð
CV VC^{C}+VC	CVV.C^{C}VC	C^{v}V.C^{C}VC	CV.C^{C}VC	CV.CCV VC
plate	1045 - C			163 - T. 2*
plɛɪt	p(^{h})ɛɪ·t			pəlɛɪt
CCV VC	CV V·C			CV.CV VC
play(ing)	159 - T. 2	904 - C*		429 - T. 2 -C
plɛɪ(+ɪŋ)	p^{ʊ}wɛɪ	p^{ʊ}lɛɪ·ʔ		p^{ʊ}lɛɪj˜in
CCV V(+VC)	C^{v}CV V	C^{v}.CV V·		C^{v}.CV V.CVC
pouring	287 - T. 2	85 - T. 2*	398*	511
pɔr+ɪŋ	p$_{v}$ɔ^w˜ɪn	p^{h}ɔwɪ˘n	boli˘n	bɔw˜ɪn
CV/r/+VC	CV.CVC	CV.CVC	CV.[l]VC	CV.CVC
pouring			398 - E*	512 E;514(DSE)*
			p^{h}ɔʔlin	p^{hʊ}wɪ˘n'
			CVʔ.[l]VC	C^{v}.CVC
pouring			402 - PR E*	512 - PR E*
			p^{h}ɔʀ ː in	p^{h}ʊ^{ə}wɪ˘n·’
			CV.[r]: VC	CV^{v}.CVC·
pouring				518 - PR E*
				pɔrɪn'
				CV[r]VC
present	679 - E	917	191	268*
prɛzənt	pɑ̃n^{t}θ˜in	pʊɰæðɪ^{ə}nt	p^{h}ʊwæ̃n^{t}θɛk^{h}	p^{ʊ}wɛðɪ˘⟨n⟩t
CCV.CVCC	CVC^{c}·CVC	CV.ÇV.CV^{v}CC	CV.CVC.^{C}CVC	Cv.CV.CV<C>C
pretty		885		
prɪti		bj̇ɪ˘t^{h}i˘ɪʔ		
CCV.CV		C^{c}V.CV		
/b/				
basket	280 - T. 2	1211*	243	12*
bæskət	bak^{θ}ɛθ	bwæ-bakfkɪ^t	bakθɛɪʔ	baθɪk^{h}
CVC.CVC	CVC.^{C}VC	CCV-CVCC.CVC	CV^{c}.CV V	CV.CVC

basket		1216 - E* bæfk^{h}ɛɪt^{h} CVC.CV^{v}C		
bath bæθ CVC		1119 bæ^{ə}f CV^{v}C	581* ba^{ə}ʃ^{f} CV^{v}C^{C}	622* baθ-ᵖf CVC-CC
bath			581 - SE bæ^{ə}f CV^{v}C	627 ba$^{>ə}$f CV^{v}C
bathtub bæθ#tʌb CVC#CVC	463 bʌθ^ʌ^{ə}b CV.CV^{v}C			
black blæk CCVC		825* b^{ʊ}̩læ^{ə}k^{h} C^{ɣ}.CV^{v}C	630 b^{ʊ}lak^{h} C^{v}.CVC	53* bʊlʌ<g$_{o}$ CV.CVC
black		1188 ba^{ɛ}k^{h} CV^{v}C		
book bʊk CVC	292 - T. 2 bok^{h} CVC			200 - T. 2 NC
books bʊk+s CVC+C	1052(2)-C, E(1); 1055 - C bʊkθ CVCC			203, 205(DE) -T. 2-C b{o$^{˘}$/ʊ} kθ CVCC
boot but CVC	441 bo^{ʊ}t CV^{v}C	985 bot^{h} CVC	570 - E bo^{ʊ}t^{h} CV^{v}C	58, 412 (PR SE)* bu$^{˘}$ t CVC
boot	448 - E bʊt CVC	1135 bʊ^{ə}t^{h} CV^{v}C		92, 408 bo$^{\sim}$(^)t^{h} CVC
bread brɛd CCVC		897* bræd CCVC	175* b^{ə}læ^d C^{v}.CVC	
bread		897 - C, SE* b^{ʊ}rj̩æ^{ə}d C^{v}.C^{c}V^{v}C	176 - PR E bʊ ː lad CV: CVC	
bread		899 - C, E* b^{ʊ}læd$_{o}$ C^{v}.CVC	177 - PR E bʊ̩ːlad C^{ɣ}̩ː.CVC	

bread			180 - PR E*	342
			bʊwad	bʊwɛᵊd
			CV.CVC	CV.CVᵛC
bread			180 - PR E*	
			bᵘrᵘw·æd	
			Cᵛ.Cᵛ.C·VC	
broken	892 - C			
brɔʊk+ən	bokĩ˜n			
CCV VC+VC	CV.CVC			
broom		1081*	136*	256
brum		bᵊjʌ˜m	bᵊrʌɑʌm	bᵘrᵂũm
CCVC		Cᵛʳ.CVᵛC	Cᵛ.CᵛVC	Cᵛ·CVC
broom		1082 - SE		
		bᵘwʌᵅm		
		Cᵛ.CVᵛC		
brother	314 - T. 2			
brʌðəˠ	bwʌDoᵘ			
CCV.CV/ɾ/	CCV.CVᵛ			
brown		824, 833*	630*	
braʊn		bᵘɰa{ʊ/ʊ̃}n	bᵘlaᵅn	
CCV VC		Cᵛ.CV {V/ᵛ}C	Cᵛ.CVᵛC	
brush	232	1015 - C, PR SE*	14	
brʌʃ	bʌᵊθ	bʌʃ	bᵘɰʌᵊθ	
CCVC	CV ᵛC	CVC	Cᵛ.ÇVᵛC	
brush	767 - C		817*	794 - E*
	bʌθ		bwʌᵊʃ	bʊɰʌᵊʃ
	CVC		CCVᵛC	CV.ÇVᵛC
brushing	718 - C			
brʌʃ+ɪŋ	bᵛrʌfĩ˜n			
CCVC+VC	CᶜCV.CVC			
brushing	730 - C, E			
	bʌθĩ˜n			
	CV.CVC			
buzzing	185 - T. 2 - E	1220	253*	436*
bʌz+ɪŋ	bʌðĩn	bʌðĩ˜n	bʌz>ĩ˜n	bʌʤĩ˜n
CVC+VC	CV.CVC	CV.CVC	CV.CVC	CV.CCVC

/t/

toes	39	759*		178*
toʊ+z	T·oð	To^{d}ð$_{o}$		t^{h}o^{ʊ}ð$_{o}$
CV V+C	C·VC	CV^{C}C		CV^{v}C
together	250 - C	1201 - C*		692 - C*
tugɛðə˞	tugɛdʊ	gɛto^{ʊ}ʔ		tʊgʔgadʊ
CV.CV.CV/ɪ/	CV.CV.CV	CV.CV^{v}		CVCʔ.CV.CV
toothbrush		1013	818*	789(quiet)*
tuθ+brʌʃ		t^{ʊ}wuʃbʌ^{t}θ	to^{ʌt}ʃ<b^{ə}ɣ$_{ʌ}$^{ə}ʃ	t^{h}uθbʊwʌθ
CVC+CCVC		C^{v}.CVC.CV^{C}C	CV^{C}C.C^{v}.ÇV^{v}C	CVC.CV.CVC
toothbrush				791*
				t^{h}utʃbʊwʌθ
				CVC^{C}.CVCVC
tree	1085 - C			
tri	θ^{ʌə}wɪ^{i}			
CCV	C^{v}CV			
tree	1087 - C, DSE			387 - T. 2 - C*
	tɪ^{i}			twɪ^{i}
	CV			CCV
truck	167	792*	484	584*
trʌk	^{t}θwɑ$^{˘ə}$k	t^{ə}ra^{ə}k^{h}	t^{hʊ}ɣak	t^{h}ə˞ʌk
CCVC	^{C}CCV^{v}C	C^{v}.CV^{v}C	C^{v}.ÇVC	Cə˞VC
truck	412 - C	965 - C*		
	Twa^{ə}k	θʊwʌə^{k}h		
	CCV^{v}C	C^{v}.CV^{v}C		
truck	1140 - C	965 - C, SE*		
	θwʌ^{ə}k	s^{ʊ}-t^{ʊ}ɣʌk^{h}		
	CCV^{v}C	C^{v}-C^{v}.ÇVC		
twenty		1191 - C*	480*	
twɛnti		ʧwãnt^{h}iː ^{ɪ}$_{o}$	t^{hʊ}wãnt^{h}i$_{o}$	
CCVC.CV		C^{C}CVC.CV^{v}·	Cv.CVC.CV	
twenty			1003 - PR E; 1004	
			tw{ã/æ}ntɪ^{i}	
			CCVC.CV (2)	
twenty-three		909		
twɛnti#θri		θæ̃ntɪ^f^{ʊ}wi^{ɪ}ʔ		
CCVC.CV#CCV		CVC.CV.C^{v}.CV		

twenty-three		910 θæ̃nfĩ˘nf·iʔ CVC.CVC.C·V		
twin(s?) twɪn(+z) CCVC(+C?)			497 twĩnð CCVCC	
twinkle twɪŋkəl CCVC.CV/l/	176 - C (2) θ^ĩ˘ŋko^{u} CVC.CV^{v} (2)			
/d/				
dad dæd CVC	327 - T. 2 dæt^{h} CVC	137 - T. 2* Dæ^{ə}D CV^{v}C		820 dɛ˘d$_{o}$ CVC
diving	615 - DSE daɪf$_{V}$ĩn CV V.CVC	1106 daɪfĩ˘n CV V.CVC	77 daɪv$_{o}$ĩ˘n CV V.CVC	311 NC
dolly dɑl+i CVC+V		901 - E* dɑ^{hə}$_{o}$li˘ʔ CV.^{cvr}.CV	56 dɑ^{u}lɪ^^{i}ʔ CV^{v}.CV	774 (E-syl 1) daʊ-dɑ-li' CV V-CV.CV'
dolly		925* dæ^{u}ʔli CV^{v}ʔCV		
dolly		927 - SE* da·li CV·CV		
dragon drægən CCV.CVC		932* d^{u}ragɪ^n C^{v}.CV.CVC		
draw drɑ: CCV:		827* drɑ^{ə}$_{o}$ CCV^{v}		
drawing drɑ+ɪŋ CCV+VC	1064 - C ^{d}ðaʊwĩ˘n ^{C}CV^{v}.CVC			
dress drɛs CCVC	72 T^{θ}wɑ^{ə}T C^{C}CV^{v}C	773* ʤ^{ə}ɣ̩æð$_{o}$ C^{C}v.ÇVC	798 d^{u}ɣ̩a^{ə}s C^{v}.CV^{v}C	703;492 - T. 2 dʊw{a^{ə}/ʌ}θ CV.CV^{v}C

dress	1155a - C ^{d}ðæd$_{o}$ ^{C}CVC	778 - C* θwæ^{ət}θ CCV^{v}CC		
/k/				
cage kɛɪʤ CV VC^{C}	387 - T. 2 - E k^{h}ɛɪdð CV VC^{C}	1060 NC	214* gɪʃ CVC	242* kiʒ ː CVC:
cagey kɛɪʤ+i CV VC^{C}+V	390 - T. 2 - E k^{h}ɛɪdði CV V.C^{C}V	1061 - PR E* k^{ʊ}wɛɪdðɪi? C^{v}.CV V.C^{C}V	217 - C, PR E* k^{h}ɛɪʤ·i$^{˘}$ CV V.C^{C}.V	245(clenched teeth) k^{h}ɛ$^{∧}$iʒɪ^{ə}? CV^{v}.CV^{v}
cagey		1063 - SE* k^{h}ɛɪʔʒi CV V.ʔCV		
clean klin CCVC		861 - E k^{hʊ}l̆in C^{v}.CVC		
cleaner klinə˞ CCV.CV/r/			515 - PR E k^{o}li$^{˘}$no$^{ʊ}{}_{o}$ C^{v}.CV.CV^{v}	
clothes klouz CCV VC	367 - C kwoð CCVC			932* kʊwot^{h} CV.CVC
clothes				932 - PR SE* k^{ʊ}wuS C^{v}.CVC
clothes				933 - PR SE* kəlo$^{∧ʊ}$T^{θ} CV.CV^{v}C^{C}
cry kraɪ CCV V			358 kwaɪ CCV V	488 k^{ʊ}waɪ C^{v}.CV V
cry			359 - PR E kʊwə˞ CV.CV[r]	489 - PR SE kawaɪ CV.CV V
cry			360 - PR E kə˞laɪ CV[r].CV V	490 - PR E* kʊw̧aɪ CV.ÇV V

cry				492 (car-eye, PR E)* karaɪ CV.CV V
cry				492 - E* kəɾʌɪ CəɾV V
crying kraɪ(j)+ɪŋ CCV V(C)+VC	975 kᵘwaɪjĩ̃n Cᵛ.CV V.CVC		348, 357 k{ʰ/ᵘ}waɪjĩn CCV V.CVC	483* kʰwãĩn CCV VC
quarter kwɔrtəɾ CCV/ɾ/.CV/ɾ/	433 - T. 2 - E kʰɔdʊ CV.CV		885 kʰotʰʊʔ CV.CVᵛ	
queen kwin CCVC	258 kəwĩ̃n Cᵛ.CVC	1198* kʰowĩ̃n CV.CVC		
queen	272 - DSE kwĩ̃n CCVC			
/g/				
girl	1127 - C			147, 297-T. 2 206, 375 - T. 2-C
	gɔrl CV[rl]			NC
girl	1192 - C gowə̃ CV.CV			141 - C* kʊwəʔ CV.CV
glove glʌv CCVC	528 gwʌəvₒ CCVᵛC	232 - T. 2 gʊwaəv CV.CVᵛC	1034 gᵘvʌv Cᵛ.CVC	868* gəlʌv CV.CVC
glove		233 - SE* gəlʌəv Cᵛ.CVᵛC	1035 - PR SE gᵘwav Cᵛ.CVC	
glove			1036 - PR SE gᵘlʌv Cᵛ.CVC	
grape grɛɪp CCV VC			405 golep CV.CVC	

grape

406 - (PR E-syl 1)
gɔrlep
CV[r].[l]VC

grape

407
gʊr$_w$ep^h
CV.CVC

great
greɪt
CCV VC

1201 - C
git
CVC

689 - C*
gɛᴵt
CVᵛC

green
grin
CCVC

424 - T. 2
gᵁwin
Cᵛ.CVC

835*
gʊɰi˘ n
CV.CVC

101*
k$^{hu}{}_o$wĭ˘n
CV.CVC

green

837 - SE
gʊwĭ˘˘n
CV.CVC

/f/

find

1224 - C

704, 713, 717 - T. 2 - C

faɪnd
CV VCC

faɪn
CV VC

fãn
CVC

find

14, 20 - T. 2 - C
f{ʌ/a}~n
CVC

fingers
fɪŋgɚ+z
CVC.CV/r/+C

46
fɾ̃ŋgʊ⟨θʔ⟩
CVC.CV<C>

169
fɪŋgɔ⟨θ⟩
CVC.CV<C>

fish
fɪʃ
CVC

363
fiθ
CVC

1096
fi·ᴵθ
CV·C

70
fiθ
CVC

72

NC

fish

631 - SE
fiθ^
CVC

1097 - PR E
f^iθ
CVC

72
f·i˘·θ
C·V·C

73 - SE*
fɪʃ^
CVC

fish

73 - SE*
liθ
CVC

flower
flaʊwɚ
CCV.CV/r/

687
ᵖfaʍoʊ
ᶜCV.CVᵛ

1058*
fwaʊː
CCV V:

85*
falo^ʔ
CV.CV

flower

88 - SE*
faˑʔl$_ɾ$oʔ
CV..CV

flowers flaʊwə˞+z CCV V.CV/r/+z				726 fʊlaɪjɔʊ CV.CV^{vc}.CV^{v}
fly flaɪ CCV V	625 - T. 2 f^{w}aɪ C^{C}V V		1005* fʊwaɪʔ C^{v}.CV V	759 NC
fly			1005 - SE* fʊlaɪʔ CV.CV V	760 - PR SE* NC
friend frɛnd CCVCC	526 - C fʌ$^{ə̃}$nd CV^{v}CC			
fruit frut CCVC			874 fʊwoʊt C^{v}.CV^{v}C	941* fʊɰ̣ut C^{v}.ÇVC
fruit			876 - PR E fʊɰ̣oʊt C^{v}.ÇV^{v}C	
fume fj̇um C^{C}VC	4 - C.T. - E fʊ̃m CVC			
/v/				
vacuum væ.kj̇um CV.C^{C}VC			514 - PR E vak^{h}ə˞ʔk^{h}ʌʊm CV.Cə˞ʔ.CV^{v}C	
van væn CVC	378 - E v$_{o}$a<^{ə}n CV^{v}C	963 fa˘^{ə}n CV^{v}C	606 v$_{o}$a^{ə}n CV^{v}C	600 (E-[v]);601-E* v{ɛ˘/ã}n CVC (2)
/θ/				
thing θɪŋ CVC	398 - C ðɪ˜ŋ CVC			
think θɪŋk CVCC				265 - T. 2 - C θɪŋk CVCC
three θri CCV	79 f·i C·V	911 NC	22 fʊwĩʔ CV.CV	787 fʊwiˈ CV.CV

three		1163 - C, E fwɪ^{i}ʔ CCV		
throw θroʊ CCV V	209 fwʊ˘ CCV	206 - T. 2 - C fo(^{w}ɪ^t^{h}) CV(C)		903, 904(SE) f(əl)oʊ C(VC)V V
throwing θrow+ɪŋ CCVC+VC	207 - E fʊ˘wĭn CV.CVC	204 - T. 2 - C f$_{w}$owĭn CV.CVC		543(quiet) fwɔ^wĭn CCV.CVC
thumb θʌm CVC	49,350;535 - C fʌ̃m CVC (3)	756, 1145 NC	460* fː ᵊvə˞lʌm C:^{v}ə˞.CVC	
thumb			461 - SE* faᵊ̃m CV^{v}C	
/ð/				
the	777,861,1066 1079, 1097, 1087 1133 (2), 1140 1155, 1179 (2) 1183, 1197, 1208 - C di CV	778, 204(2) - T. 2 - C di(˘-1) CV		163 - C 260, 343, 384 489, 579, 583 628, 665 - T. 2 - C NC
the	1066 - C, E ði CV	818 - C* ðə CV		271, 801(T. 2) - C, E NC
/s/				
Santa Claus sæntə+klɑz CVC.CV+CCVC	472 θʌ̃ntəkɑᵊ⟨D⟩ CVC.CV.CV^{v}(C)	1130* θʌnək^{h}ʌð CV.CV.CVC	282* ʃ<æntəkwɑᵊʒo CVC.CV.CCV^{v}C	20* θʌ̃ntəkɑ⟨ð⟩ CVC.CV.CV<C>
Santa Claus		1131 - SE θænək^{h}ʊwɑð CV.CV.CV.CVC		
scarf skɑrf CCV/r/C	707 karf CVrC	1079 NC	130 NC	250; 251, 253(SE) NC

scarf			131 - PR SE* kɬ-kəlˌaʊf C^{C}-C^{v}.C^{c}V VC	255 - E* θ^kaʊf CCV VC
scarf			133 - E* kɬ-θka^{ə}f C^{C}-CV^{v}C	
screwdriver skru draɪvə˞ CCCV. CCV V.CV/r/	420 θkuθaɪvɔʊ CCV.CV V.CV^{v}	830* kθ ː koðaɪvɔʔ CC:CV.CVV.CV	633* θkʊlou ðaɪvɔ^^{ə}ʔ CCV.CVV.CVV. CV^{v}	566* sk^{h}wudə-ʃ- tθ$_{v}$aɪvə CCCV.CV-C- CCV V.CV
sewing machine sowɪŋ#məʃin CV.CVC# CV.CVC	640 - E ^{t}θowĩnəθɛ^{ɪ}n ^{C}CV.CVC .V.CV^{v}C	1067* ^{t}θowĩ^nbi˘θɪ^n ^{C}CV.CVC. CV.CVC	25* θoĩn^{t}θĩn CV.VC. ^{C}CVC	271 - C* ^{t}θowĩ˘˘nmɪ˘θi˘ĩn ^{C}CV.CVC. CV.CVC
sitting sɪt+ɪŋ CVC+VC	1045 - C satĩ˘n CV.CVC			101* θɛɪtĩ˘n CV V.CVC
skating skɛɪt+ɪŋ CCV VC+VC	810 θ^kɛɪtĩ˘n CCV V.CVC		479 ([s] - E) Sɪkət^{h}ĩ˘n CV.CV.CVC	
skates skɛɪt+s CCV VC+C			446 θkɛ^{ɪ}tθ CCV ^{v}CC	
sky skɑɪ CCV V	176 - C skɑɪ CCV V		443* ^{t}θ·kɑɪ ^{C}C·CV V	
sleep slip CCVC	640 - T. 2 - C 642 - T. 2 θwip CCVC (2)	763* d$ʒ^{h}$wɛ^{ɪ}p ^{C}CCV^{v}C	689* θ^{ʊ}ˌlip C^{v}ÇVC	204* ðəlɪ^p CV.CVC
sleep	591 - C θip CVC		692 - PR E θ^{ʊ}wip C^{v}.CVC	378, 382(DSE) -T. 2 - C* θəlip CV.CVC
sleep			702 ʃip CVC	

smiling				447 - T. 2 - DE, C
smaɪl+ɪŋ				θmaĩn
CCV V/l/+VC				CCV VC
smooth	189 - T. 2 - E	103 - T. 2	942*	
smuð	θmov	Smo^{ʊ}v	mo^{ʊ}v	
CCVC	CCVC	CCV^{v}C	CV^{v}C	
snake	436	1132	726	
snɛɪk	θnɛɪk	θnɛɪk^{h}	θnɛ̃^ ĩk^{h}	
CCV VC	CCV VC	CCV VC	CCV VC	
snake			726 - DSE	401
			snɛɪk^{h}	
			CCV VC	NC
snakey	352 - E		880*	404*
snɛɪk+i	θnik^{h}ɛɪ		ʃ<nɛɪk^{h}ɪi?	θnik^{h}i˘?
CCV VC+V	CCV.CV V		CCV V.CV	CCV.CV
snow			117	
snoʊ			^{t}θn·o^{ʊ} (GF)	
CCV V			^{C}CC.V^{v}	
snowing	702 - C	1074*	119*	248*
snow+ɪŋ	nõwĩ˘n	θnowẽ^n	^{t}θnolĩ˘n	θ^n̥owĩ˘n
CCVC+VC	CV.CVC	CCV.CVC	^{C}CCV.CVC	CCV.CVC
snowing			121 - E	
			^{t}θowĩn'	
			^{C}CV.CVC'	
soap	462 - C	858*	586	30
soʊp	^{t}θ^o^{ʊ}·p^{h}	θo^{ʊ}p	θ^o^{ʊ}p	
CV VC	^{C}CV^{v}C	CV^{v}C	CV^{v}C	NC
spider	339	1159 - C	982*	
spaɪdə˞	θ^paɪjʊ	θpaɪjo^{ʊ}	paɪjo^{ʊ}?	
CCV V.CV/ɾ/	CCV V.CV	CCV V.CV^{v}	CV V.CV^{v}	
spoon		996, 1166	712, 967	573;658 (PR SE)*
spun		θpõ(^)(^{ʊ})n(.)	θpõn	θ^pũn
CCVC		CCVC(.)	CCVC	CCV^{v}C
spring	449 - T. 2 - E	845*	761 - E*	803*
sprɪŋ	θ^pĩ˘n	p^{h}owẽn	θp^{ʊ}ɰĩ˘n	Spʊwĩ˘n
CCCVC	CCVC	CV.CVC	CC^{v}.ÇVC	CCV.CVC
spring		845 - E*		
		pr$_{w}$ĩ˘˘n		
		CCVC		

squirrel	210	1116*	575*	423*
skwɚl	θ^·kijoᵘ	θ^kowɚʔ	ʃkʊloʊhəₒ	Skᵘwɔᵘ⟨l⟩
CCCV/rl/	C.CV.CVᵛ	CCV.CV[r]	CCV.CVᵛ	CCᵛCVᵛ<c>
star	170;173, 176(C-2)	998, 1000(SE)	635*	778*
star	θ(·)ɑ(·)r(·)	(t)θar(o)(.)	ʃ<tɑɚ	θ^tɑɚ
CCV/r/	C(·)V(·)[r](·) (4)	(C)CVr	CCVɚ	CCVɚ
string	414 - T. 2	838*	222	763, 764(E);797*
strɪŋ	θʊwĩn	ʤᵘwe^n	dʊɰĩn	{S - 1,
E}trĩ⟨n/ŋ?⟩				
CCCVC	CV.CVC	CCᵛ.CVC	CV.ÇVC	CCVC
sweater		804*		595*
swɛtɚ		ʤəradoʔ		tʃʊwatʊʔ
CCV.CV/r/		CCv.CV.CV		CCV.CV.CV
/z/				
zoo	259	45 - T. 2	554	551
zu	θoᵘʔ	tθ - tθuₒ	dʒuₒ	tʃːʊᵘ
CV	CVᵛ	CC - CCV	CCV	CCVᵛ
zoo				551 - E*
				θ^ːuᵘ
				C:Vᵛ
/ʃ/				
sheep	1066 - C, E		974*	648;250 - T. 2 - C
ʃip	θip		ʃ^ip	
CVC	CVC		CVC	NC
shoe	1217 - C; 20 - T. 2 56 - C		952, 985(SE)	785*
ʃu	θo(^)ᵘ	θoᵘ	ts˃ɪoₒ	θ^oᵘʔ
CV	CVᵛ (2)	CVᵛ	CCV V	CVᵛ
shoe	14 - T. 2 - C	953 - PR SE*	787 - SE*	60 (PR E), 66 - SE *(quiet)
	tθoᵘ	ʃ·oᵘ	tʃʊuʔ	θʊu
	CCVᵛ	C..Vᵛ	CCVᵛ	CVᵛ (2)
/ʧ/				
chair	1022,1029 - C	997	757 - PR*	684(clenched teeth)
ʧɛr	tθɛɪjo(ʊ)	tθɛjoː	ʧɛɪjoʊʔ	ʧɪjə
CCVC	CCV V.CVᵛ	CCV.CV:	CCV V.CVᵛ	CCV.CV

chair		997 - PR SE*	1018	684- PR SE*
		ʒɛjoᵘʔ	ᵗθɛᵊ	ʧɛᴧᴜ
		CV.CVᵛ	ᶜCVᵛ	CCV.ᵛᵛ
chair		1200*		987;101, 147(C) - T. 2
		tʃɛjoʔ		
		CᶜV.CV		NC
cherries	690 - E	1105*		355*
ʧɛr+ɪz	ᵗθɛwɪⁱ	θɛwiˇθ		θəʃɛᴧⁱʔθɛwiᴵᴲ
CᶜVC+VC	ᶜCV.CV	CV.CVC		CV.CVᵛʔ.CV.CV
choochoo	231 - T. 2		923*	824*
ʧuʧu	tθutθutθ		tθoʧuᵘʔ	ʧuʧuᵘ
CᶜV.CᶜV	CᶜV.CᶜVCᶜ		CᶜV.CᶜVᵛ	CCV.CCV
/ʤ/				
judge	236 - T. 2 - E	192 - T. 2*	928 - E*	373 - E
ʤᴧʤ	dʲᴧdð	ʤᴧdᵟₒ	ʤᴧdʒₒ	ʤₒ·ᴧᵊʤ
CᶜVCᶜ	CᶜVCᶜ	CᶜVCᶜ	CᶜVᶜC	Cᶜ.VᵛCᶜ
jump	21		167(s/b -ing)	190(1 - s/b -ing)* 268, 270 (C) - T. 2
ʤᴧmp	dðɑ̃mp		dðₒᴧᵊmp	tʃ ːᴧᵊm⟨p⟩
CᶜVCC	ᶜCVCC		CCVᵛCC	ᶜC: VᵛC<C>
jump	1070 - C		660 - PR	183
	ᵈðæᵊp		ᵈðᴧᵊm⟨p⟩	ᵗθ^ɑ̃mp
	ᶜCVᵛC		ᶜCVᵛC<C>	ᶜCVCC
/r/				
rabbit	520	927	417	
ræbɪt	wæbɛᴧᴵtˈ	wæbiˇtʰ	ᵥwabiˇt	
CV.CVC	CV.CVᵛC	CV.CVC	CV.CVC	
rabbit			419 - SE*	
			rᵂaˇ bɪ^tʰ	
			CV.CVC	
roar	223 (S,SE)		935, 936(PR E) 937a (PR E), 938a, 938c, 938d	499* (almost retro.)
rɔr	wɔr			ᵥwɔəˠ
CV/ɪ/	CVr (2)		NC (6)	CVəˠ

roar			937b, 938b lɔr CV[r]	

/l/

laugh læf CVC	977 - SE lː æf C:VC	183 - T. 2 ᵥlaf CVC	353, 354 (SE) (v)l{ʌ/aᵊ}f CV(ᵛ)C	486, 487 (DSE) l(·)a(ᵊ)f C·VᵛC
laughing læf+ɪŋ CVC+VC	976 - E vafĩ˜n CV.CVC	181 - T. 2* lɑfẽ˜ɪn CV.CVᵛC	351 lafĩn CV.CVC	485 NC
leaf lif CVC	987 wɛ^ɪf CVᵛC	882* ʊlif V.CVC	825 ᵥlif CVC	575 NC
little lɪtəl CV.CV/l/	119 - C, E wʊɾə CV.CV	820 - C wʊdo CV.CV		
Lyle lɑɪjəl CV VCV/l/	225 - E wɑɪjoᵘ CV V.CVv	1241 - E* lɑɪ·ʔloᵘʔ CV V·ʔ.CVᵛ	367 NC	497 - E* jlɑɪjɔʊₒ ᶜCV V.CV V

/w/

watching wɑtʃ+ɪŋ CVCᶜ+VC	483 wɑðĩ˜n CV.CVC	1127 - PR E* wat.ʰ˜ɪn CV.C·VC	608* waᵈʒĩn CV.ᶜCVC	382;379(C, DE)* watʃᵥĩ˜n CVCᶜVC (2)

/j/

yeh(/yes) jɛ(s) CV(C)	667 ʲjɛᵊ vCVv	750 jɛᵊ CVv		547 jaᵊS CVvC
yellow jɛlou CV.CV V		944* ᵥlædoᵘₒ CV.CVᵛ	644 laᵊʔ CVᵛ	
yellow			647 - SE* jaᵊʔloᵘʔ CVᵛʔ.CVᵛ	76, 77 (SE) jɑ(ᵊʔ)loʊʔ CV(ᵛʔ).CVᵛ

/h/

hanging hæŋ+ɪŋ CVC+VC	368 - E han·ĩ˜n CVC·.VC		164 - E ha˃-haˇn.n̄ĩn CV-CVC.CVC	282 - PR E hʌn̄ĩn CV.CVC

Subject 6

AGE	2;10	3;0 2 sessions 3 days apart: 2nd session Tape 2 - 275 ff.	3;3 2 sessions 5 days apart: 2nd session=Tape 2	3;4.09

N.B. Many utterances spoken quietly or with glottal fry. For first tape, many connected speech utterances could not be glossed, because of the high frequency of glottals. PR E = prompted for loud imitation on first tape, otherwise just elicited imitation.

Adult forms

Vowel
Initial:

eat	897 - C	974 - C, E	410, 742 - T. 2 - C*	
it VC	iːʔ V:ʔ	iʔ Vʔ	i{ɾ/t} VC	
eating		855 - PR E	740-T. 2-PR DSE (from whisper)	608 - C
it+ɪŋ VC+VC		iᵊn̄ĩ Vᵛ.CV	it^{h}ĩn V.CVC	 NC
ice ʌɪs V VC		543(E), 749 - T. 2 ʌɪθ V VC	684 - T. 2 - E NC	667 NC
icecubes ʌɪs#kjub+z V VC#C^{C}VC+C		750 - PR E ʌɪʔub$_{o}$θ V Vʔ.VCC	829 - T. 2 - E* ʌɪθʔub$_{o}$θ V VCʔ.VCC	672 - E(σ_2-')* ʌɪ^{k}ʃuːðˈ V V^{c}.CV:Cˈ
icy ʌɪs+i V VC+V		545 - T. 2 - E ʌɪθɪiʔ V V.CV	699 - T. 2 - PR E ʌɪçiʔ V V.CV	669 - E(sep. σ)* ʌɪsːi V V.C:V
if ɪf VC		901 - C ɪʔ Vʔ	819 - T. 2 - C NC	
if (between wd. process)			869 - T. 2 - C* (before you) iç	

it	816 - C	812, 841, 875 878 , 889, 892 990, 1121, 1174 - C; 189, 538 569, 600, 621, 640, 685(2), 705, 706, 716(2), 787, 794 - T. 2 - C	958, 992 - C 646, 801, 906 904, 919, 975	939 - T. 2- C
ɪt VC	ɪʔ Vʔ	NC	NC	
it		873, 901, 1066 1068 - C; 62, 80 14 , 17 - T. 2 - C I V	915 - C; 100, 687, 912 - T. 2 - C NC	
it		794 - T. 2 - C $I^{ə}{}_{o}$ V^{v}		
it		888, 889 - C; 518 - T. 2 - C* (1=sentence final) ɪt/ɾ VC	898, 934, 976 978, 981, 989 1001 - C; 117, 159, 706, 742 788, 802, 858 - T. 2 - C $ɪt^{(h-3)}$ VC	278, 324, 566 628 , 656, 746 947 - C ɪt VC
itch ɪʧ VC^{C}		803 - T. 2 - PR E $ɪt^{h}$ VC	838 - T. 2 - E* ɪtθ VC^{C}	362 - E, 364 - SE* ɪʧ VC^{C}
itchy ɪʧ+i VC^{C}+V		804 - T. 2 - PR E ɪʔiç Vʔ.VC	842 - T. 2-PR E* $ɪ^{t}ʃi$ V^{c}.CV	368 - E NC
itchy		809 - T. 2 - C ɪʔiʔ V.ʔV		
it's	818 - E, C	589 - T. 2 - C, E*	991, 1000-C, DE 130, 730 - T. 2 - C	15 - C* It
ɪt+s VC+C	ɪʔ Vʔ	ɪtθ VCC	NC	VC
it's			72 - T. 2 - C* ɪtS VCC	631 - C* ɪtθ VCC

off	872, 874 - C	875 - C		
Between word process	My shoe fell off fell off > [{ʔ/f}ʌʊ]			
ɑf	(h)ɑəʔ	ɑəʔ		
VC	CVvʔ	Vvʔ		
off		875 - C, E; 828 - T. 2 - C* ɑ(ː)f VC		
on	1038, 1051, 1058 -C, E	878, 946 - C* 587, 671, 716 760, 810, 184 -T. 2-C	916 - C	
ɑn	{ɔ̃-2/ə}	ɑ̃n		
VC	V	VC	NC	
up	1146; 1160 - C	952 - C*	120 - T. 2 - C	
ʌp	ʌʔ	ʌp		
VC	Vʔ	VC	NC	
/m/				
mad	1055 - E			
mæd	mæː			
CVC	CV:			
mask		667 - T. 2 - PR E		37*
mæsk		mæəo		mætθ
CVCC		CVv		CVcC
mommy	1071, 1072 - C	25 - T. 2 - C		
mʌmi	mɐ̃mi			
CV.CV	CV.CV	NC		
music			643 - T. 2-PR E*	312*
mjusɪk			mjʊʒɛk	muˇθɪkʰ
CCv.CVC			Ccv.CVC	CV.CVC
/n/				
noise		463 - T. 2 - E	599 - T. 2 - E*	519*
nɔɪz		nɔʷɛɪʔ	nɔɪtθ	nɔɪð
CV VC		CV.cVvʔ	CV VcC	CV VC
noisy		465 - T. 2 - PR E	601 - T. 2 - E	520*
nɔɪz+i		nɔɪjiʔ	nɔɪθɪi	nɔɪzi
CV VC+V		CV V.CV	CV V.CV	CV V.CV

/p/

pages		860 - PR E	895 - T. 2*	745 - DE
pɛɪʤ+əz		$b^{v}ɛɪhi^{ə}{}_{o}$	$pɛɪt^{h}$	pɪʔʃ
CV VC^{C}+VC		C^{C}V V.CV^{v}	CV VC	CVʔC
pages			896 - T. 2-PR E*	746 - PR E*
			pɛɪjɪs>	$p^{h}ɛɪʤɪð_{o}$
			CV V.CVC	CV V.C^{C}VC
party		1041 - C	685 - T. 2*	548 - C
pɑrti		⟨b/p⟩ɑdi(ç)	$paɪri_{o}$	$pari_{o}$
CV/r/.CV		CV.CV$^{(c)}$	CV^{v}.CV	CV.CV
pig	850 - E	1174 - C*	937 - T. 2 - C*	
pɪg	$p^{h}i:$	bi	$bi^{˘}k^{h}$	
CVC	CV:	CV	CVC	
plant		677 - T. 2 - C		277 (plur.)
plænt		$bæ̃:t^{h}$		$bəlæ̃^{n}t^{θ}$
CCVCC		CV: C		CV.CV^{C}C^{C}
play		1041 - C	947 - C*	293 - E*
plɛɪ		pɛɪ	$p_{w}{}^{h}ɛɪ$	pəlɛɪ
CCV V		CV V	CV V	CV.CV V
play			788 - T. 2 - C	
			pɛɪ	
			CV V	
please				962 - C(song)
pliz				piS
CCVC				CVC
pop		889 - C	693 - T. 2*	
pɑp		pɑʔ	$p^{h}ap^{h}$	
CVC		CVʔ	CVC	
present		750 - C	776 - T. 2 - E	632, 688 - C*
prɛzənt		hæʔən	pɛʔθə̃n^{t}	p{ɛ/a}ðə̃nt
CCV.CVCC		CV.ʔVC	CVʔ.CVC^{C}	CV.CVCC

/b/

basket	297 - T. 2	353 - T. 2 - PR E	817
bæskət	$bæhɛ^{h}$	$bæk^{h}ɛ⟨ʔ⟩$	bæθɪt
CVC.CVC	CV.CV^{h}	CV.CV<>	CV.CVC
bathtub	972	637 - T. 2*	703*
bæθ#tʌb	$bæ^{h}tʌ⟨b⟩$	$bæ^{θ}tʌp$	$bæθtʌb_{o}$
CVC#CVC	CV^{h}.CV<C>	CV^{C}.CVC	CVC.CVC

bed	828	718 - T. 2*	953;947 - C 45, 48(2) - T. 2 - C*	
bɛd CVC	ʔɛᵊo ʔVᵛ	bæ^tʰ CVC	ba(^-3)(ə-1)d(o) CV(v)C	
bed	830 - PR E bæo CV			
big bɪg CVC	893, 1105 (DE)-C bi(ç) CV(C)			15 - C* bɪ^g̈ CVC
big	1183 - C, E bɪ ː o CV:o	1019 - C bɪoʕ CVᶜ		
big		62, 555 - T. 2 - C b{ɪ^/iᴵo} CV	79 - T. 2 - C bɪⁱʔ CVʔ	
birthday	880 (DE); 882-C	611 - T. 2 - DE*	113, 471 (whisper)	537, 541 - C* 685 - T. 2 - C
bə-θ#dɛɪ CV/r/C#CV V	bʊ{h/ç}ɪⁱ CV.CV	bʊθ ː ɛɪʔ CVC:.V V	bʊθi{ː/ʔ} CV.CV:	bʊθdɛɪ CVC.CV V
birthday		750 (C), 560 - T. 2 - C, DSE bʊhi CV.CV		
birthday		900 - C* bʊçiç ː CV.CVC:		
birthday		559 - T. 2 - C bʊç<ɪⁱ ː o CV.CV:		
black blæk CCVC	1097 - C, E bæʔ CVʔ		805 - T. 2* bækʰ CVC	87* bəlækʰ CV.CVC
blow blou CCV V				923 - C, E bɔu CV V
blow				923 - C, E* blou CCV V

blowing			380 - T. 2 - DSE	
blo(w)+ɪŋ			boũn	
CCV(C)+VC			CV VC	
blue			377 - T. 2 - E*	85, 167 (teeth clenched)
blu			pəl$^{(flap)}$ʊ^{u}	{p^{h}/b}əlʊ^{u}
CCV			CV.CV	CV.CV
broke		1116 - E;919, 1169 - C	724 - T. 2 - C*	693 - C
brouk		bo$^{(ʊ-2)}$ʔ	bouk^{h}	
CCV VC		CV$^{(v)}$ʔ	CV VC	NC
brush	927; 927 - C, DE	714, 50, 58	990 - E; 953	38*
		14 - T. 2 - C*	-T. 2(C)*	
brʌʃ	b^{v}ʌʔ	b$^{(w-1)}$ʌ(ʔ)	bʌʃ	bʊwʌʃ<
CCVC	C^{c}Vʔ	C$^{(c)}$V(ʔ)	CVC	CV.CVC
brush		17 - T. 2 - C	989 - C	42, 479*
		bʌ^{h}	b^{w}ʌʃ	bʌtʃ
		CV^{h}	C^{c}VC	CVC^{C}
brush		206, 209 - T. 2 -C	991 - C, PR DE*	
		bʌ^{ə}(o)	bʌʃθ	
		CV^{v}	CVCC	
brushing			780 - T. 2 - C	
brʌʃ+ɪŋ			bʌʃʔʃi⟨n⟩	
CCVC+VC			CVCʔ.CV<C>	
/t/				
teeth	927 - C	800		476*
tiθ	t^{h}iː	t^{h}iʔɪʔ		t^{h}iθ
CVC	CV:	CVʔVʔ		CVC
toes	924 - PR E	791 - E*		
toʊ+z	t^{ˇ}ʊ^{u}	T^{h}oʔ		
CV V+C	CV	CVʔ		
too	1183 - C, E	227 - T. 2 - C*	675 - T. 2 - C	15 - C;408 - E 434, 539 - C, E; 770 , 893- C
tu	ʔʊ	t^{h}u	T^{h}ʊ^{u}	{t^{h}/d^{-1}}u
CV	ʔV	CV	CV	CV
truck	845	689 - T. 2		494*
trʌk	ʔʌ^{ə}ʔ	ʔʌʔ		tʃʊwʌk
CCVC	ʔVvʔ	ʔVʔ		^{c}CV.CVC

/d/

dog	872 - E	1066 - C, E; 525 - T. 2 - C	995, 997 - C*	
dɑg	daʔ	dɑ($^{ə}_{o}$)	dɑg	
CVC	CVʔ	CV^{v}	CVC	
dress		812 - C	100 - T. 2	767*
drɛs		ʔæ^{ə}ʔ	ʔʌθ^	gʊwaθ
CCVC		ʔV^{v}ʔ	ʔVC	CV.CVC
dressing		853 - T. 2 - E	868 - T. 2 - E*	770 - E
drɛs+ɪŋ		hɛhĩ^{ə}ʔ	daθ ːĩn	d^{ʊ}wat^{h}
CCVC+VC		CV.CV^{v}ʔ	CV.C:VC	C^{v}.CVC

/k/

cage		620 - T. 2	753-T. 2-C, DSE*	655*
kɛɪʤ		ʔɛɪ	ʔɛɪ^{d}	sɛɪʤ$_{o}$
CV VC^{C}		ʔV V	ʔV V^{C}	CV VCC
cake	881 - E	612 - T. 2 - E	778 - T. 2 - C*	295
kɛɪk	ʔɛɪʔ	ʔeɪʔ	k^{h}ɛɪk	
CV VC	ʔV Vʔ	ʔV^{v}ʔ	CV VC	NC
calling		322 - T. 2	391, 393 (DSE) - T. 2 - E*	132 - C*
kal+ɪŋ		ʔɑ^{ʊ}hɛ̃	kɑwĩn	k^{h}alĩn
CV/l/+VC		ʔV^{v}.CV	CV.CVC	CV.CVC
can't		275, 276 -T. 2-C	945 - C; 907 - T. 2(C)	
kæn+t		ʔæ̃ʔ	ʔæ̃$^{(ə)}$ʔ	
CVC+C		ʔVʔ	ʔV^{v}ʔ	
caw		1128		
kɑ		ʔɑ^{ə}ʔ		
CV		ʔV^{v}		
cawcaw		1129 - PR SE	456 - T. 2	
kɑkɑ		k^{h}ɑ^{ə}k^{h}ɑʔ	k^{h}ɑk^{h}ɑ$^{ə}_{o}$	
CV.CV		CV^{v}.CV	CV.CV^{v}	
clock		1106	236 - T. 2 - C	869*
klɑk		ʔɑʔ	kɑ^{ə}k^{h}	kəlɑk^{h}
CCVC		ʔVʔ	CV^{v}C	CV.CVC
come		569 - T. 2 - C	435 - T. 2 - C, E	68 - C*
kʌm		ʔʌ̃m		kʌ̃m
CVC		ʔVC	NC	CVC

crayons		740 - T. 2	798 - T. 2 - C	159*
kreɪjɑn+z		ʔɛɪjə̃n	kɛɪjə̃n'	k^{h}jɛɪjɑn·ð
CCV V.CVC+C		ʔV V.CVC	CV V.CVC'	C^{c}V V.CVC·C
quarter		820 - T. 2 - PR E		877 - PR E*
kwɔrtə˞		wɔʔjo^		k^{h}ɔ ː dʊʔ
CCV/r/.CV/r/		CVʔ.CV		CV:CVʔ
quarters			945 - T. 2 - C*	
kwɔrtə˞+z			ʔɔdɔθ	
CCV/r/.CV/r/+C			ʔV.CVC	
quick			245 - T. 2 - E	
kwɪk			k^{h}ɪ$^{ə}k^{h}$	
CCVC			$CV^{v}C$	
/g/				
get		560 - T. 2 - C(2)	356 - T. 2 - C, E	104 - C*
gɛt		ʔɛ(ʔ)	ʔɛʔ	gɪɾ
CVC		ʔV(ʔ)	ʔVʔ	CVC
glasses	922 - PR E	576 - T. 2 - C	718-T. 2-PR DSE	598*
glæs+əz	ʔæhɛ^{ə}	ʔæhɪ^{ə}ʔ	ʔæθɛð	gʊlæ^{t}θɛθ
CCVC+VC	ʔV.CV^{v}	ʔV.CV^{v}ʔ	ʔʌ.CVC	^{C}V.^{c}CV.CVC
go	801 - C	548(S), 553 - C 216, 866-T. 2-C	947, 958 - C 78 - T. 2 - C	647, 656 - C*
goʊ	ʔʊ	ʔo$^{(ʊ-2)}$ʔ	ʔ{o/^ʊ}	gɔ ː / ɔ^
CV V	ʔV V	$ʔV^{v}$	ʔV	CV:
go				759 - C ʔɔ^{ʊ} $ʔV^{v}$
going		219 - T. 2 - C	114 - T. 2 - C*	548 - C*
go+(w)ɪŋ		ʔowiʔ	ʔowĩn	gɔwĩn
CV+(C)VC		ʔV.CVʔ	ʔV.CVC	CV.CVC
green		727 - T. 2		82, 162
grin		ʔĩn		gʊwĩn
CCVC		ʔVC		CV.CVC
ground			980 - C	
graʊnd			ʔæʊ̃n	
CCV VCC			ʔVVC	
gum	809;1071, 1072-C	640(2), 643(2) 845 (2) - T. 2 - C	949, 951 - T. 2 - C	
gʌm	gʌ̃m			
CVC	CVC (3)	NC (6)	NC (2)	

Gummi bear		840 - T. 2		
gʌmi#bɛr		gʌmibɛᵊ		
CVCV#CV/r/		CV.CV.CVᵛ		
/f/				
fell	872, 874 (2)		316 - T. 2	515 - C(2)
Between word process	My shoe fell off (see other words)			
fɛl	{ʔ-2/f-SC}ʌʊ		fɛʊ	
CVC	{ʔ-2/C}V V		CV V	NC
fish	960	524 - T. 2	1014; 792 - T. 2* 30	
fɪʃ	fɪo	fɪʔ	fɪ(^ʔ)ʃ	fɪᵗʃ
CVC	CV	CVʔ	CV(ʔ)C	CVᶜC
fishing		523 - T. 2	1010*	605
fɪʃ+ɪŋ		fɪʔiʔ	fɪʃɪn	
CVC+VC		CVʔ.Vʔ	CV.CVC	NC
flop			586 - T. 2 - E*	
flɑp			flap	
CCVC			CCVC	
flower		618 - T. 2		8
flaʊwəˠ		fæʔjʊʔ		faɪjʊᵊ
CCV V.CVr		CVʔ.CVʔ		CV V.CVᵛ
fly			584 - T. 2 - E	207 - E*
flɑɪ			fɑɪ	fəlɑɪ
CCV V			CV V	CV.CV V
/v/				
van		578, 865 - T. 2 - C		321 - C
væn		væ̃ᵊn		
CVC		CVᵛC		NC
/θ/				
three	868 - DE	1081 - E*	763 - T. 2	460, 461, 512*
θri	hʲi	fiʔ		fʊwiː
CCV	CV	CV	NC	CV.CV:
throwing		484 - T. 2 - PR E	562 - T. 2*	465*
θrow+ɪŋ		foˆiʔ	fowɪ̂n	sʊwowɪ̂n
CCVC+VC		CV Vʔ	CV.CVC	CV.CV.CVC

thumb		1055	925	470; 727 - E*
θʌm		fɐ̃m	fɐ̃ᵊm	θɐ̃m
CVC		CVC	CVᵛC	CVC
/ð/				
that	821; 992, 1049 1108, 1114 (E), 1192 (E) - C	755, , 842,862, 863, 1121, 1156, 1169 - C; 525 - T. 2 - C (2)	888 - C* 319, 447 - T. 2 - C	
ðæt	{d-5/ʔ}æ(ə)ʔ	dæ(ʔ-4)	ðæ(ʔ-2)	
CVC	CV(v)ʔ	CV(ʔ-4)	CV(ʔ-2)	
that		754, 851 - T. 2 - C	916 - C; 158-T. 2 - C	670 - C
		dæᵊʔ	{D/d}æ(ə)ʔ	Dæʔ
		CVᵛʔ	CVᵛʔ	CVʔ
that			974 - C* ðæt	540 - C
			CVC	NC
that			54, 836 (2) - T. 2 - C*	21, 385, 456= - C
			dæ(ə-1)t	{D-2/d}(j)æt
			CVᵛC	C(c)VC
/s/				
scarf		593 - T. 2 - PR E		428*
skarf		ʔaᵁf		kʌʊf
CCV/r/C		ʔVᵛC		CV VC
screwdriver		784-T. 2-E, PR E	142 - T. 2 - C, DE	778 - PR E*
skrudraɪvə˞		ʔuʔaɪjuʔ	ʔʊ^ʔvᵂaɪβə	tʃʊᵘʃaɪvʊ
CCCV.CCV V.CV/r/		ʔV.ʔV V.CVʔ	ʔV.ʔCᶜV V.CV	ᶜCV.CV V.CV
see	1170 - C E*	749, 992 - C; 556, 592, 780 - T. 2 - C	795 - T. 2 - C	759 - C; 831 - C,
si	çi	{h-3/ç-2}i	hiː	si
CV	CV	CV	CV:	CV
sis		842, 847 - T. 2 - PR E	862 - T. 2 - E*	833
sɪs		hɪs(ː)	s>ɪs>>	s>-sɪθ
CVC		CVC(:)	CVC	CVC

sis		846 - PR E hɪ$^{ə}{}_{o}$ CV$^{v}{}_{o}$		
sleep		985	953 - PR E*	404 - PR SE* (from whisper)
slip CCVC		hiʔ CVʔ	θip CVC	həwip CV.CVC
sleep				408 - DSE S ː ip C:VC
sleep				409 - PR SE hɛ^^{ɪ}p CV^{v}C
sleep				411 - PR SE t^{h}ʊwip CV.CVC
sleep				414 - C çip CVC
slide slaɪd CCV VC	1047 haɪ$_{o}$ CV V			416* θʊ'waɪd CV'.CV VC
smooth smuð CCVC		773 - T. 2 - E muʔ⟨v⟩ CVʔ<C>	825 - T. 2 - E mu ː v CV: C	826 - E; 827-DSE* mu ː ð CVC
snake		1009; 837-T. 2-C	167 - T. 2*	716; 928*
snɛɪk CCV VC		nɛɪʔ CV Vʔ	nʌɪk CV VC	nɛɪk^{h} CV VC
snow snoʊ CCV V				425 θ^{ə}noʊ C^{v}·CV V
snowing snow+ɪŋ CCVC+VC		589 - T. 2 - C hõwɪ$^{i}{}_{o}$ CV.CV	731 - T. 2* θowĩn CV.CVC	426* nowĩn CV.CVC
soap soʊp CV VC	856 ʔoʊʔ ʔV^{v}ʔ	941-PR E, PR SE* h{o/ʌ}^{ʊ}ʔ CV^{v}ʔ	639 - T. 2* ʔoʊp^{h} ʔV VC	435* θoʊp CV VC

spider		1068 - C	198 - T. 2 - C*	439
spɑɪdɚ		pɑ^{wə}	pɑɪd$^{ə}{}_{o}$	pɑdoʊ
CCV V.CV/ɾ/		CV.^{cv}	CV V.C^{v}	CV.CV V
star		680 - T. 2 - E	77 - T. 2 - C*	
star		dɑ^{ʊ}ʔ	t^{h}aʊ$_{o}$	
CCV/ɾ/		CV^{v}ʔ	CV V	
starry		681 - T. 2 - PR E; 682 - T. 2 - C	95 - T. 2 - C, DE	790 - C, E
stari		dɑvɪ$^{i}{}_{o}$	ta^{ʊ}wi	tawi
CCV/ɾ/+V		CV.CV	CV^{v}.CV	CV.CV
sunshine				447, 958(3) - C (learned from song)
sʌn#ʃɑɪn				$^{(t-1)}$s>ɑ̃n$^{(t-2)}$ʃɑ̃ĩn
CVC#CV VC				$^{(c)}$CVC.$^{(c)}$CV VC
sweater		943	70 - T. 2 - C*	453 - E; 846 - C, E
swɛtɚ		fɑɪjoʔ	fɛdʊ^{ʊʌ}	f{a/ɛ}{d/t}ʊ$^{˘}$
CCV.CV/ɾ/		CV V.CVʔ	CV.CV	CV.CV
swim		551 (E);553 (C) - T. 2		
swɪm		hĩ{m/n}		
CCVC		CVC		
swimming			966	
swɪm+ɪŋ			hɪmĩn	
CCVC+VC			CV.CVC	
/z/				
zebra	1169 - C			
zibrə	hijəʔ			
CV.CCV	CV.CVʔ			
zipper	?	654 - T. 2 - C*		526 - E*
zɪpɚ	ʔɪʔʊʔ	hɪʔʊ^{ə}ʔ$^{ə}{}_{o}$		ðɪpʊ ː
CVCV/ɾ/	ʔV.ʔVʔ	CV.ʔV^{v}ʔ		CV.CV
zoo		460 - T. 2	591 - T. 2*	518
zu		^{t}ʃʊ$_{o}$	^{t}θ ː ʊ^{u}	
CV		^{c}CV	^{c}C:V	NC
zoo		462 - T. 2 - E		
		zʲu^{ʊ}ʔ		
		C^{c}V		

/ʃ/

shoe	822	939 - E		772*
ʃu	hu ː	huʷəʔ		tʃu ː
CV	CV:	CV.^{cv}		^{c}CV:
shoe	870, 872			
Between word process	Context: My shoe fell off fell>[ʔ, SC faʊ] fʊ CV			
shopping	1067 - DE			
ʃɑp+ɪŋ	hɑʔi ː			
CVC+VC	CVʔ.V:			

/ʧ/

chair	934	1138 - E	309 - T. 2-PR DE	101*
ʧɛr	ʔɛə	ʔɛʊ<	ʔɛʊʔ	tʃɛə
C^{C}VC	ʔV^{v}	ʔV^{v}	ʔV^{v}ʔ	^{c}CV^{v}
church		695 - T. 2 - E	422 - T. 2 - DSE	140 - E, PR SE*
ʧəˑʧ		ʔoʊʔ	ʔʌʊ⟨t⟩	ʔ{ʊ/oʊ}ʧ
C^{C}V/ɾ/C^{C}		ʔV^{v}ʔ	ʔV V<>	ʔVC^{C}
church				141 - E*
				ʧoʊʧ
				C^{C}V VC^{C}

/ʤ/

judge		848 - T. 2 - E	865 - T. 2 - E*	675 - DE*
ʤʌʤ		ʔʌəʔ	dʌd$_{o}$θ	sʌʤ$_{o}$
C^{C}VC^{C}		ʔV^{v}ʔ	CVC^{C}	CVC^{C}
jump			905 - E	644 - C; 903*
ʤʌmp			ʔɐ̃p	ʃʌ(ʔ)ə̃mp
C^{C}VCC			ʔVC	CV.(ʔ)VCC
jumping		768	906*	647 - C*
ʤʌmp+ɪŋ		hʌ^{m}pĩ	ʔʌpː ĩn	ʃɐ̃mpĩn
C^{C}VCC+VC		CV^{c}.CV	ʔV.C:VC	CVC.CVC

/ɾ/

rabbit		674	998 - C	584*
ræbɪt		wæbɪ$^{i}_{o}$ʔ	wæˈbɪʔ	wæbɪt^{h}
CV.CVC		CV.CV	CV^{v}.CVʔ	CV.CVC

read		605 - T. 2	758 - T. 2-PR SE (from whisper)	697 - C
rid		wiː	wiː t^h	wi{ː t^h- sent.final/ɾ_#V}
CVC		CV:	CV:C	NC
running		1030	664 - T. 2*	650
rʌn+ɪŋ		$wʌni_o$ʔ	wʌnĩ⟨n/ŋ⟩	wːːʌn̄ĩn
CVC+VC		CVCVʔ	CV.CVC	CV.CVC
/l/				
lamb	1195			
læm	$næʔ^{hə}{}_o$			
CVC	CVʔ			
leaf	915 - PR E(2)	1170 - E*		76 - E
lif	liː (ʔ/^{h})	lif		vlif
CVC	CV(ʔ/^{h})	CVC		CVC
like	799, 1088, 1095 1114, 1115, 1151	870, 1018 - C; 91, 529, 530 - C 643(2)- T. 2 - C	928 - C; 142, 583 (E), 626, 670 564, 598,	- T. 2 - C
lʌɪk	lʌ(<-1)ɪʔ	lʌɪ(ʔ-8)	lʌɪ(ʔ-4)	
CV VC	CV Vʔ	CV V(ʔ)	CV V(ʔ-4)	
like			54 - T. 2 - C lɛ^I CV^v	
like (it)			742 - T. 2 - C* lʌɪk CV VC	
little	892 - C	308 - T. 2 - C		
lɪtəl	Lʌɾɪlatflapʊ			
CV.CV/l/	CV.CV	NC		
little	892, 992-C, DSE	537 - T. 2 - C	73, 634 - T. 2 - C	672 - C
	Lɛɾɪdentalflapɔ/ʊ	lɪɾʊ̃	lɪɾ{ʊ/ɔ}	lɪɾʊ
	CV.CV	CV.CV	CV.CV	CV.CV
/w/				
one	799, 1021 - C	769 - C	237 - T. 2 - E	459 - E
wʌn	wʌ̃n		wʌ̃^{ə}n	
CVC	CVC	NC	CV^{v}C	NC

wagon	905	534 - T. 2*	980 - PR E*	683 - E
wægən	wɛɪ̯ə	wæ̃ɪ̯ʔæ̃ːo	wægĩn	
CV.CVC	CV V:.^{cv}	CV^{v}.ʔV:	CV.CVC	NC
watch	957	1040 - C	671 - T. 2 - C	721 - C*
watʃ	waʔ			watʃ
CVC^{C}	CVʔ	NC	NC	CVC^{C}
watching			667 - T. 2 - E*	720 - C*
watʃ+ɪŋ			wat.ʃɪn	watθɪ̈n
CVC^{C}+VC			CVC.CVC	CVC.CVC

/j/

yeh	889	863 - C		
	jɛə	jɛəʔ		
	CV^{v}	CV^{v}ʔ		
yellow		735, 774 - T. 2	724, 793 - T. 2-C	166 - C* (follows red)
jɛloʊ		lɛl{ʊ/oᵘo}ʔ	l{ʌ/æ}{l/ɾ}ɔʊ	ᵘʏ̨ɛlʊ
CV.CV V		CV.CV	CV.CV V	^{v}.ÇV.CV

/h/

had	763, 764 - C	756 - C	747, 748 - T. 2 - C, DE*	
hæd	hæʔ	hæ	hæd	
CVC	CVʔ	CV	CVC	
have	799, 987 - C	805 - C, E	916, 919, 1011-C 470, 940 - T. 2- C	340 - C*
hæv	hæ	hɛəʔ	h{a-^{2}/æə}	hævd
CVC	CV	CV^{v}ʔ	CV$^{(v)}$	CVCC
helicopter	998			
hɛləkaptə˞	haɪjo^hapTɔᵘo			
CV.CV.CVC.	CV V.CV.CVC.			
CV/ɾ/	CV^{v}			