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PATTERN, CONTROL, AND CONTRAST IN BEGINNING SPEECH

A CASE STUDY IN THE DEVELOPMENT OF WORD FORM AND WORD FUNCTION

BY

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Dedication

For my teachers, for my friends
for the friends who have taught me
and the teachers who have befriended
me; and so, most of all, for the
children I have loved and learned from:

Stephen Phillip Menn
Daniel Joseph Menn
and Jacob Hankamer

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I especially thank my unpaid and noble assistants: Annie Zaenen and Randa Mulford, auxiliary observers: Mavis Donohue, auxiliary transcriber; Sharon Haselkorn, consulting child psychologist, and Robin Ault, video-cameraperson, editor, and general life-support system.

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CHAPTER ONE

Introduction, Rationale and Methodology

1.1 Description

This study follows linguistic aspects of the developing communicative competence of a child named Jacob from a first observation when he was twelve months and eight days old until he was twenty months and twenty-two days old. At the time of the first observation, he babbled freely, but had only one vocalization that was recognizable as a 'word'. Jacob's native language, and that of his parents and the investigator, was American English.

The study focused on the acquisition of phonology: the sound patterns of those of the child's utterances considered to be words, the way in which those patterns were related to one another, and the way in which they were related to the sound pattern of the language he was learning, English.

In defining the area of study, it was necessary to consider in detail the notion of 'word' in very early child speech. This topic proved to be of interest in its own right, and it became the subject matter for chapter 2 of this work. Chapters 3, 4 and 5 roughly follow the usual mode of description of the phonology of a non-tone language: first, phonetics and phonemic structure, then phonological rules, and last, suprasegmental phonology.

Many hours of data must be collected in order to do a longitudinal study of a young child's phonological development. The method chosen here was to have the investigator be an active participant-observer in a natural setting: I became the child's caregiver in his home for twenty hours a week on a regular three-day-per-week schedule over the eight and one-half months. Six to eight selected hours of this time were audiotaped and about two hours per month were videotaped by my assistant, Robin Ault, or by a colleague, Sharon Haselkorn of the Harvard Graduate School of Education, as data for her comparative study of the development of communication skills. Haselkorn also carried out periodic cognitive tests on Jacob, the results of which appear in the supplementary section on psychological testing.

Two auxiliary observers, Randa Mulford and Annie Zaenen of the Harvard linguistics department, came weekly and interacted with Jacob and me; monthly high-quality audiotapes were made in a sound-treated studio at the Massachusetts Institute of Technology Research Laboratory of Electronics; and Jacob's parents, Dr. Judith Aissen and Professor Jorge Hankamer, both of the Harvard Linguistics Department contributed their observations.

1.2 Rationale

What is the relevance of the study of the beginnings of the acquisition of phonology to phonological theory? The reader no doubt expects the author of a thesis in linguistics on a topic of language acquisition to claim that the study of language acquisition is of central importance to the study of language. Yet I have no intention of doing so. My concern is rather the following: since so little is known about language acquisition, and especially about the acquisition of phonology, linguists have felt free to build into their theories 'hypothetical language learners', LADs and LASses, which behaved, not as true black boxes, but as black boxes about which certain assumptions could be made without fear of contradiction by evidence.

It is imperative, for the integrity of linguistic theory, that real children learning real languages be studied in a variety of situations and investigative paradigms; naturalistic and experimental; longitudinal, cross-sectional, and comparative; monolingual, cross-linguistic, and bilingual. The conveniently empty LAD boxes must be replaced by closer approximations of humans learning to talk, just as the ideal speaker-hearer and the homogeneous linguistic community are now being replaced by closer approximations to humans using language.

The impact on linguistic theory of going beyond the homogeneous speech community has already been considerable, and the demise of the ideal speaker-hearer promises to have far-reaching consequences, but what will happen when the LAD, poor bastard, is replaced by a better approximation to a child is not in general forseeable.

In phonological theory, hypothetical language learners have been most often invoked in discussion of abstractness and naturalness. Analysis of the error patterns of children learning language is certainly relevant to the abstractness question, because in phonology as elsewhere in language learning children overgeneralize patterns that they have learned, and therefore by seeing what patterns are overgeneralized, one can gather evidence as to what phonological

patterns speakers are sensitive to and what patterns are beyond their recovery (Kiparsky and Menn 1975, Myerson 1975). Such information is the main factual input to abstractness arguments. However, Jacob in the present study was too young to provide evidence relevant to the abstractness controversy.

The role of the hypothetical language learner is less clear with respect to naturalness. The far-reaching speculations of David Stampe have claimed that there is an intimate link between the patterns of language acquisition, 'natural' relations among sounds in adult language synchronically and diachronically, patterns of second-language acquisition, and the nature of phonological rules (Stampe 1969, Miller 1972, Edwards 1974, Kiparsky & Menn 1975). The value of this entire structure does not rest wholly on the validity of its claim concerning language acquisition, and many of its observations concerning the physiological basis for certain frequent historical sound changes are important whether or not these changes are causally related to similar changes found in language acquisition. Nevertheless, the acquisition of phonology is given a central place in that theory, and many of its assertions would have to be revised if the acquisition of phonology does not follow the course which Stampe predicts.

1.3 Theories of child phonology

How do children arrive at the highly organized sound patterns of adult language? For the sake of exposition, I will present two opposing possible theoretical descriptions of a child's development towards a mature form of any structured behavior.

On the one hand, some embryonic form of the adult pattern could be present in the child, and the course of development could be an inexorable 'unfolding' of the pattern, which would become steadily more like the pattern found in adults.

On the other hand, the course of learning could be first a mastery of individual surface manifestations of the adult pattern; the development of the pattern as such would follow, as a tying-together or abstraction of what has already been mastered as output behavior.

To start with a non-linguistic hypothetical example, one might imagine that the learning of arithmetic was a successive learning of postulates: learning how to add would be synonymous with learning lists of such general abstract statements as 'equals added to equals are equal' 'the sum of two positive numbers is greater than either of them', etc. The more postulates the learner mastered and applied to arithmetic problems, the closer he/she would be to the adult pattern.

In contrast, the learning of arithmetic could proceed entirely by the memorization of addition tables, multiplication tables, etc.; the regularities that are manifested by these patterns would be abstracted by some form of induction, but insights about possible patterns that had not been manifested -- for example, about arithmetic with other number bases -- would not occur.

The best-known current theories of the acquisition of phonology, those of Jakobson and Stampe, are strictly 'unfolding' theories, in which some simpler form of the adult pattern or a directive for deriving the adult pattern is innately available to the child. The course of the acquisition of phonology is described as the elaboration of this pattern or the implementation of this directive. What is "out there" in the ambient language influences development only as a specification of the end state, that is, of the point at which the child's system matches up with the adult system.

However, there are also behavioristic theories of the acquisition of phonology which see the child's learning as primarily motor (or rather auditory-motor). In such theories, the child first learns phonetic targets, and then abstraction of features and rules (if any is admitted to take place) follows as an internal organization of what can already be produced. The phenomena "out there" in the adult language are the starting point for the pattern extraction process, and provide continuing input to it, instead of only marking the end-state of acquisition as they do in an 'unfolding' theory.

Although the extraction model is antithetical to the unfolding model in this way, it is not necessarily opposed to the unfolding model in the matter of innateness, as might be assumed. The extraction model specifies nothing at all about what might be innate in the acquisition of phonology. It would be possible to have a version of an extraction model where no specific linguistic ability was involved in pattern extraction. Nothing beyond our general cognitive ability to discern regularities might be required. On the other hand, one could have a version of an extraction theory which held that the set of patterns which a child is capable of extracting is very highly constrained, constrained to be similar to the patterns found in adult language, even at a point at which the child has apprehended only a small part of the data that are "out there".

I think that Olmsted (1971) could be interpreted as advocating a low-innateness version of an extraction model of the acquisition of phonology, but in general the extraction model in its pure form is not held by any researchers (to my knowledge) who have done intensive work on the corpuses from individual small children. The reason for this is simple: a pattern-extraction theory does not allow for feedback from the pattern to the motor performance. Extraction is a

one-way street. In such a theory there is generalization, but not overgeneralization; there is no extension of patterns to new instances, but only a recognition that a new instance fits the patterns.

However, overgeneralization is as characteristic of the acquisition of phonology as it is of the acquisition of syntax. We shall see it in Jacob; the published studies of Smith (1973), Ingram (1973, 1974), and others are dominated by manifestations of it in a variety of guises some of which we shall discuss later.

Let us consider 'unfolding' models further. Jakobson's (structuralist) theory views the acquisition of phonology as a process of successive mastery of phonemic contrasts. The basic mode of organization is constant: there are phonemes distinguished from one another by binary features, and the elaboration consists of an increase in the number of features which can be distinguished in production. Elaboration continues until the phonemic structure of child's speech matches (the structure of) adult speech. Acquisition of articulatory motor control plays no theoretical role. Note that there is no reanalysis of features, no reassignment of phonemes to different classes, but only successively finer splitting of classes. It was precisely on the analogy of Jakobson's theory that McNeill constructed his original short-lived but elegant theory of the acquisition of syntax (McNeill 1966) by the unfolding of a universal grammatical hierarchy.

David Stampe's generativist theory of the acquisition of phonology is also an 'unfolding' theory. However, where Jakobson's theory deals exclusively with the general mastery of phonemic contrasts, without regard to the phonetic structure of the words in which those contrasts are manifested, Stampe's theory is more closely attuned to the central importance of phonetic context in child speech. Stampe recognizes the fact that acquisition of phonemic contrasts across-the-board is a small part of what goes on in the acquisition of phonology; much more of phonological development is concerned with the mastery of contrasts in certain positions in the word, or with the ability to produce certain combinations of phonemes. For example, fricatives may have been acquired word-finally but not in word-initial position, or the child may be unable to produce [t] in any word that has a [k] elsewhere in it.

Stampe holds that there are universal, anatomically-based constraints operating automatically in child speech production, and that the early part of acquisition of phonology is a process of learning to overcome those constraints which keep the child from matching the adult production.

I take the position that in phonology as in syntax -- and indeed in cognitive learning in general -- neither a pure extraction nor a pure unfolding model is adequate. Instead, what takes place is continuing interaction: patterns extracted from what the child already knows at a certain point guides his attack on new forms and the search for similar patterns; conversely, new data from "out there" cause revision of patterns possessed by the learner.

In an interaction model, there is indeterminacy as to how much of the acquisition of phonology is aided by a specifically linguistic innate mechanism. Perhaps there is no such thing, but then -- perhaps there is. Perhaps there ARE different options available to the child for organizing linguistic data than there are for the organization of comparably complex non-linguistic data.

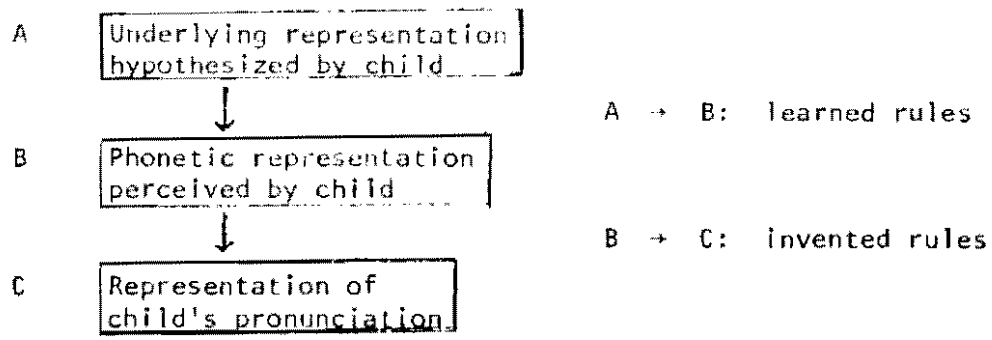
Until much more is known about the ways that children organize the linguistic data which they take in, we must regard the 'innateness question' as being not yet ripe for solution. The prior questions are: What linguistic data are available to children? What data about language use are available to children? How do children organize the information which they take in?

Two chapters of this thesis present data which I take to support an interactionist theory of the acquisition of articulatory phonology, and another presents data on the acquisition of intonation pattern which also supports an interactionist view.

This theory, or rather an aspect of this theory, has also been referred to as a 'problem-solving' theory, and as a 'discovery theory' (Kiparsky and Menn 1975). This is because the way in which it differs most clearly from 'unfolding' theories is in its explanation of the origin of the rules of child phonology. It holds that the rules of child phonology are not simply consequences of infantile articulatory inabilities, but that the rules are discovered or invented by children as one way of dealing with the difficulties which they encounter in attempting to match adult speech. Rules of child phonology are the linguist's codification of the child's generalization of certain patterns of ways of saying words or sounds, and those patterns come from the child's organization of his/her attempts to say words. The patterns are not in any useful sense 'latent' in the child, but must be created by him or her. This position is also taken by Ferguson and Farwell (1975), and also seems to be the one taken by Drachman (1975).

Let me expand on this rather condensed account of the connection between an interactionist theory of the acquisition of phonology and a discovery theory of the origin of the rules of child phonology.

First I should discuss the notion 'rule of child phonology'. Rules of child phonology are not fully parallel to rules of adult phonology. Consider the following schema, adapted from Kiparsky and Menn (1975), representing the principal theoretical levels needed to deal with the acquisition of phonology.



"The representations in the three boxes [A, B, C] each have a different status. A is constituted by the child's hypotheses about the underlying representations of the adult language he is learning. B is constituted by the child's perceptions of the phonetic representations of the adult language he is learning (...it is possible and even likely that these are distinct in some respects from the adult phonetic representations, though there is little concrete data on this point). And C is the child's ("intended") pronunciation..., which may in turn be different in certain ways from the physical output, as when a purely PHYSICAL limitation... merges segments which the child may believe he is in fact distinguishing.

"In the early stages of language acquisition, A and B coincide, while B and C are maximally distinct. As the child masters more of the phonetics, after the initial period of rule invention C approaches B and the system of rules (B → C) shrinks. The process normally terminates when C becomes identical with B. Independently, and surely in part concurrently, though continuing well into adolescence, a second learning process goes on. As the child keeps discovering the phonological relationships of his language, A becomes increasingly different from B and the system of rules (A → B) becomes increasingly elaborate. This process terminates when A and (A → B) develop into the adult lexicon and rule system." (Kiparsky and Menn: 25-26)

Rules of child phonology, then, link the child's internalized representation of the adult word to the articulatory instruction he/she will use in trying to say it. (For a further analysis of (B → C) into several intermediate levels, see Ingram 1974.) They are different from rules of adult phonology (A → B) in that they do not represent

a link between the surface and an abstract form: they are like the rules which can be written to link the surface forms of different dialects, or different historical stages of the same language. By a gentle exercise of Occam's razor, we make the methodological assumption that B is close to the adult surface phonetic form until the subject's behavior gives us reason to think otherwise in a given case.

In this context we can bring out a very important point. In historical sound change, there is a great difference (even if there may be an intervening continuum in the short term) between there being a tendency for the tongue to slip in a certain fashion and there being a regular rule or a lexical change. For example, there might be a change of s to š before a high vowel as a slip of the tongue, a sporadic lexical change, an optional allophonic rule, or a regular rule applying to a phonetically defined domain. The physics and physiology of speech make [s] → [š]/[high vowel] a probable accident, but whether the change becomes a rule is a matter of the phonological structure of the language, the social setting, and possibly some other factors that we know nothing about.

Similar considerations hold for rules of child phonology. A physiological tendency to lose certain distinctions -- for example, to voice all initial stops -- may encourage the invention of a rule of voicing, but a given child may not exhibit this tendency, may avoid words with initial unvoiced stops, may voice only certain lexically or phonologically specified initial stops, or may perhaps invent a rule preserving the voicing contrast in some unexpected fashion (cf. those children who do not produce clusters of [s + nasal stop], but preserve the information in the adult word by metathesis: 'snow' → [nos] (Greenlee 1974)).

The invention of a rule, 'natural' or not, is the establishment of a systematic connection between level 'B', the child's perceived representation of a word or a sound, and 'C', his/her output representation of the word or sound. Here, to reiterate, the 'discovery' or interactionist theory differs most sharply from Stampe's 'unfolding' theory, which holds that 'natural' (physiologically probable) rules do not have to be established, but rather that they operate automatically until/unless they are overcome by the child.

The discovery theory claims that the child is actively searching for ways to manage the formidable motor task of producing acceptable words; that is, trying to match adult models and accepting or rejecting his/her own productions, possibly on the basis of auditory feedback alone or on a combination of that with feedback from adults. If a child happens to say an initial 'd' in the course of trying to produce an adult word that begins with 't', he/she may accept this

as a tolerable approximation and from it develop an initial voicing rule, but the fact that it is difficult for beginning speakers of English to learn to delay voicing onset (Kewley-Port and Preston, 1969) does not give an automatic voicing-rule.

Next, we should turn our attention to the kinds of patterns present in child sound production, since I have claimed that the rules of child phonology arise as generalizations of patterns which the child has extracted. (The rules of adult phonology, of course, also eventually become available to the child through abstraction of patterns.) One way to classify patterns is by the theoretical 'levels' at which they are manifested. Child phonology is concerned with (at least) the following kinds of patterns:

1) Generalizations which hold for the output forms of words the child says (patterns within level C for the chart), e.g. '[d] is the only initial consonant' (Jacob, earliest stage); 'all two syllable words are stressed on the first syllable' (Jacob, most of the studied period); 'the consonants in a CVC word are homorganic (i.e. have the same place of articulation)' (D. Menn; in Menn 1971). Formally, such generalizations are known as surface structure constraints.

2) Inferred generalization about the forms which the investigator takes as underlying the child's output (level A, which equals level B for the very young child), e.g. 'there are no words with underlying initial /g/'; 'there are two underlying back vowels' (possibly true of Jacob late in the study); 'palatal affricates are analyzed as clusters of palatal stop plus fricative' (suggested for D. Menn in Menn 1971). Most such statements concern the phonemic analysis of the child's speech and parallel the phonemic analyses made for underlying forms in adult speech, but deep structure constraints relating the possible co-occurrence of underlying phonemes also concern this level.

3) Generalizations about the relationships between the adult words which the child is (presumed to be) trying to say and his/her output forms (C) of those words, that is, rules of child phonology as commonly written, e.g. 'initial /p/ in the adult word appears as [b]' (J. Velten, Velten 1943); adult 'medial coronals are deleted in the child's output' (D. Menn data); 'adult final stops are deleted' (many sources).

4) Generalizations about relationships between the hypothesized underlying forms of the child's words (level A) and the presumed model word (discussed in Ingram 1974, Menn 1971). Hypothetical examples: 'the distinction between adult voiced and unvoiced stops is not made in the underlying form' (a possible interpretation of the Velten data); 'the English allophones [t] and [ʔ] of /t/ are treated as separate phonemes by the child'.

5) Generalizations of relations between the hypothesized underlying forms of the child's words and his/her output, (B → C) on the chart, rules of child phonology proper. Examples from Jacob: 'underlying final voiced stops were deleted or devoiced'; 'sporadic anticipatory vowel assimilation occurred in CV_1CV_2 words'.

Cutting across this categorization of patterns by levels, we see that some of the patterns referred to are concerned with the co-occurrence of segments or successive features in a given word, while others are concerned with the internal organization of a set of elements or relationships. Of the first kind are the generalizations requiring the two consonants in a CVC word to be homorganic and the rules of consonant assimilation or of vowel assimilation. Examples of the second kind are phonemic analyses of the child's output level or underlying level, and statements relating the rules which apply to individual underlying phonemes. As a specific instance, D. Menn's deletions of medial /l/, /d/, /t/, and /n/ form the coherent pattern captured by the above statement that 'medial coronals were deleted'.

Crucial to the theory of the origin of rules of child phonology is consideration of the relationship between patterns manifested at a single level and rules connecting levels.

Let us use consonant harmony, already mentioned several times, as an example. One possible manifestation of a consonant harmony restriction could be a requirement that at the child's underlying level of representation (B) all the stops in a given word must be homorganic. That means that words in the adult language which do not obey this constraint would not have both consonants encoded by the child, or the words would not be encoded at all. If this can actually happen, presumably it would be analogous to the way an adult can fail to 'hear' foreign sounds or sound clusters in speech signals. The observable correlates of failure to encode adult words which are 'too complicated' in that they violate some constraint, e.g. a consonant harmony constraint, could be various. The child should confuse certain minimal pairs embedded in a speech situation, but there are quite a number of hypothetical sub-cases not germane to the present topic (see Ingram 1974). One way or another, the child should 'do better' on perception and production of 'quack', 'cocoa', 'Daddy', etc. as compared to 'duck', 'bottle', 'cup'; a child whose underlying forms must obey consonant harmony restrictions should produce words which violate that restriction in a fashion consistent with his/her knowing at most what one of the consonants is.

If this same consonant harmony constraint were present, not at the underlying level, but at level C, the level of the child's output representation, one might observe exactly the same production behavior but no perceptual confusion. If the child has rules available to alter some of the input words to make them fit this consonant harmony output constraint, he/she will be able to attempt a wider (phonological) variety of words. Quite a variety of rules could have this effect: 1) deletion of the final consonant of CVC words (Jacob), so that 'duck' becomes [dʌ], 2) weakening of the final stop of a CVC word so that it escapes the harmony constraint, as 'duck' becoming [dʌʔ], (Jacob), or 3) a rule of assimilation bringing one of the stops into harmony with the other, making 'duck' into 'guck' (D. Menn) or into 'dutt' (hypothetical). Or the child may already have a rule which does not in general seem to have anything to do with the harmonic restriction, and yet have the effect of bringing some words into conformity with a harmony constraint. For example, D. Menn had a rule deleting medial coronals, as we have mentioned, and this (along with some others) applied to 'kittens' to give [gɪ̃s], which obviated the necessity of his assimilating one or the other of the (non-continuant) stops. A general rule substituting dentals for velars would also have the effect of making 'duck' into 'dut' without the operation of any assimilation rule. When a pattern holds among forms at the output level (C) but not at the underlying level (B), there may be forms at the underlying level (B) which do not fit that pattern, words which the child does not say. The child may in this case invent phonological rules (B → C) for producing certain of those words so that they conform to the output pattern. This may be seen as a kind of *overgeneralization of the output pattern*, since after the invention of these rules the child produces words in accordance with the pattern, some of which are not in accordance with it in the adult language.

In phonology, the technical term for a group of rules which have the effect of bringing underlying forms into accord with some output constraint is a 'conspiracy' (Kisseberth 1970), and child phonology is full of rules which form conspiracies. This form of overgeneralization is manifested in the present corpus in the formation of a number of different rules, and in several sporadic sound-shifts as well (sec. 4.2). I claim that this type of overgeneralization of output form is the source of many of the rules of child phonology. It is not itself an overgeneralization of rules in the sense in which we have been using the term 'rule' but an overgeneralization of output pattern.

The rules in this corpus which show overgeneralization of output pattern are /b/ → [d] (section 4.3), /ɛj/ → [i] in closed syllables (section 4.4.2), $[V_{-high}]$ → [aj] ("bice" rule) (section 4.4.3), deletion and weakening of final stops (ch. 3 passim), and stress shift (section 4.4.1).

Some of these rules, like /b/ → [d], arose from Jacob's original attempts to say a new word using motor patterns that he was already familiar with, a process I term 'carryover'. The other rules that resulted from a generalization process were those, like the "bice" rule, which came from the conflation or 'consolidation' of two or more similar output patterns, both of which he had the ability to produce.

Under these interpretations of the data, an interactionist theory finds considerable support. Both rule generalization by 'carryover' and pattern generalization by 'consolidation' involve starting with a certain production ability and generalizing a pattern extracted from this production or its product to new cases. Either new words can be produced as new rules are formed by carryover, or new rules are invented in the course of consolidation which can then be applied to new words.

Note that consolidation generally involves the loss in production of contrasts which the child is actually able to maintain. As Ferguson and Farwell have pointed out (1975), an 'unfolding' theory would have to be drastically modified to allow for such regression. On the other hand, as Kiparsky and Menn (1975) maintain, surface regression is characteristic of any learning process that involves the overgeneralization of patterns to new cases. Regression would also, of course, be inexplicable in a pure-extraction model such as Olmsted's.

In the acquisition of intonation contour, we also see at least one event which supports an interactionist acquisition theory: apparently in organizing his own phonetic tendencies, Jacob created a regular pitch classification of rising utterances which is not present in the adult language or interpretable as a 'primitive stage' of classification in the adult language. This classification, then, could not have 'unfolded' or have been a result of imitation. It seems to be the case that Jacob extracted a pattern from his own initial uses and generalized it. This model of rule discovery is what an interactionist theory claims is the basic way language is learned.

The phonological core of this study, then, is relevant to psycholinguistics because it supports a theory which portrays the acquisition of phonology not as an automatic consequence of innate programming, but as being, like the acquisition of syntax, an arena in which the child uses strategies and invents rules in the effort to master his/her language. The overall procedure is the familiar one of learning special cases, extending a pattern based on those cases, and learning exceptions to the pattern. We also have an interesting variant of this: learning of two similar cases, a period of fluctuation in which the pattern of each is extended to the other, and then resolution into the stage of the overgeneralized pattern. It would be interesting to see if there are parallels to this developmental sequence in syntax.

1.4 Content of thesis by chapters

Chapter 2 is concerned with the meaning of the term 'word', and shows that children's early utterance-types may be different from words of the adult language in the following independent ways:

1) less phonetic control -- the tokens of an utterance-type may show a wider variety of sounds than adult words,

2) less semantic coherence -- an utterance-type may be used to express a wider variety of meanings than adult words, or it may be pure sound play.

3) ritualization, or lack of what I have called 'symbolic autonomy': an utterance-type may be tightly bound to a particular social or physical situation, rather than being usable in a variety of contexts; it may be a signal rather than a true symbol.

Jacob had early utterance-types, which I have called 'proto-words', which differed from adult words in one or more of these three ways. In particular, the earliest proto-words lacked symbolic autonomy, but could be seen developing it over the period of the study. Chapter two also discusses Jacob's marked preference for words designating actions rather than objects, and the hypothesis that, for Jacob at least, one of the problems in learning to talk was learning WHEN to use words. The clearest developmental change in Jacob's use of words was the 'freeing-up' of words from ritualized or highly limited uses, so that a given word could have a variety of function. This study supports Michael Halliday's recent (1975) empirical and theoretical work on the gradual development of what he calls a level of 'form' in beginning speech.

Chapter three begins the presentation of the sound patterns of Jacob's words (except for intonation contour). A child might approach the analysis and production of a word holistically, segmentally, or prosodically. Jacob certainly used both of the latter approaches; the evidence for this statement comes from the nature of the patterns which he overgeneralized.

Some of the segmental elements in Jacob's vocalic system may be related to one another in ways unlike the ways in which phonemes seem to be related in adult language, but the evidence is not conclusive because of the small number of words involved.

Jacob's learning of segments can be fitted into the Jakobsonian model of the acquisition of phonology only at the cost of ignoring most of what really seemed to be taking place. The Jakobson model does not take into sufficient account the dual nature of the process of acquiring the phonemic system of a language: 1) the conceptual

aspect, involving (1a) the recognition that a segment in a word is the same as some other segments and distinct from some others (1b) the recognition (on some level) that segments are not merely phonetic targets but are related to one another as members of a phonemic system and 2) the motor aspect, the process of acquiring sufficient control over the production of a sound. In particular, the Jakobson model does not allow for the possibility that a sound may be conceptualized as a target (1a) before it is analyzed as belonging to a phonemic system (1b), but it seems possible that this occurred in Jacob's development.

Jacob learned to avoid, and therefore must have been able to distinguish, words beginning with labials until after he learned to say words beginning with dentals and /k/. This pattern of acquisition can be described as conceptual ability to distinguish the labials preceding motor ability to produce them. Later, Jacob avoided initial /p/ and initial /g/, even though he had initial /b/, initial /k/, final /p/, and a voicing contrast between initial /t/ and initial /d/. This result fits in with work by Ferguson and his colleagues (Ferguson 1973, Ferguson & Farwell 1975) who note that in child language, the presence of feature oppositions in a child's speech (e.g. labial, -voiced) does not guarantee the free combination of those features $\begin{bmatrix}\text{labial}\\ \text{-voice}\end{bmatrix}$ in the child's production.

In Jakobson's purely structural phonemic analysis, two major phenomena of Jacob's development have no theoretical status: the avoidance of certain targets, which we have just summarized, and lexical variation, which involves the apparent paradox of Jacob controlling a sound or a feature in one word and yet having a broader target -- a much sloppier production -- in other words. Lexical variation seems to arise from a variety of causes which a theory of the acquisition of phonology will have to take into account.

In Chapter 4 we study the factors which combine or conspire to limit Jacob's output to a small set of word-shapes or canonical forms. Selective avoidance of adult words containing certain consonants, context-free substitutions, and conditioned phonological rules were involved in this conspiracy, and the following psycholinguistic model is suggested as an account of what the child might be doing that gives rise to the observed results:

1) The child may meet the problem of how to say a new word (or segment) by making use of a word or segment he/she already knows how to say, resolving a new problem into one already solved and a subproblem that may be ignored or given further attention. Jacob's isolated case of the production of /b/ as [d], which he already knew how to say, is an instance of this strategy, the use of what we have called 'carryover.'

2) Two similar words, one or both of which are new to the child's output may temporarily influence one another and then 'consolidate', as when 'tea' and 'tape', after both having the vowel fluctuate among his front vowels, became homonymous as [ti]. There seems to be internal pressure to reduce the inventory of canonical forms even when the motor ability to produce the word exists, but the reduction does not occur without an interim period of confusion. Changes from the adult model in the child's production of a word, arising either from the child's extension of a pattern which he/she knows to a new word or from the consolidation of two output patterns, may become quite regular, and such regular changes are the 'rules' of child phonology.

Rules of child phonology, as we have said, are not like rules of adult phonology in one fundamental respect: they do not represent abstractions from the patterns of surface data, but instead represent the ways that the child has invented to produce approximations of what he/she has perceived as the adult model word.

Chapter 5 describes Jacob's early (13-15 months) use of intonation contours, and presents a hypothesis as to how he learned some of those uses and the nature of his knowledge.

In English, intonation contour carries information about the syntactic class of an utterance (declarative, wh-question, yes-no question) and about its function (rhetorical vs. sincere question, warning vs. command), although in a very complicated fashion in most instances (Lieberman 1975). Menyuk and Bernholz (1969) showed that adults can reliably classify the intonation patterns of children's utterances as sounding like questions, like declarative statements, or like exclamations, and most diarists have felt that children at the one word stage were using contrasting intonation meaningfully, rather than as a sort of tonal babble, but Bloom pointed out that as of 1973 this intuition had not been proven correct.

From the data of this study, we find that Jacob used varied intonation contour in purely phatic 'free' babble, but that he also consistently used certain intonation patterns in conjunction with actions that communicated particular intentions, so that we can ascribe meaning to his use of those contours.

In the period from 13 to 15 months, Jacob used rising contours which listeners characterized as 'requests', to obtain goods and services, and to initiate social contact, and later to ask for confirmation that a word he used or an action he performed had been approved by his audience. These rising contours appeared first on babbled utterances and later on words.

Between 13-1/2 and 15 months, instrumental measurement of Jacob's intonation contours further showed what might be called a socio-linguistic functional differentiation among the rising contours; requests using English words, regardless of their ends, and requests using babble which were directed towards social ends, rose to a moderate pitch peak of 450 Hz, which was not far above the pitch of speech addressed to him. Requests using babble which were directed at getting an object or at getting an adult to do something for him (instrumental use of the adult) had pitch peaks of 550 Hz or more. Almost all falling-contour utterances remained below 450 Hz.

As Jacob used more words, he did not abandon the high pitch range, but found a new way to use it contrastively: at 16-1/2 months he used a mid-high-low demonstrative contour modeled on adult 'What's that?', which cut across his old social/instrumental categories and should be considered as a more adult-like use of intonation contour.

It is possible that Jacob learned the rising request contour by watching adults request objects, but there is another hypothesis which accords better with his apparently limited general understanding of conversational roles: Jacob's use of rising intonation contour, to obtain his ends could have arisen as an attempt to elicit offering behavior from adults by imitating the rising contour used by adults when they offered objects to him.

In general, function, rather than intonation contour was the most coherent basis for categorization of Jacob's utterances. They fell into the functional groups of greeting, 'curious noises', narrative, request/demand, offering/giving; contour appeared to signal a modulation, in at least the last two categories, of the behavior along a continuum whose poles might be described as dominant-submissive or peremptory-ingratiating 'request' and 'demand' should not be viewed as separate functions in Jacob's case, and probably not in general.

1.5 Methodology

Three kinds of information are necessary in order to study child phonology: what words a child says, what sort of variation there is among the tokens of a word, and what words are understood -- are in the passive vocabulary -- but are not said. The first two are obviously the subject matter of child phonology, but the importance of the third has only been recognized recently, when Ferguson (1973) began to suggest that children might be deliberately avoiding certain words because of the sounds they contained.

Pursuit of this information requires rich contextual data, to determine what the child has understood and what the child has meant by what he/she said. Since children at the threshold of speech typically speak very little, many hours of observation are necessary to get enough utterances to support arguments about understanding in the child's repertoire. The investigator, a video camera, or both, must be present: audiotape is not enough.

I used the anthropological investigative paradigm of having the investigator act as a participant while observing, because in no other way could a normal social interaction pattern be maintained between adult and small child for twenty hours per week. Deviations from the normal caregiver-child pattern occurred, some inevitable and some deliberately planned. It is not outside the bounds of possibility that some subtle effect on Jacob's phonological development may have occurred as a result of these deviations from normal, although that presently seems unlikely. However, it is quite likely that artifact was created in the following respect: since I wanted Jacob to talk more, probably, than most parents do, and wanted to say things to him that he would be likely to respond to, the density of language-eliciting behavior on my part was high, and I searched actively for topics of interest to him. In this way I probably contributed to the apparent bias he had in favor of action-words as opposed to names of objects, for when I found that he liked such words I introduced more of them into our games. The original bias was Jacob's, but the observed distribution of his vocabulary was probably skewed by my reaction to that bias.

Another possible artifact from my eliciting behavior was that I may have asked Jacob more questions of the form "Do you wanna do X?" than normal, and this could have contributed to his fondness for rising intonation contour.

Finally, because I transcribed the tapes for each session promptly and because I was making some transcriptions on the spot, I listened to Jacob more intently than an ordinary caregiver would have, and he probably got more positive feedback than most children.

I did not teach Jacob any nonsense words, but I did introduce one noise-imitation game just in order to check and see if he understood the idea of imitating noises: Jacob, in the first few weeks of the study, had given no indication that he had even caught on to the idea of imitation of adult vocalization, and as an experiment I 'razzberried' at him (a 'razzberry' is a loud bilabial trill usually viewed as an impolite noise but socially acceptable as a means of entertaining babies); he imitated me swiftly and accurately, settling the question.

1.6 Evaluation of imitated utterances

Observers of child language must decide how to deal with imitated utterances, because these often show special phonological characteristics. Even when a child has well-established phonological rules, imitations often come closer to the adult model than spontaneous utterances of the same period. The following anecdote will serve as an example: Daniel Menn, at a time when he was regularly producing 'duck' (and also 'stuck', 'truck') as [gʌk], was standing where he could not see his toy duck. I said to him, 'Why don't you get your duck? It's down there.' Daniel said [dʌk]?, and then came, followed my point, saw the toy, and said [gʌk]. Then he said 'no', and turned away from it.

This sort of event is probably akin to what happens when an adult tries to produce a foreign sound or sound-pattern ('*Nk*rumah', '*Kh*rushchev): it is much easier to do it when one still has the sound 'ringing in one's ears' than after a time delay, and it is also easier when one is attending to the production as a task in imitation than when attending to the meaning of a message one is trying to convey.

During most of this account, the focus will be on Jacob's spontaneous utterances, as displaying Jacob's own patterns most clearly. However, there is one circumstance in which the strongest evidence as to Jacob's patterns can be drawn from his imitated utterances: the cases in which Jacob's pattern was different from the adult model even when he was imitating. For example, in chapter 4 there is a point at which Jacob imitated the word 'bag' as [bajg], giving evidence of the strength of a diphthongizing rule which he then had.

Another division was made in collecting the data, although I have not made use of it in analysis as yet. There is at least a theoretical difference between imitating a brand-new word and imitating a word which is part of one's passive vocabulary. In the latter case, there is stored information about the sound of the word which may play a part in determining the output. At some periods of Jacob's development, there seemed to be a considerable portion of his total output that consisted of words which he understood, but which he only said when he had just heard them. I called this set of words his 'shadow' vocabulary, thus dividing Jacob's linguistic world into four parts: 'Imitations', 'Passive Vocabulary' 'Shadow Vocabulary', and 'Active Vocabulary'. The difficulty of deciding what the child understands and when he is shadowing and when imitating is very difficult and in general requires ad hoc judgements -- for example, when Daniel said [dʌk] it seemed that he had failed to recognize the familiar word for an instant, until he saw the object. It was probably a case of imitation rather than shadowing, but the

truth is inaccessible. Nevertheless, the distinction is useful conceptually, and reference to Jacob as 'shadowing' words in the sense just defined will be made throughout the thesis.

1.7 Psychological testing: supplement section

Periodically, as I mentioned, S. Haselkorn administered four of the six Užgiris and Hunt scale tests, which are tasks based on Piagetian theory of cognitive development. The scores on these tests, the scales, and the tests are reproduced in the supplement section. These tests cannot be translated into a simple placement of Jacob in one of the Piagetian sensorimotor stages at each test session, for reasons that are detailed in the supplement section, but roughly we can say that Jacob at 13:23 was in transition from sensorimotor stage IV to stage V, and that he had arrived in stage VI by 15:26. There is a great temptation to tie his cognitive development to the evolution of his language from a 'signal' system to a 'symbol' system, but the details of these parallel evolutions are so ragged that I find generalizations about what sensorimotor stage goes with what level of language use to be inappropriate at present.

CHAPTER TWO

Topics in the semantics of Jacob's early speech: Words and Proto-words

Section 2.1 Introduction

As the title indicates, this chapter is by no means intended to do justice to the full range of semantic information in the Jacob corpus. We shall only consider here material from the first half (approximately) of the study -- 12:8 to about 16:15, with a few specific ends in view, all concerned with the nature of early words or word-like utterances.

The first of the ends is phonological: in order to 'do phonology', we must know what utterances are to be counted as words. At the threshold of speech, as we shall see in section 2.2, this is a non-trivial question.

Specific examples of sets of utterances which are more structured than babble but fall short of being words are described in some detail, and we conclude from examining them that for Jacob, phonetic and semantic criteria of 'wordiness' do not seem to be correlated, so that judgements as to which utterances are 'words' for purposes of phonological analysis must be made on grounds internal to the child's phonological system.

Consideration of the defining properties of words leads us to the second major topic of this chapter: Jacob's early semantic development may involve the transition from verbal signals to verbal symbols. This is a crucial step in the ontogenesis of speech; its significance has especially been stressed by Halliday (1975). We suggest that this essential development be seen as a reflection of a general cognitive problem-solving ability.

The third topic, discussed in section 2.3, is to present the evidence for the very striking semantic selectivity of Jacob's early speech. Rather than names of objects, Jacob strongly preferred certain types of action-words. Here we are dealing with one of the ways children differ from one another. Not all children show semantic selectivity, and those who do may have different favorite topics.

In section 2.4 there is a preliminary comparison of Jacob's semantic development with that described by Halliday for his son Nigel (Halliday 1975) and in section 2.5 we place Jacob's development in the cross-sectional context provided by Katherine Nelson's 1973 study of the semantic structure of the first fifty words of 18 children aged 12 to 24 months.

Section 2.2 On defining words

2.2.1 The problem

Listening to the vocalizations of children, especially those between the ages of 12 and 24 months, we are struck with a descriptive problem that is very marginal in working with adult language: of the many noises a child makes, which ones are meaningful in the way that adult words are and which ones are sound play? What can we say about those which seem to have communicative intent -- judging by the child's body attitude, facial expression, and gestures -- but in one way or another don't seem to accord with our intuitions of what a 'word' is?

Psychologists and psycholinguists (e.g. Nelson 1973) are seriously interested in the child's 'first words', for if there is to be a theory of how children learn what words are used for, such a theory must be able to explain children's initial hypotheses. In turn, the evidence as to what these 'initial hypotheses' are must be, in large part, how the child uses language.

Phonologists are also concerned with the matter of defining 'word', for phonology is defined on words (Ferguson 1973, Ferguson and Farwell 1975, Jakobson 1968), a matter which we will return to in ch. 3. This section is then a necessary prolegomenon to the study of child phonology and the acquisition of linguistic communicative skill.

In this chapter we shall try to develop some explicit criteria for 'being a word', and to consider how vocalizations can be like words in some respects and yet fail to satisfy the criteria for being a word. (Throughout, we will be dealing only with single-morpheme words; for comparison of this chapter with treatments of adult language, it is necessary to replace the term 'word' by the term 'morpheme'.)

Any notion of 'word' requires at least that a sound pattern and a meaning be associated recurrently; there may be variation in the sound of the vocalization and in its meaning and function, but if the meaning does not recur when sound-patterns recur, we have babble, and if sound patterns do not recur when a recurrent meaning is apparently intended, we do not have linguistic expression of that

meaning. The notion also requires minimally that recurrent sound-meaning pairs be used, at least some of the time, with communicative intent, ruling out involuntary noises. We should not, of course, rule out talking to oneself, which Jacob did, especially for self-regulation.

Not all authors use the term 'babble' to refer to all sounds where a recurrent vocal-tract configuration is not associated with recurrent meaning. Indeed, I do not intend to conflate 'babble' with the earlier type of vocalization called 'cooing', but Jacob at 12 months was well past the cooing stage, and differentiating between babble and cooing is therefore unnecessary for the present purpose.

'Babble' is also often distinguished from 'jargon', a term used for those sound patterns where the listening adult irresistibly feels that the child believes that he/she is 'speaking' as other people do. Such advanced babble is not solo play, but is accompanied by the eye-contact, intonation patterns, and body posture appropriate to conversation.

Cooing, babble, and jargon merge into one another, and the last of them, as we shall see, merges into speech. We shall call all of Jacob's pre-speech vocalizations babble, and the functional distinction of sound-play vs. conversation will be taken to apply to the category 'babble'.

We shall frequently refer to the communicative function of babble. It may seem strange to refer to the communicative function of 'meaningless' sounds, but a false paradox is created by shifting the sense in which we use the word 'meaning'. As has been pointed out by Jakobson among others (Jakobson 1966), communication has many aspects besides the transmission of messages about the world beyond the participants in a communicative act. We also transmit information about our willingness to send and receive messages-in-the-narrow-sense; if we are willing to send and to receive, then there is a community or solidarity set up between us and those who are willing to reciprocate. This exchange of reassurance or solidarity is a basic element in social interaction among animals, including ourselves. This kind of communication, called 'phatic communication', is available to babies at the level of shared eye-contact by the fourth week of life (Robson 1967) and at the level of shared attention to aspects of the external world (following gaze or point at an object) from a few months of age (Bruner 1975). Babble also becomes the channel for phatic communication, and Jacob used it freely at the time this study began (12:8).

During the early months of the study, 'babble' began to do more than signal mutual attention. On the one hand, the exterior form developed into harangues and monologues, including striking imitations of one side of telephone conversations, which we will discuss in detail later. On the other hand, babble also developed richer content, as we will see in chapter 5. The sounds became 'carriers' for intonation contours which Jacob used, along with gestures, to communicate to adults that he wanted them to do something for him. Here sound-meaning correspondence developed, but the 'sound' which recurred was pitch contour, not an articulation sequence, and we will retain the term 'babble' for the sounds which carry the meaningful contours. If English were a tone language, this terminological decision would probably be inappropriate, but in English, the way in which segmental phones carry meaning is different from the way intonation carries meaning, and the way they are learned seems to be different as well. (see ch. 5)

Returning after this discussion to the notion of 'word', we see that our requirements of recurrence and communicative intent are still too weak to define 'word'. Groans, sighs, and 'razzberries' (loud bilabial trill expressive of contempt), for example, show sound-meaning correspondence and are frequently used with communicative intent, but they are not 'words'. Reflecting on their exclusion, we see that another major stricture on words is that they must fit into the phonological system of a language. Certainly a few small groups of utterances, mostly onomatopoeic (swoosh, bzz, mraow) and a few types of affective modification (a lo:::ng time) disturb the picture, but by and large the sound of a word must not only be conventionalized (as a razzberry certainly is) but must furthermore conform to the phonetic surface structure constraints of the language it belongs to.

We also require, if we are not dealing with pathology, that the meaning of the utterance be accepted by other speakers of the language, or at least comprehensible to some of them.

When we look at a corpus of children's utterances, we will find that many of them, beyond a certain point in development, have so high a degree of phonetic and semantic consistency within the child's usage, even though they do not quite match adult models, that we shall want to refer to them as 'words'. Beyond picking out words, we look for recurring patterns of sound and recurring situations. When we find recurrences of sound pattern (including recurring intonation patterns), we can speak of having recurring tokens of utterance-types.

Some of the utterance-types are direct expressions of affect (discontent, pleasure, excitement) or pure sound play (which usually indicate contentment and may be interpretable as an expression of well-being (Dore, Franklin et al. 1974)). We then begin to find utterance-types which are used in much more clearly-defined circumstances (Bruner 1975, Halliday 1976): perhaps to accompany pointing, hiding, or other action, to initiate interaction with adults, or to obtain some kind of help from them. Tokens of these types may closely resemble adult words which would be appropriate to the situation in which the child utters them, or they may seem to be the child's 'own invention'. Such utterance-types, more wordlike than expressions of affect but different from our notion of 'word' on phonological, semantic, or functional grounds are a major focus of interest in a study of the early acquisition of language. Since I have been unable to find a term for such utterance-types that has both charm and clarity, I shall refer to them as 'proto-words'.

In subsections 2.1.2 and 2.2.3 we shall proceed to develop the notion of 'word' more fully, and then we shall see in 2.2.4 that until nearly 17 mos, almost all of Jacob's utterances that could be collected from the onset of speech (the first proto-word) were proto-words rather than true words when he first acquired them. Most of them developed towards being true words, and the rest (with the predictable exception of those proto-words modeled on adult utterances which are not true words either, like 'uh-oh') dropped out of use.

2.2.2 Criteria for 'being a word'

In dealing with the problem of defining 'word' for Jacob, a set of three criteria seemed appropriate: 1) the degree of phonetic consistency 2) the degree of semantic coherence 3) the amount of what I shall refer to as 'autonomy', that is, the property of being a true symbol, detachable from a particular real-world context and usable in a variety of pragmatic situations. A well-behaved word is 1) phonetically consistent to the extent of showing variation in only a few features about a well-defined phonetic target, in degree comparable to the variations found in adult surface phonetics 2) semantically coherent to no less an extent than the chain-complex of semantic properties[1] which define common words like 'cut' (with a knife, with a scissors, a cut on the hand, a cut of meat...) or 'on' (light on, shoe on, dish on the table, picture on the wall, fly on the ceiling) 3) autonomous in that it is not part of a motor act or a ritual; may be used with varying intonations and to refer in different sorts of speech acts.

The first two criteria were foreshadowed in 2.1.1; autonomy will be discussed in 2.2.3. We shall describe a given proto-word at a given time in Jacob's development as being more or less word-like with respect to each of the criteria.

It was originally hoped that the criteria developed for being-a-word would covary: that the notion of 'being a word' would develop for Jacob in such a way that we would find 'primitive words', low on all criteria, which would gradually develop into or be replaced by 'true words', high on all criteria. It would then have been possible to use non-phonological criteria to judge what utterance types should count as 'words'; much more importantly, such covariance would suggest that the child develops from observation, a theory of what 'words' are.

The data to be presented force the abandonment of this approach, and suggest a separation of phonological progress towards adult language from semantic progress.

2.2.3 Symbolic Autonomy

Two major lines of development seem to occur in Jacob's use of speech: an increase in phonetic control, which will be discussed most fully in chapter 3, and an increase in symbolic autonomy. Few of Jacob's recognizable utterance types which were weak with respect to the criterion of semantic coherence, and his generalizations never seemed to be the wild examples found in the literature (E. Clark, 1973). Instead they moved along reasonable tracks of association, (see section 2.2.4), so there is little to be said in Jacob's case about development of semantic coherence.

Autonomy is an absolutely crucial property in the development of a communication system beyond the capacity of a finite list of uncombinable signals, for if the elements in a communication system are not autonomous, that means that they are no more than vocal gestures, and cannot be used to convey novel messages (cf. Hockett 1966).

We will see that symbolic autonomy did not simply appear, but that it developed as Jacob pressed his limited lexicon into the pursuit of various goals. For this to be the case is entirely consistent with the well-supported overall picture of child language development enunciated by Slobin (1971, 1973) "New forms first express old functions, and new functions are first expressed by old forms" -- what I have lightly called the 'inchworm' model of rule-growth. Here, at the threshold of language, Jacob first used proto-words to accompany actions and interactions with which he had become familiar; then,

apparently, he seemed to find that some of those proto-words could convey messages to others, messages which were propositions, demands, or requests. Slobin points out that his developmental principle is a familiar one in the psychology of cognitive development. We may place it in a larger ontogenetic and phylogenetic context by considering that the ability to utilize existing ways-of-doing-things to accomplish new ends -- an ability which requires some rudimentary separation of means from ends -- is a fundamental property of higher intelligence. We know that apes, in the right circumstances, can solve problems of tool using (Kohler 1925) and that tutored apes clearly achieve symbolic autonomy (Gardner and Gardner 1960, Premack 1971). We may view Jacob's progress as a manifestation of the ontogenetic development of this ability to dissociate several aspects of an action from one another or to dissociate actions from their context and employ them in new contexts.

A note of caution must be added here, however. J.A. Fodor has pointed out (pers. comm.) that while the hypothesis that Jacob must DISCOVER that words are good for more than just one function will explain the data, other explanations are possible which are compatible with an opposing view: that a child of speaking age is already potentially able to use any signal which he/she has as a symbol if the situation is appropriate. Cognitive development might well have outstripped linguistic development so much at the beginning of speech that multiple uses for words are in principle available as soon as the words are; the reason that we see so few uses for each word may have to do with the child's interest, his/her surroundings, or what these first words mean to him/her. As examples arise in this chapter and we develop the notion of autonomy more fully, we will attempt to describe what sort of evidence would be necessary to enable us to choose between the first hypothesis, that symbols must be invented by each child and are likely to be absent from the earliest speech, and the second, that a child who can speak is already at a stage of cognitive development where signals easily can become symbols, so that what is described as a lack of symbolic autonomy is due to other important factors in his/her environment or development.

2.2.4 Utterance types which fail to be 'true' words in Jacob's output: iterated patterned babble

When we cannot collect utterances into putative tokens of a type at all, we have babble; none of the three criteria for wordhood, as far as the observer can tell, are met by sets of such utterances. Let us first examine a group of very clearly recognizable sets of utterances which can rank fairly low on phonetic consistency

and have no semantic content (and therefore no autonomy): these may be described as *iterated patterned babble* (iPB). They consist of repeated one or two-syllable units, and it is their utterance as long iterated strings which makes them recognizable as tokens of one type, even when the phonetic control is poor and there are no semantic clues to help the observer recognize them as recurring elements in Jacob's output.

Jacob had three clear IPB's, one of which did in fact have semantic content and went on to develop autonomy; also at least one of his other utterance-types which would ordinarily be considered a 'real' word seems to be better described as an IPB with semantic content. The first iterated patterned babble to occur in Jacob's speech was roughly [dɨgʌ]^{n}, with notable variation (see ch. 3 for phonetic details) even in the units of a single iterated string. It seemed to be pure sound play, yet to have some connection with the way he said his name, a poorly controlled [déka] (used only in the context of a peekaboo game, representing 'Where's Jacob?') (further discussion of this relationship in ch. 4, sec. 3). Impressionistically, this IPB might be described as soundplay variations on the theme of 'Jacob', for he just seemed to run around saying it.

The second IPB to appear, which we shall symbolize as [ioio] (more precisely, [io(io)^{n}]) was interesting in a different way. It became one of Jacob's favorite utterance types. [ioio] apparently originated as accompaniment to rotating an object, for example a wheel on an axle or a loose knob. Very rarely -- once or twice in about a hundred tokens -- Jacob seemed to 'just say' it without any apparent connection with rotation. Jacob varied the actual form considerably, though not very much within a single iterated string; we find [ioioio...], [wiʌwiʌwiʌ...], [ajajaj...], with a characteristic alternation of front and non-front segments, one a glide or a high vowel (or the sequence [wi]) and the other a low vowel. There was possibly an etymological connection of [ioio] with the word 'wheel', which was not in Jacob's active vocabulary at the time [ioio] arose, but which had been in his passive vocabulary for quite some time.

A little before [ioio] appeared, Jacob began to use an iterated sequence 'round and round' [w̃ʌ̃mbw̃ʌ̃]. 'Round and round' already had autonomy to some degree, for it was used predicatively of an object rotating (e.g. tape reels) and to accompany Jacob's action causing an object to rotate. However, once he devised [ioio], he almost always used it as the sound with which to accompany his own action on an object.

After a few weeks in which [ioio] was used only to accompany action (as far as anyone was able to tell), [ioio] began to show symbolic autonomy across speech-act categories. He used it at 15:11 as a predicate, pointing to some phonograph records not rotating at that time, and at 15:16 with a rising contour, to ask permission to turn a knob on a tape recorder (generally forbidden action), and with great insistence in demanding to be allowed to turn a decorative suspended disk. At the same time it maintained its primary use as an accompaniment to action.

Here, then, we have one dimension of autonomy: a word that at first accompanies an action X is found helping to express the meaning 'I want to perform action X' and 'One could perform action X with that object... 'or perhaps a formulation that involves the desired state of the object rather than the causation of that state, i.e. a word that at first means 'this object does X' comes to help in the communication of the messages 'I want that object to do X' and 'That object could do X'.

This developmental sequence corresponds with that described originally by Gruber (1967) -- although I have reservations concerning his "performative" terminology -- and more recently by Bates, Camaioni and Volterra (1975) and Halliday (1975, see section 2.5).

We do have one case from a videotaped session (tapes by S. Haselkorn) which gives an argument that Jacob originally could use [ioio] only as a signal meaning 'I'm turning something/something is turning'. At 14:28, about two weeks before Jacob was first observed to use [ioio] with the functions of requesting, demanding, or predicating potential states, he was playing with a revolving office chair. When he was helped up into it, he began to rock; Haselkorn and I, studying the videotape, agree that he seems to have been trying to make the chair turn by this rocking. As he rocked, he said [ioio] in a falling tone. He discovered in a few moments that the chair could not be made to turn by his own efforts. When an adult asked him if he wanted to 'go around', he acted very pleased, and enjoyed being turned very much. But whenever the adult stopped, Jacob used only grunts and gestures to elicit a repetition of the action. He did not use [ioio], or 'round', which was also in his vocabulary, to attempt to elicit action from the adults present.

One might interpret this as demonstrating the hypothesis of this section: that at 14:28, [ioio] had not developed sufficient autonomy to do anything but accompany Jacob's own action, but that at 15:16, 2 1/2 weeks later, it had changed from being a signal of ongoing action to a symbol which genuinely referred to rotation, actual or potential, desired or merely contemplated, demanded or requested.

But the classic nemesis of behavioral study rises to haunt us. 'He didn't' does not prove 'he couldn't have'.

To show conclusively that a signal is merely a signal and not an autonomous symbol for a child, it seems to me (after discussion with J. A. Fodor, who brought the problem to my attention) that all of the following very improbable conditions would have to be satisfied:

1) The child uses the signal spontaneously

2) He/she wants something that can be obtained only by a novel use of that signal (a very rare communicative condition)

3) The novel use has the same referential meaning for the signal as the child's established use has (How would one verify that?)

4) The child's failure to use the signal as a symbol cannot be ascribed to the usual factors that interfere with performance: overmotivation, lack of interest, fatigue, etc.

Given these difficulties, the problem of the ontogenesis of symbolic autonomy in speech will probably have to be resolved indirectly, in the context of the child's total cognitive development, rather than in a language-centered study such as the present one. However, we will not drop the topic, which is of the greatest importance in forming a picture of language development; we will instead bring forward all the evidence so far gleaned from Jacob in the hope of illuminating the problem as much as possible.

At the point, then, when [ioio] was used for requests and commands as well as narratives, it was certainly very wordlike. The only criterion of those which have been set up in this chapter on which it fell short was phonetic consistency. Some other items which it seems more natural to call 'words', for example 'thankyou', were as poor phonetically and lacked autonomy. I think the reason for being reluctant to call [ioio] a word after it developed autonomy is external to Jacob's speech: 'thankyou' can be repeated over and over, but [ioio] even if it derives from 'wheel', is not based on an iterable English word.

After several months' tenure as a favorite utterance type, [ioio] disappeared almost completely, although Jacob's interest in rotating objects did not. Presumably he became aware -- or began to care -- that it was not a word used around him except when his parents were imitating him as a game. It certainly had plenty of instrumental reinforcement, however; in discourse, Jacob's parents and I soon came to treat it as a word like any other, and one finds frequent exchanges like

J: [ioioio] Adult: Oh, you wanta turn that? Ok.

J: [ioioio] Adult: Yeah, you're making that go around, arencha.

The third iterated patterned babble was rather short-lived, roughly [oɣi]^{n}, and it may have been based on the word 'okay', which Jacob of course heard frequently, but very rarely used (one or two observed tokens of 'okay' over the entire observation period). It had a range of phonetic variation similar to the other IPB's, and had no discernable semantic content.

We have already alluded to Jacob's 'thankyou', a CVCV form, as being very much like an IPB on internal grounds -- that is, just comparing it with other items in his output and ignoring its relatively good semantic match with an adult model word. 'Thankyou' was recognized as Jacob's 'first word'; it was the only one he seemed to have at the start of observation at 12:8. Like Bruner's subject M (Bruner 1975) and, I believe, many other children, he used it in the game of "giving" when handing an object to someone, and not to mark the receipt of an object. (A discussion of this fact as it sheds light on the child's concept of who-is-supposed-to-say-what in conversation will be found in ch. 5.) 'Thankyou' was one of Jacob's most frequent words, averaging well over one token per session for the first sixty sessions (12:8 to 17:4); then it rather suddenly became rare, and was not heard after 18:25.

The stop articulation varied from alveolar through palatal to velar; the first vowel was non-back and usually mid-high or mid-low; the second vowel was usually non-front and non-low (see appendix). Occasionally the second syllable had a final *m*. 'Thankyou' could be produced as the two-syllable unit or iterated several times in accompaniment to a single act of giving. The greater frequency of single-unit utterances sets it somewhat apart from the three IPB's discussed previously; it seems that in order to represent Jacob's speech fairly, the IPB should not be set up as a rigid either/or classification, but as a 'squishy' one; 'thankyou' is less of an IPB than [ioio] with respect to amount of iteration.

(Discussion of the problematic phonetic structure of 'thankyou' and its theoretical interpretation is in chapter 3.)

'Thankyou', in adult language, like greetings and interjections, is a word closely tied to action, or rather to social interaction. It is thus of low autonomy in adult language as well as in child language. In judging the 'wordiness' of Jacob's 'thankyou' we therefore should not downgrade it because of its low autonomy, unless we wish to revise the way in which we speak of adult language and deny 'word' status to 'thankyou' in English.

It should be noted that children more advanced than Jacob at 15 months, in their creative use of language, may use a word which has low autonomy in the adult language in a variety of ways. Jacob at 18:2 used 'bye-bye' with rising contour to ask his father, who was preparing to leave the apartment, if he was indeed about to go out (see ch. 5), and Daniel Menn, at 25 months, used 'bye' predicatively (X is gone) and desideratively (take X away), although he was not exposed to such possible nursery-language use by those around him (Menn 1973). There is, however, a minimal level of autonomy possessed by any word in adult language: a word can always be used as its own name, as for example 'goodbye' is used in the sentence "Say 'goodbye' now". Children probably come to master this use very early; a perfect example of it is found in this sequence from the Daniel Menn corpus at age 2:6:22, where Daniel reported

> "Hi man -- not here now", i.e. "I said 'hi' to the man -- he's not here now."

Returning to Jacob's use of 'thankyou', it never manifested any autonomy; during the final period mentioned, when it had become very rare, only four tokens in eighteen sessions, it was used on the next-to-last of these occasions to mark the receipt of an object. Jacob had no concomitant loss of interest in the 'giving' game when 'thankyou' became rare. Instead he began to mark 'giving' with a rising intonation contour on a babble 'carrier' (see ch. 5) while offering an object, a much closer match to adult behavior. There were probably some phonological contributing factors to certain fluctuations (Menn 1975, and see ch. 3) in the fortunes of 'thankyou' which we have not taken up here, but its final demise probably occurred because Jacob had come to understand that adults do not say 'thankyou' when giving someone something.

We will conclude by remarking that although 'thankyou' apparently always accompanied an act of giving, it was not, as a behaviorist might suppose, describable as an auxiliary motor act which somehow, via association, got linked into the sequence of motor acts involved in giving. There is, first of all, not a unique sequence of motor acts involved in 'giving'. Furthermore, 'thankyou' did not always come at a certain place in the act (e.g. the beginning of motion towards the recipient, bringing the object into contact with the recipient's hand, release or withdrawal of the object). The same general observation applies to the association of [ioio] with the act of rotating an object, and to all the instances to be discussed later in which Jacob's speech was closely connected with some particular kind of action. As is widely said, early speech is closely tied to action; furthermore, in both adult and child language, the best semantic characterization of certain words seems to be 'what you say when you do X'. But the way in which certain words and actions are linked cannot be understood mechanically.

2.2.5 Other early utterance-types

Quite a number -- in fact, almost all -- of Jacob's early utterance-types were deficient with respect to some of our criteria for being-a-word. Most of these proto-words are lacking in autonomy. Some accompany specific types of action, like 'there', used when Jacob put an object down, occasionally when he gave it to someone; 'here', used to accompany handing an object, and 'thankyou' and [ioio] (in its early stages) as discussed above. Some others were involved with interpersonal or intransitive action, for example: 'byebye', 'peekaboo', 'Jacob' (= 'where's Jacob?'), 'bounce' (while bouncing up and down). Other proto-words showed evolution, like [ioio] did, towards autonomy: an excellent case is the very frequent item 'down', which was originally used only to accompany knocking down block towers, but soon could be used to describe falling in general, first of objects that he caused to fall, then as comments on the action of another person, then on his own position, and eventually as an imperative or request and as a comment on position of an object not resulting from any action that he could have witnessed or inferred. (An early example of this progress towards autonomy came at 14:24 when Jacob stood looking out of an 8th-storey window, repeating 'down' over and over.) 'Down' did not make comparable progress in phonetic development, however; it came into Jacob's active vocabulary at 13:25 showing a well-controlled alveolar onset but much variation in the vowel and final nasal (see ch. 3), and maintained its extreme variability throughout the rest of the study.

With respect to the criterion of semantic coherence, 'down' might seem a little weak, since Jacob occasionally used it to accompany vertical-downwards slapping motions. (This use seems peculiar to the English-speaking adult; however, assuming that this was indeed a 'use of the word "down"', one can certainly argue that it is not a bizarre overgeneralization but a natural extension of meaning.)

Standing back from this discussion for a moment, we can see that in speaking of the developing autonomy of [ioio] we were concerned with its development across speech act lines. (K. Nelson drew this point to my attention.) However, in discussing 'down', we observed development of autonomy within one type of speech act, the narrative. The case of 'down' brings out the fact that we should, at least theoretically, distinguish the notion of the extension of a single referential use to different contexts from the notion of the generalization of the reference of a word. The problem is a nasty one, because it requires us to figure out what part of the child's meaning is represented in his/her utterance (Greenfield, Smith, and Laufer forthcoming). If 'down', for example, happened

to mean for the child roughly what it means for the adult, then in each of the many contexts in which Jacob used it to comment on downward motion or low position we would have the same narrow referent expressing a very small part of the child's thought: the word would have high autonomy and low generality. If, on the other hand, 'down' meant 'motion down and pushing down and lying down and ifyoupushedsomethingthereitwouldfall down' -- if it referred to a more inclusive concept than the adult word, then it would be of high generality (low specificity) and could be of low autonomy -- the child could be unable to use it for a new situation like 'He's getting ready to get down'. Instead of being one sharp tool of many uses it would be a cumbersome multipurpose gadget that cannot be adapted to any use for which it was not designed, reminiscent of McNeill's hypothetical holophrase (McNeill 1966) although not so extreme. It took much work to show that the concept of holophrase was untenable. To find out just how vague children's words may be will probably take a great deal more. Getting back to the data in hand, barking (active from 15:29) and meowing (active from 17:27) showed a similar development of autonomy, from being 'what you do when you look at an animal picture' to expression of a desire to look out the window in hopes of seeing a dog or a cat.

Another proto-word had a somewhat different history. It was weak on both phonological and semantic consistency, but it seemed to have considerable autonomy from the time when it was first observed, around 15:15 -- although this is difficult to argue when the meaning is ill-defined. This item was a liquid babble that we shall refer to as 'hello'; it appeared frequently while Jacob played at peering out the front apartment door or at the beginning of 'conversations' on his toy telephone (in the latter instance, with a rising intonation contour: cf. 'Hello?'). The semantic coherence was apparently weak in that 'hello' also appeared when there was no evidence that Jacob was in or pretending to be in a greeting situation. It may have been a general interaction initiator, but he also seemed just to like the sound. This fact, coupled with a rather weak articulation of the liquid, was probably why no adult realized at the time that he had such an utterance-type. Recurrent liquid babble was noted, but no semantic content was recognized until videotapes of Jacob at the door and playing with his toy telephone were studied.

Since 'hello' thus lacked semantic coherence how can we argue for autonomy? Perhaps the other situations in which Jacob used it were not different uses of one basic meaning but instances of a very diffuse meaning? In the case of 'hello' we have a fair argument: it was used principally in two types of instances which are semantically related but represent different speech acts: the situations described above, and also (15:21) while handing the toy phone to an adult,

trying to get the adult to 'talk' on it. But it was also present in unrelated 'handing' situations. Altogether it remains a problematic proto-word.

2.2.6 The problem of the relationships among the three criteria for being a word

If we summarize and tabulate the cases discussed so far in section 2.2, which are all the principal cases in the data, we see that there is no correlation among the three parameters of wordiness except that weak semantic coherence implies a low rating for symbolic autonomy because it becomes, as we have just said, hard to defend a claim of autonomy when semantic coherence is low.

[ioio] was phonetically poorly constrained, but semantically and with respect to autonomy it was much like its better-controlled near-synonym, 'round and round'. [dɨgʌ] and [oɣi] were phonetically poorly constrained and also semantically empty. 'Thankyou' was poor phonologically and showed no autonomy but had high semantic coherence; 'down' is very much like [ioio] without regard to the fact that it was a deliberately taught and frequently modeled English word while [ioio] was Jacob's own invention. (Aside: this suggests to me that perhaps any item in a child's active vocabulary is best looked at as being his/her 'own invention'.)

Table 2.1 below is a schematic representation of the descriptions which I have just summarized, which are representative of the proto-words and IPB of the whole corpus.

With no evident correlations between phonetic consistency and the semantic aspects of 'wordiness', we must conclude that decisions on what utterances to 'count in' as words for the sake of phonology will have to be made on grounds internal to phonology.

We should not leave the topic without discussing another sort of interrelation between phonetic consistency and semantic coherence: a trade-off relation, resulting from the problems adults have with recognizing children's utterance-types. An utterance can be recognized by adults, and responded to as having content, only if it has sufficient semantic AND phonetic coherence for the adult to become aware of it as recurrent. A type with high phonetic consistency, however, can be recognized as the 'same word' in a great variety of uses ("Isn't it funny, he uses the same word for 'dog' and 'cat'"); reciprocally, high semantic coherence means that a word with poor phonetic consistency is recognizable (Jacob is believed to be saying 'down' while knocking over blocks whether he says [dæm], [do], or [da^{w}].) And finally, frequency (especially iteration) plays a role in helping

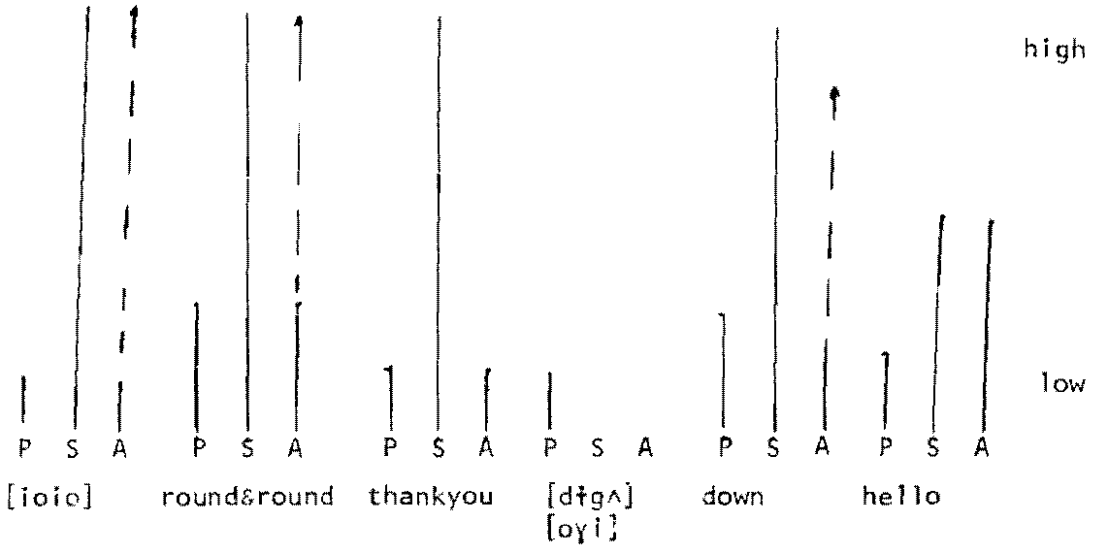


Table 2.1

(Dotted lines indicate increase over time)

Proto-words & IPB

P: Phonetic consistency
S: Semantic coherence
A: Symbolic autonomy

the adult 'catch on' to the fact that the child is 'saying something,' and so does resemblance to an adult word which is appropriate to the contexts in which the child used his utterance.

Have we any evidence to support some kind of selection theory from these considerations? Do words which adults fail to recognize die out? Would 'hello' have survived in Jacob's vocabulary if it had been recognized, or did whatever made it such an obscure form also contribute to its short life? After all, the child's opinion of his/her words may be much more important than feedback from adults, and that would minimize the importance of the adult's ability to recognize a proto-word. The question of whether the child's words survive because they are recognized by adults, or whether, on the contrary, the child abandons certain words because he does not hear them in the ambient language must rest entirely indeterminate for the present. A participant-observer study such as this one is not the appropriate mode for the investigation of this question.

In order to find out if the child stops using words when adults fail to recognize them, it would be necessary to have a study in which there was no feedback to those adults who interacted with the child. The data would have to be detailed enough so that the investigator could recognize (proto-) words which were based on words in the adult language, but which the child's caregivers had not noticed (like 'hello' in the present study). The fate of those words could be then compared with that of similar words which the caregivers had been able to recognize.

2.2.7 Possible bias and differences of interpretation

In the last subsection we have focused on the problems of identifying the child's utterance. There is a notable difference between Jacob and other children whose early utterances have been studied, and it MAY be an artifact. The participant observer, constantly interacting with the child, tends to listen for utterances which have obvious clues to their content; transcribing audiotape, one becomes dependent on audible cues (Yes, Jacob, it sure did fall down!). Other authors, notably Dore et al (1974), report phonetic patterns much more tenuously connected with content than anything I reported (except the semantically empty but easily recognized iterated patterned babbles). These patterns seem to be expressions of affect -- contentment, effort, annoyance, etc. It is entirely possible that Jacob also had these, but that they remain to be discovered in further analysis of the videotapes. It is also possible that, while Jacob's tone of voice certainly varied with his mood, he had no consistent sound patterns correlated with those moods.

2.3 Jacob's semantic selection

2.3.1 Description

Important work has been done in recent years on the characterization of what children talk about in early speech, and what ends they accomplish by speaking. K. Nelson (1973), with an unusually large sample, calls attention to the ways children may differ in what they use early speech for.

Jacob's proto-words showed a distinct semantic bias towards action-names which also was found in his response to words spoken by others. This bias became less evident at the same time that symbolic autonomy was developing in his proto-words, and the two changes are probably related, although I am at present unable to specify just how.

The bias is quite evident from our discussion in 2.2: he used his proto-words almost entirely to accompany action, and they were specific to the action, not to anything acted upon: rotation, placing, bouncing, hiding, giving, pushing down, building up, hitting, and so forth. For example, if he was rotating a top, he said [ioio] or 'round', not 'top'. Furthermore, items in his passive vocabulary that he was at all likely to respond to were words that designated actions of this kind. He responded very little to overtures of the familiar types "where's the block?" and not much more to "Give me the doll." I discovered after considerable frustration that if I wanted Jacob to respond to verbal cues with any reliability, I had better suggest to him that he try one of the actions he liked, such as bouncing, rocking, 'flying', or spinning an object.

Let me make it clear that Jacob during this initial period did know, and occasionally use or respond to the names of some objects (see passive vocabulary list, appendix); the bias we are discussing does not arise from any inability to learn names, but from either his interest in them or his understanding of what people mean by saying them. We shall return later to hypotheses concerning the cause of Jacob's bias, after we have given a full description of it.

Subjectively, it seemed that Jacob's attention was no more directed to an object by an adult naming that object than by his catching sight of that object among others. He could take it or leave it; he felt no social obligation to respond. Interactions between Jacob and me involving the teaching of action words and his subsequent response to and use of them usually became an amusing game for both of us. After he watched me knock on a door while saying 'knock-knock', or tap with a pencil on a block saying 'tap-tap', or caress a toy animal saying 'nice monkey', Jacob would usually imitate the action, and then would not only perform the action himself on verbal suggestion, but usually would turn to me expectantly after he knocked or tapped and wait for me to repeat the word -- whereupon he would repeat the action.

Table 2.2 Jacob's early words (gross vocabulary)

Listed chronologically within semantic groups

Each word is listed with age at first attestation, whether that occurrence was imitated or spontaneous. In this table, italicized words are those which I judge to have become part of Jacob's active vocabulary within two months after their first occurrence; words in parentheses were 'transient' in that they occurred at most once more within two months after their first occurrence. Preceding each word in this table is its appendix reference number, which is a ROUGH reflection of 'order of acquisition' (a very rough term).

Action Words		Names of Objects	
12:8	1. *thankyou*	12:12	2. (toast)
12:15	3. *there*	13:6	10. (key)
12:19	4. *no* (inhibits action)	13:6	11. (glasses)
13:6	7. *Jacob* (in game)	13:8	12. (tree)
13:15	13. bye-bye	13:22	20. (ring)
13:20	14. jingle	13:22	22. (dot)
13:22	8. *down*	13:29	18. (pencap)
13:29	19. (peekaboo)	13:29	20. (*doll*)
14:0	27. *around*	14:0	28. (diaper)
14:0	30. *up*	14:7	33. (turtle)
14:3	23. (bounce)	14:12	33. (monkey)
14:12	32. *tap-tap*	14:17	36. (cow)
14:17	24. (on)	14:17	38. (book)
14:17	34. (close)	14:17	37. (cracker)
14:21	40. *roll*	14:21	39. *earring* (associated w. act)
14:21	43. (zip)	14:21	42. (duck)
14:21	44. (whee)	14:28	46. (teether)
14:24	26. ioio	14:28	48. (stick)
15:22	49. *hot*	15:1	55. (boot)
15:22	51. (*here*)	15:5	56./57. (shoes and socks)
15:22	53. *hello*	15:16	58. *hole*
15:22	59. (pull)		
total: 22, active, 13; 14 had more than two occurrences within two months after first use		total, 22, active, 3; only 'earring' had more than two occurrences within two months after first use; all but 'toast' used as labels	

Remainder of words attested by 15:22

12:19	5. [dɨgʌ] babble	13:3	9. hm	14:17	35. (moo)
12:19	6. razzberry	14:7	25. [oɣi] babble	14:28	47. *woof*

(words not heard by L.M. or found on tape have been omitted from this list; their inclusion would not affect the outcome)

2.3.2 Possible explanations of Jacob's semantic selection

It is entirely possible that Jacob's semantic selectivity is a reflection of his interests and personality -- a fine topic for study, but not a linguistic matter. It is possible to imagine psycholinguistic explanations, however, and it seems worthwhile to mention them as areas for future investigation.

Two possibilities have come to mind: 1) Perhaps Jacob's lack of response to certain typical object-oriented remarks, such as 'where's the doggie?' might be due to a failure to realize that adults want him to respond to those remarks and are not neutrally offering verbal material for his inspection. This hypothesis would be rendered implausible if it could be established that a child of Jacob's general level of skill at social interaction should know what adults want of him/her when they ask 'Where's the doggie?'

2) The second hypothesis relates to Jacob's lack of inclination to say names of objects rather than to his infrequent response to them, but it is not entirely independent of the first hypothesis. Perhaps Jacob did not know when it is appropriate to say names of objects. Is there a process of learning WHEN to talk? What form does it take? Consider that action words (clap hands, roll, tap-tap...) are almost invariably presented along with the action; the action is seldom performed in silence, or accompanied only by unrelated chatter. The action-words under consideration do not concern the routine activities of getting dressed, eating, being bathed. They are highly focused and are only continued by the adult so long as they seem capable of amusing the child; they are ends in themselves. Jacob had very favorable circumstances for learning that the word was part of 'what you do' when you perform the action. (He by no means learned to say all the action words that he learned to respond to. There is phonetic selectivity as well as semantic selectivity, as we shall see in section 4.1)

Objects, however, are different. A ball might have lain on the floor for several hours, and once in that time an adult might have said 'Look, Jacob, there's a ball'. Jacob typically attended to such statements, and certainly learned the referent of 'ball'. But in such circumstances, there is no clear indication as to what the occasions are on which it is appropriate to say 'ball'. In the naming of transient objects (e.g. vehicles and passers-by, as might be seen from a window or while walking) the clues as to when to talk are clearer, but one does not, in the city, name every passing person or object.

I suggest, then, that a part of learning words is learning what the occasions are on which people say them. This is an aspect of their function, and is conceptually separate from their referential meaning. Names of objects may have a clear referent but an obscure function for some children, they may become part of the passive vocabulary and yet not be used. It would be easier to learn when to say words that are part of games or other clearly-defined brief actions and interactions.

Can not knowing (or not having a theory about) when or why something is said by adults inhibit a child from saying it? This is a much more delicate aspect of meaning than referential meaning.

It should be understood that for a child to have a theory of what the appropriate occasions for an utterance are does not mean that his/her theory is correct. It is tantalizing to note, in that respect, that in the first fifty words of gross vocabulary, in table 2.2, there are 22 names of objects, and 21 of those were used only as pure labels in a naming-game situation. The one that was used to get an adult to do anything beyond attending to the utterance was the rare, very early word 'toast', used to request toast once at 12:12 and again for the same purpose at 16:5. While Jacob's action words were being extended to uses as comments, demands, and requests on occasion before 16 months, no object word except for 'toast' was used to request a desired object (or to elicit any action involving an object) until 17:20 when he asked for 'tea'. Possibly when Jacob did develop a theory of 'when to name' objects, the theory was that object names are used just as they were most frequently used to him: as labels in a game of naming objects. It should be understood that Jacob frequently desired objects other than toast, and communicated his desires very well, by reaching towards what he wanted and babbling usually with a rising intonation contour (see ch.5). Some confirmation for the hypothesis that Jacob failed to use object names because he didn't know when to say them comes from the fact that the first object name which he used at all frequently was one for which the appropriate occasion was unusually clear: starting at 16:19 he squealed what was apparently his word for 'siren' whenever he heard one outside.

Holzman (pers. comm.) suggests another possible interpretation of a shift from use of action proto-words to a greater variety of function-types. She supposes that the earliest aspect of word-learning is a learning of what-to-say-when, as certainly seems to be the case for Jacob. Now suppose that the insight that things-have-names lags behind the more superficial knowledge that *people say certain things at certain times*. Without the understanding that things have names, a child could do very little correct labeling; the expected results might be very like the wild type of 'overgeneralization' (anything in a silver frame is 'baby', anything dimly breast-like is 'nenin') (Clark 1973).

Now in the particular case of Jacob, it appears to be the case that Holzman's model does not explain the data, for his accurate responses when he was asked to give someone an object would be difficult to account for if he did not know that the word designated the object. However, Holzman's emphasis on children's use of the exterior form certainly accords with the general evidence in this thesis, and her model seems to me to be likely to be the correct one for explaining the behavior of some children.

Section 2.4 Remarks on Halliday's findings

M.A.K. Halliday's very important book *Learning How to Mean* (1975) reports intensive work on the development of language in his son 'Nigel'. A detailed general comparison of Nigel and Jacob is called for and would be very rewarding, but it falls outside the scope of this thesis. Here we shall take up the topic of Nigel's development of symbolic autonomy.

Nigel's development is similar to Jacob's in some respects and differs in others. For each of them, however, it is true that items in his output initially lack autonomy and develop it gradually. Halliday puts his observation as follows:

> The child's language system at [the first] stage is a two-level system. It consists of a content and an expression, and each element in the system is a simple sign having just these two aspects; it is a content-expression pair. In other words, the system differs from the adult language system in that it has no intermediate level... (p. 6) no level of form. (p. 8)

Halliday then goes on to describe aspects of his son's speech which are not strictly analogous to any we have developed here; his description of the functions of speech is considerably elaborated and forms a principal part of his exposition. The crucial term of comparison, however, is that Nigel's content-expression pairs (which would be described in our terms as proto-words lacking autonomy) begin to develop new functions; in Nigel's case, the breakthrough comes on three proper names, which are found at around 16 months with contrasting intonation patterns: "Here for the first time is a set of options which do not form a simple taxonomy. The personal names Anna, Daddy, Mummy may be combined either with high level tone, meaning 'I'm looking for you' or with mid falling tone, meaning something like 'hullo, there you are!'" (fig. 5) "[It] ceases at this point to be possible to interpret the system as a simple inventory of meanings...he is developing a semantics that is not only a lexical semantics but also a grammatical semantics, a meaning potential that is organized in sets of options which combine." (p. 36).

We should note a disparity between Nigel and Jacob which may be of some general interest. Halliday finds that Nigel begins 'dialogues' at about the same time that he begins to develop autonomy. He suggests that these occurrences both of central importance are not independent of one another. However, for Jacob, who was apparently a much freer babbler than Nigel, one cannot ascribe a definite onset to the emergence of dialogue. From the earliest weeks (13:3) of this study, Jacob engaged in the 'outer form' of dialogue, as well as in the outer form of monologue. Among his monologues were arm-waving babbled harangues (which observers jokingly identified with academic argument style) and later he babbled (one-sider) 'telephone conversations'. The dialogues were sometimes exchanges of syllabic babble with his parents; with me they tended to be exchanges of 'hm', with varying intonation contour. (Jacob babbles variously at me, but I did not imitate him, finding it more natural to respond with the 'hm'.)

On the other hand, dialogues with genuine verbal exchanges of information develop more slowly. One might consider the cases where Jacob verbally requested action or permission to act (found by 15 months) as early forms of dialogue. More sophisticated early dialogues are elicitation of object names from the adult (around 17 months) and verbal 'no' responses to adult questions (about 19 months).

I suggest that the emergence of verbal dialogue is a complex topic in its own right, and I doubt that it bears a simple relationship to the development of symbolic autonomy.

2.5 Comparison of the semantic structure and growth of Jacob's vocabulary with the data from K. Nelson's study

We are fortunate in possessing Katherine Nelson's study (1973) *Structure and Strategy in Learning to Talk*, which follows the language development of eighteen children during their second year (with a follow-up at 30 months). In Nelson's study, vocabulary records were kept by the children's mothers, and Nelson obtained a variety of other measures in interview and test situations. Jacob can be compared with those subjects with respect to many of the indices recorded by Nelson, and the present study can thus be placed in a comparative context. We find, basically, that Jacob is typical in his overall vocabulary growth and his semantic categories, but that he is very unusual, with respect to Nelson's sample, in the following respects: 1) the lack of proper names in his first fifty words, 2) the overwhelming number of action words in the first ten words, and 3) the large proportion (30% at least) of his vocabulary which still consists of action words when the first fifty words are tabulated.

Before continuing with the comparison, we shall need to make a temporary shift in terminology. Nelson restricts her corpus to spontaneously produced utterance-types which have sufficient semantic and phonetic consistency to be recognizable as recurrent meaningful elements; evidence of autonomy was not analyzed. On the latter topic, she states (p. 15):

> At this level detailed analyses have not been made of the use of a particular word by a particular child across situations and over time... The mothers in this study on the whole reported that early words were used quite consistently to express a particular function, that is, reference, demand, etc. It has often been asserted that young children use a single word for a variety of different functional statements. This view is not strongly supported; the evidence on the contrary suggests that these children were quite consistent, not to say repetitious, in the use of words they knew. This question deserved more direct and intensive study.

(Before we continue, note that the evolution of autonomy in Jacob's utterances was slow enough to accord well with Nelson's data, but eventually extensive enough, for at least some words, to accord with the 'folklore' assertion of functional variety as well. If other children who are studied in detail acquire autonomy in the same slow way that Jacob and Nigel did, the apparent contradiction noted by Nelson can be considered as resolved.)

Returning to our terminological problem: Nelson refers to all recurrent meaningful utterance-types as 'words', which is consistent with general usage regarding child language; considerations of the details of phonetic and semantic consistency and of autonomy, have not generally led investigators to set up a proto-word category such as we have found necessary for our specialized purposes. For purposes of comparison, then, in this section we shall use the term 'word' in the same way that Nelson does, and shall likewise restrict our attention to the words of the child's active vocabulary. (Note with the hindsight available to us as a consequence of possessing a nearly complete record of Jacob's production types, both spontaneous and imitated, we observe that Nelson's decision to restrict her investigation to the active vocabulary was probably a very important methodological decision. Her stated (pp. 13, 14) reason for doing so is that if one includes imitated vocabulary, one must then attempt to judge whether one is dealing with pure sound imitation or whether the word is being used "with understanding" (Nelson quotes Leopold here). In a study of semantic structure, clearly only words used meaningfully are of interest, but to make such a judgment objectively is impossible -- one does not even know if reliable inter-observer agreement can be obtained. Inspection of table 2.2 reveals that Nelson's decision to focus on active vocabulary probably did much more than increase the reliability of

her data base: if her subjects were like Jacob, that decision greatly sharpened her results. Jacob's patterns of semantic selectivity show up much more clearly if we consider only his active vocabulary instead of his gross vocabulary (active, shadow, and imitated). In retrospect, it is not surprising that this should be so, although the case might be otherwise; we shall see the same sort of pattern-sharpening when we compare phonetic selectivity of active *vs.* gross vocabulary in chapter 4.)

The tables below show Jacob's vocabulary growth and semantic classes for his first fifty words according to Nelson's categories.

Tables 2.3

Jacob's vocabulary according to Nelson's (1973) categories

2.3 a) Jacob's first ten words of active vocabulary

Nelson's functional categories	Jacob's words	No. of J's words in category
Specific nominals		0
General Nominals, objects	2. toast	1
Action, description and demand	1. thankyou 3. there 5. Jacob 7. down 8. round 9. up 10. [iɔiɔ]	7
Personal-Social	4. no 6. don't	2
Modifiers		0
Function Words		0

Jacob's age at 10 words active vocabulary, 14:24

Nelson's subjects mean age at 10 words, as reported by parents, 15.1 months

Jacob's active vocabulary is numbered above in accordance with the order of acquisition as computed for table 4.2.

Tables 2.3

2.3 b) Jacob's first fifty words of active vocabulary, and comparison with Nelson's 'R' and 'E' subjects

Nelson's functional categories	Jacob's words	No. of J's words in category	% of words in category for:		
			J	'R'	'E'
Specific Nominals		0	0%	13%	15%
General Nominals, objects and substances, animals and people	2. toast 11. doll 17. duck 21. ear/earring 22. siren 23. nose 25. truck 26. light 27. door 29. car 30. hole 31. cracker 32. tea 33. key 34. hat 35. tape 37. tractor 38. cookie 41. lion 43. eye 44. shoe(s) 45. apple 47. wheel 48. box 50. ball	25	50%	62%	38%
Action, description and demand	1. thankyou 3. there 5. Jacob 7. (a)round 9. up 10. [ioio] 12. tap-tap 14. here 16. roll 39. (a)way 41. off 42. on 46. eat 49. bang	15	30%	12%	15%

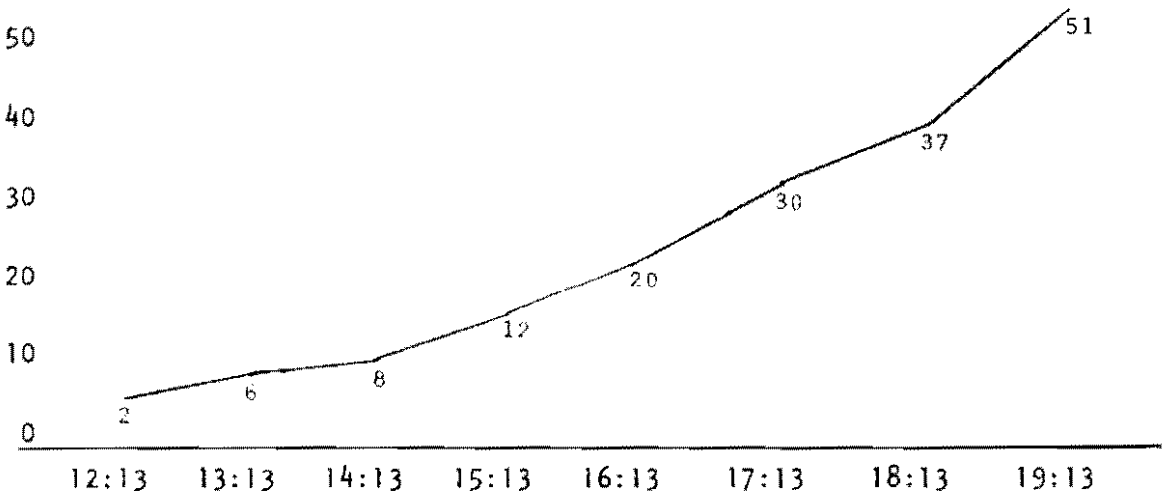
Tables 2.3

2.3 b) continued

Nelson's functional categories	Jacob's words	No. of J's words in category	% of words in category for: J	'R'	'E'
Modifiers, States	15. hot	1	2%	7%	12%
Personal-Social (standard)	4. no 6. don't 13. hello 19. uh-oh 20. bye-bye	5	10%	5%	11%
(animal noises)	18. woof-woof 28. quack 36. meow	3	6%		
Function Words	24. what's that (êsa)	1	2%	1%	8%

Notes: Animal noises, used as social exchanges as well as responses to real and pictured stimuli, are not separately categorized by Nelson. I place them as personal-social, since they were clearly not names of animals for Jacob. I have also followed Nelson's general procedure of assigning each word to a single function class, which requires a certain amount of arbitrary decision-making.

2.3 c) Jacob's active vocabulary growth for first fifty words, cumulative



Notes to Chapter Two

[1]Words in adult language have less semantic coherence than is commonly supposed. I use the Vygotskyan term in a strict sense, though I do not say that meanings are chain-complexes. A set S is a chain-complex if there is no single feature which all of the members have in common, but there are instead stepwise connections -- features in common -- between each element and some other element in such a way that all the elements are linked together by sequences of such connections. (Vygotsky 1965)

CHAPTER THREE

Phonetic Development and the Treatment of Phonetic Variation

3.1 Theory of analysis of sound patterns

As C. A. Ferguson and C. B. Farwell have emphasized (1975), the usual discussions of child phonology do not deal adequately with the great amount of phonetic variation that is often found when we compare putative tokens of the same word. We cannot simply carve out 'phonemes' and ignore small variations, because we are dealing with a developing system, a system in flux, and while some variation is random noise, some of it must be symptomatic of real changes taking place in the child's way of saying words. In this chapter we shall discuss some assumptions commonly brought to the study of child phonology, raise some questions about them, and then discuss Jacob's phonological development, raising more theoretical problems as we go and occasionally being able to make arguments for answers to some of the questions thus raised.

For some children, very little distortion of the data -- perhaps none -- is introduced by describing their output according to everyday American phonological working assumptions such as the following: appropriate units of analysis are 'phones', which are segments wholly comparable from one word to the next in similar phonetic environments, and there are 'phonemes', classes of phones in free variation or complementary distributions. If the data warrant, we may abstract away from these classes, preferring a deeper level of analysis in which underlying phonemes are related to the surface forms by sets of rules. (This device is very easy to justify in many specific cases in child phonology and is often indispensable.)

A word -- that is, the 'sound' part of a sound-meaning correspondence -- is to be described as a string of segmental phonemes modified by a small set of suprasegmental phonemes such as pitch and stress; the phonetic realization of a word so represented can then be derived by rules. Phonetic variation is either subphonemic and therefore uninteresting or else it signals full neutralization of phonemic contrast in the phonetic environments in which it occurs.

In adult language, exceptions to these principles are assumed to arise from dialect or speech-style variation, and beginning speakers are assumed to be monolectal.

Most, if not all, of the above assumptions work very well in analyzing the speech of children who have been speaking for a number of months, or perhaps just children who set up a nice rather discrete phonemic system fairly early in their speaking-lives. (That most children reported in past literature have not caused their investigators too much difficulty in the application of the phonetic/phonemic distinction may also be a result of investigators giving up on children with confusing types of variation and/or lack of high-quality tape-recorded data.)

Ferguson and Farwell (1975) seem to be the first to have called attention to the theoretical importance of the phonetic variation in early child speech. In general, theories of the acquisition of phonology since Jakobson have been concerned only with the acquisition of phonemic contrast, but the amount of smoothing and *ad hoc* interpretation of data required to make the corpuses from some children fit in with standard notions of 'phone' and 'phoneme' suggests that possibly children do not (or do not always) start out by analyzing their language in the way that they will have to eventually in order to become competent speakers. To use an analogy drawn by Paul Kiparsky, crawling precedes walking and is helpful although not necessary in developing the skills needed for walking, but is NOT a simplified kind of walking. The relation of a child's early phonologizing to the phonological structures of a mature speaker is an empirical question, not to be begged, and the difficulty of accounting for all of the variability of children's phonetic output within the phonemic model suggests that the model is inadequate.

Let us examine Jacob's output (or rather my phonetic transcription of the tapes, which is as close as we can get to the acoustic events at present), and let us start with the minimal assumption that each word is specified as an acoustic and/or articulatory target with a permissible range of variation about that target. In order to justify a description with more internal structure than that, we must compare words and see if they contain segments comparable in target and degree of variation about that target. Such segments are entitled to be called 'phones'. But even if there are some phones, perhaps not all words are completely decomposable into phone sequences, and perhaps there are other ways in which words may be compared besides segmental decomposition.

There is a very important way in which words may be analyzed that is different from the 'American' model. Instead of cutting the word 'vertically' into time-sections, it may be analyzed partially or completely in a 'horizontal' fashion, separating out aspects of the utterance which extend over its whole length -- nasality or pitch, to take two common examples. Such an analysis is called a prosodic analysis, and has been developed chiefly in Britain by J. R. Firth and his students. Some very interesting work on child language using this model has been done by Waterson (1971).

We then have three basic ways in which a child may approach a word:

1) as an unanalyzed whole, a Gestalt

2) as decomposed sequentially into time-sections: segments, syllables, or possibly some other subpart of the word's duration

3) as decomposed prosodically

Note that 2) and 3) are not mutually exclusive, and that in a child's lexicon, it is possible that some words are unanalyzed while others are analyzed sequentially, prosodically, or both; furthermore we cannot assume that if there is a sequential analysis used for one set of words it will be the same as the sequential analysis used for some other set. A homogeneous mode of analysis may be an end result, not a starting point.

There are also, cutting across these three approaches to words, two basic models for describing articulatory/acoustic target and range: discrete feature-matching or continuous 'homing-in'. Analysis by discrete features is, for many good reasons, both empirical and heuristic, very popular and I will not discuss it here, but an analogy from Jacob's non-linguistic behavior should be helpful in illustrating the sort of situation in which an analysis in terms of features does not account for the learning process.

Jacob, for most of the period of this study, delighted in pretending to feed his toy animals. At twelve or thirteen months, he was not especially particular about putting the empty spoon, piece of toast, or whatever exactly to the animal's mouth; anywhere near the end of the nose would do. However, if he was pretending to feed himself or another person, the 'food' always went to the person's mouth: he knew what and where a mouth was. By 20 months, things had changed: Jacob had become very precise about putting the 'spoons' to the toy animal's mouth. This occasioned a great deal of effort when he was 'feeding' a set of toy horses whose heads were at a great variety of angles to their necks and bodies (horse rearing, horse grazing, horse with head turned to one side, and horse in 'normal' standing position).

Most of this change cannot be ascribed to finer muscle control -- Jacob (at 20 months) had to start to feed each of the horses by turning it so that he could see its mouth clearly, and that he certainly could have done, had he cared to, at thirteen months. Such refinement of objectives does not lend itself to description in terms of making finer and finer feature-distinctions as to what is and is not a mouth. The proper description is that Jacob became more careful about doing something exactly rather than approximately.

Similarly, for the mastery of a speech sound, there is a long way to go after one has conceptually distinguished the target from everything else. Not only must one acquire the motor control prerequisite to landing close to the target, one must understand that it is necessary to get within a certain distance of the target before one's performance is good enough to be called a 'hit'.

Up to this point, I have not distinguished between input (recognition and storage) and output phases of analysis. As far as sequential *versus* prosodic analysis is concerned, I will make the simplifying assumption, which presently seems plausible to me, that the same mode of analysis describes a word for production that describes it for recognition and storage. When we come to the problem of whether the descriptors are wholly discrete, wholly continuous, or some sort of mixture, however, I hypothesize that the following model may be the best: descriptors for recognition and storage are discrete and exhaustively described by features. The targets for output are also described by these features (cf. mouth/not-mouth), but the range of acceptability requires a continuous type of description.

3.2 Data on phonetic development

After this long prologue, let us examine the phonetics of Jacob's speech. We will consider only spontaneous utterances, for Jacob's production often improved dramatically when he had just heard the adult model, and a separate study is needed to see how to evaluate shadowed and imitated words. Whatever is going on, it is clear that, as I said in chapter 2, Jacob's own patterns show up much more strongly in his spontaneous utterances than they do in his output taken as a whole.

We can narrow down the wide range of possible modes of analysis presented in the preceding section before we begin detailed description. There are only three words [ioio], 'thankyou', and 'Jacob' for which a sequential analysis into segments is wrong, and in two of those 'thankyou', 'Jacob' we can still talk about vocalic segments -- it is the consonantal portion which is best recognized as a prosodic unit not subject to sequential analysis. For the rest of Jacob's active vocabulary, as far as I can see, analysis into segments is proper, and I have taken it as basic because it is the mode of analysis with which I am familiar, but prosodic analysis is an essential counterpoint and I will sometimes deal with it explicitly or implicitly. In Jacob's speech, I have found no reason to take the syllable as a sequential unit, but this is in no way to be taken as an indication that I hold -- or that anyone should hold -- the tenet that only the segment and not the syllable can function as a sequential unit in child phonology. (For discussion of the syllable as a unit, see B. A.

Moskowitz (1970)). Therefore, setting aside [ioio] for the time being, here are charts of the vowels of Jacob's words as I heard them. Almost all the utterances used for these charts are on tape, and instrumental analysis will be undertaken in the near future.

3.2.1 Development of the vocalic system

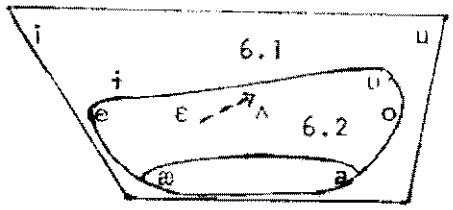
A word about the notation used and the data represented in these charts: I had divided Jacob's corpus into sections reflecting notable changes in his consonant system; in the nature of things, they were of varying lengths. Having no less arbitrary criterion for division of the corpus into time-blocks to study the development of the vocalic system, I used the same division except that I considered the shortest time-block, which was only two weeks long, together with the one which preceded it. The resulting division of the corpus is as follows:

Set # 1	12: 8 thru 14:21		Sessions 1 thru 22	
Set # 2	14:24	15:16	33	40
Set #3,4	15:22	16:28	41	56
Set #5	16:30	17:25	57	67
Set # 6	17:27	18:25	68	77
Set # 7	18:27	19:27	78	87
Set # 8	19:29	20:22	88	96

Within any chart, the tokens in the data were distributed evenly across the types unless noted: for example, in the chart of the vowel in 'there' in Set #1, eight tokens were found of the word, and they were transcribed as being equally distributed among [dɛ], [dʌ], [dæ], and [də]. This must be taken as a tentative description; only formant plots are really adequate if one wishes to decide what sort of statistical distribution the vowels have. No interesting time-shift in the type-token distribution occurs within a given chart unless noted; for example, within the chart for 'there', since there is no note to the contrary, it is not the case that [dɛ] and [dæ] were used only during the first four weeks of the time period of Set #1 and the other two forms only used during the remainder of the period. It remains possible that some fine-grained patterns of this sort exist but have escaped my notice.

Here is a sample entry to show how to read the vowel charts.

6. [æ w] 6.1 'down', 18 6.2 '(a)round', 4

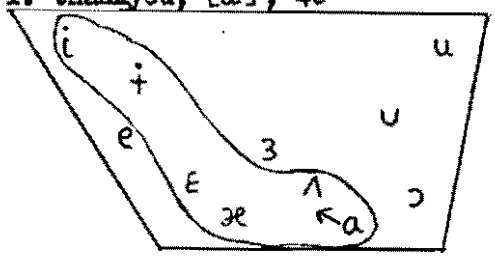


[æ w] is a phonetic representation of the adult vocalic target, presented with at least as much information as is necessary to indentify it in my dialect, and with more information if it seemed that Jacob was cognizant of finer phonetic detail than minimum. '6.' is a reference number, having no special meaning except that I have presented the charts for each set in a similar order each time. The order is roughly: special cases, high front, low front, central, low back, high back. Each adult word which occurred during the period of the 'set' in question that contained an instance of the target vowel is listed with a reference number, as 6.1 'down' and 6.2 '(a)round' in this example; the number following each target word represents the number of tokens of the word transcribed and used for analysis during the period of the 'set'. The reference numbers for each word are used to label the curves on the vowel-space chart which enclose the vowels which appeared in tokens of that word during the period. Here, '(a)round' was heard with vowels transcribed as æ and a, while there was much greater variety for 'down'.

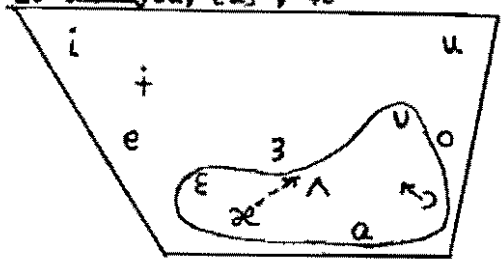
Dipthongized outputs are indicated by arrows projecting from the first vowel towards the second element: for example, in Set #1, chart 4, for the [ej] in 'Jacob' indicates one excellent rendition of the vowel by an arrow pointing from [e] towards [i]. Dotted lines indicate that some tokens were recorded with a vowel diphthongized and other tokens were recorded with the same nuclear vowel but no diphthongization. There are one or two places where an on-glide is represented as an arrow pointing towards the nuclear vowel from the appropriate direction.

Figures 3.1 Vowel Charts Set #1, 12:8 - 14:21 Sessions 1 - 32

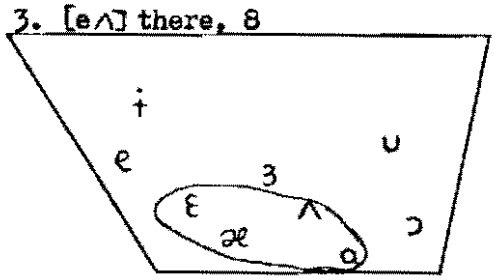
1. thankyou, [æ], 40



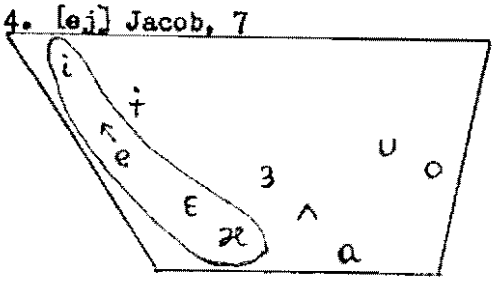
2. thankyou, [u] , 40



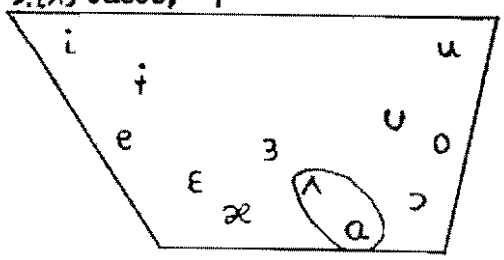
3. [eʌ] there, 8



4. [ej] Jacob, 7

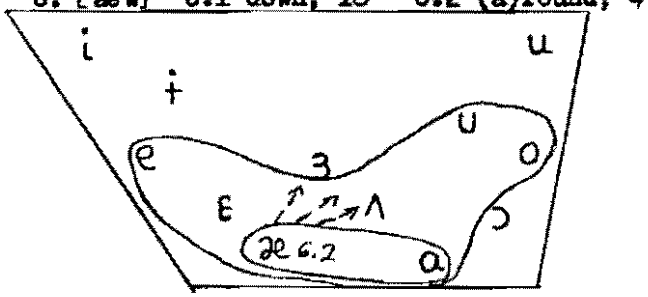


5.[ʌ] Jacob, 7

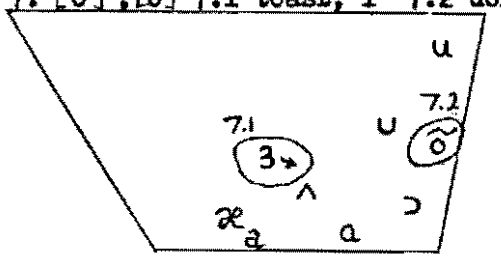


Figures 3.1 Vowel Charts Set #1, continued 12:8 - 14:21

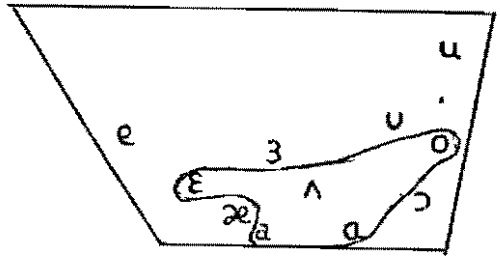
6. [æw] 6.1 down, 18 6.2 (a)round, 4



7. [o],[õ] 7.1 toast, 1 7.2 don't, 1

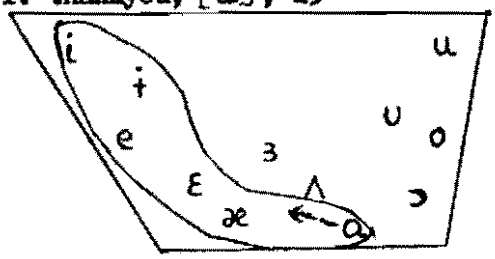


7.3 no, $(no)^n$

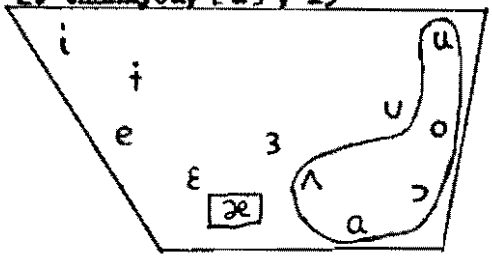


Figures 3.1 Vowel Charts Set #2, 14:24 - 15:16 Sessions 33 - 40

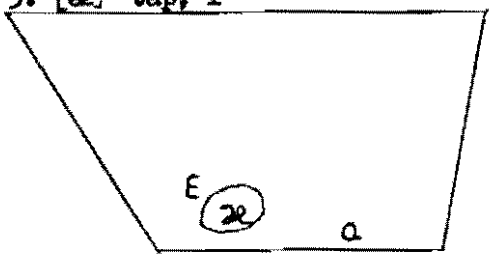
1. thankyou, [æ], 15



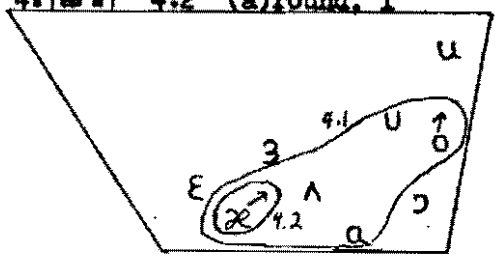
2. thankyou, [u], 15



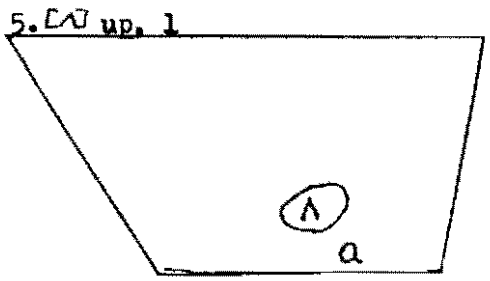
3. [æ] tap, 1

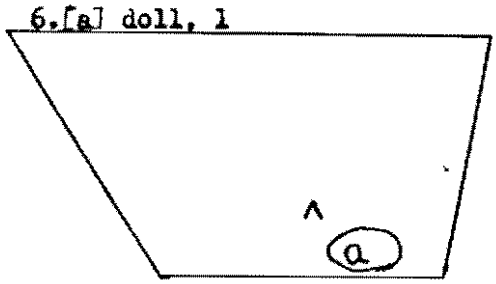


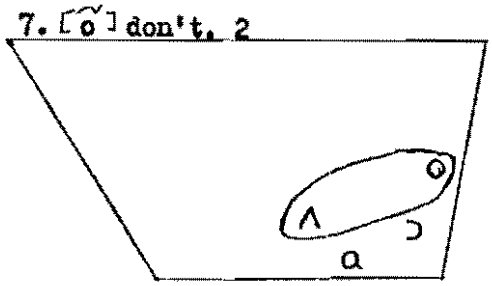
4.1 down, 12
4. [æw] 4.2 (a)round, 1



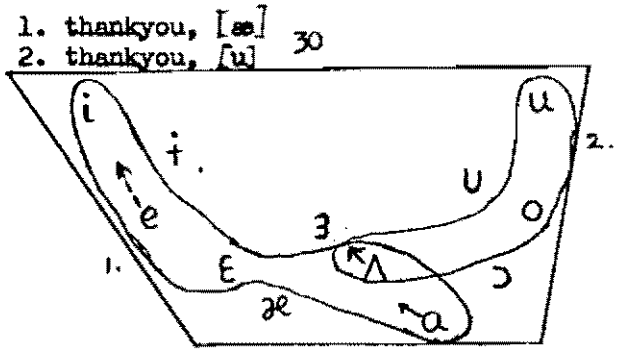
Figures 3.1 Vowel Charts Set #2, continued 14:24 - 15:16

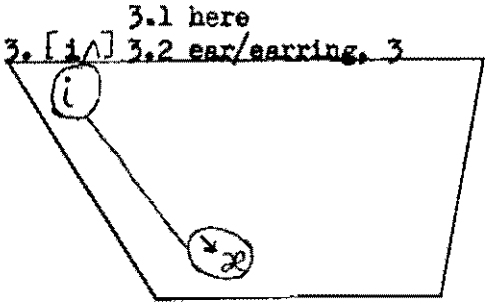


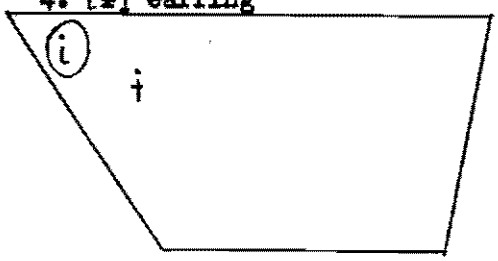


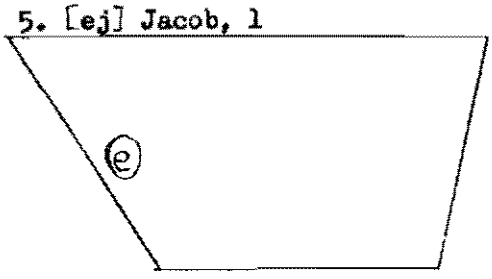


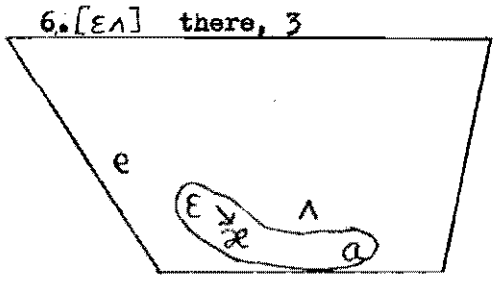
Figures 3.1 Vowel Charts, Sets #3 and #4, 15:22 - 16:28 Sessions 41 - 56





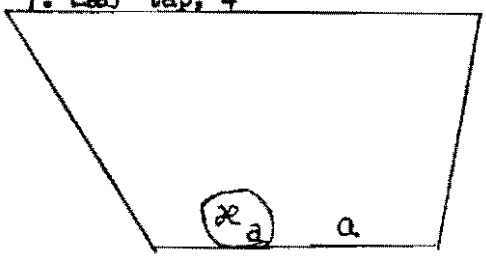




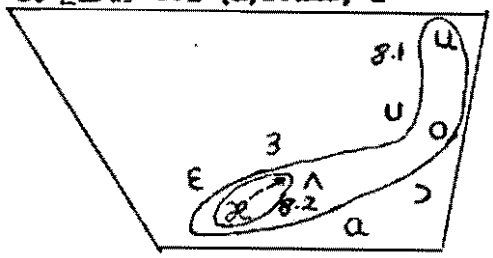


Figures 3.1 Vowel Charts Sets #3 and #4, continued 15:22 - 16:28

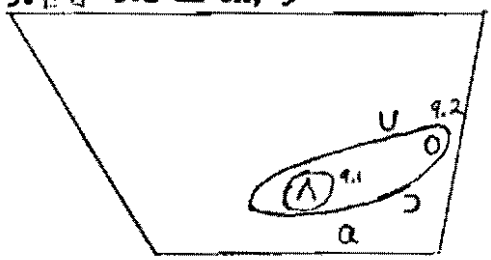
7. [æ] tap, 4



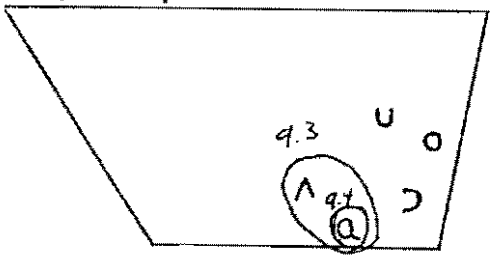
8.1 down, 30
8. [æw] 8.2 (a)round, 1



9.1 duck, 1; truck, 1
9. [ʌ] 9.2 uh-oh, 3

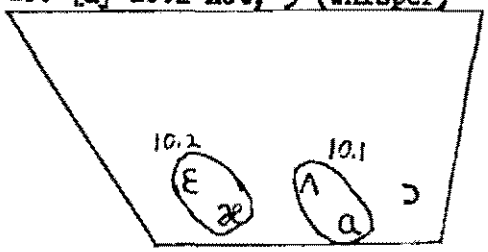


9.3 hello, 2
9.4 Jacob, 1

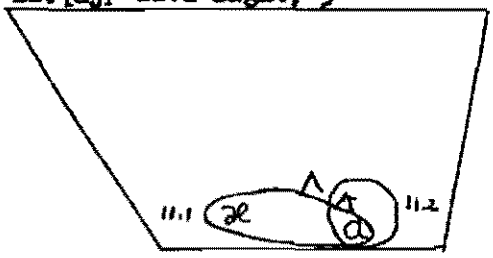


Figures 3.1 Vowel Charts Sets #3 and #4, continued 15:22 - 16:28

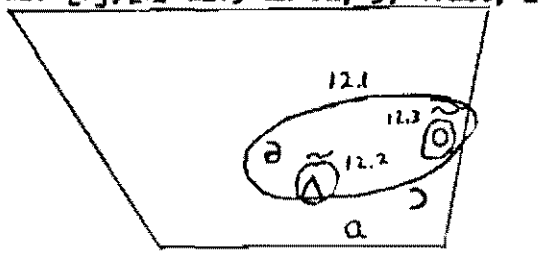
10.1 doll, 3
10. [a] 10.2 hot, 3 (whisper)



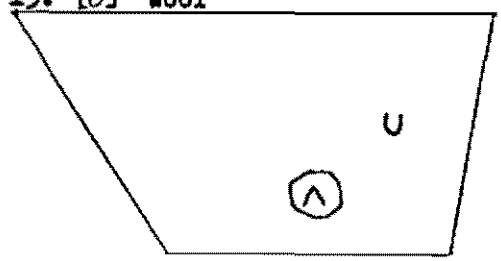
11.1 bye-bye, 3
11. [aj] 11.2 light, 3



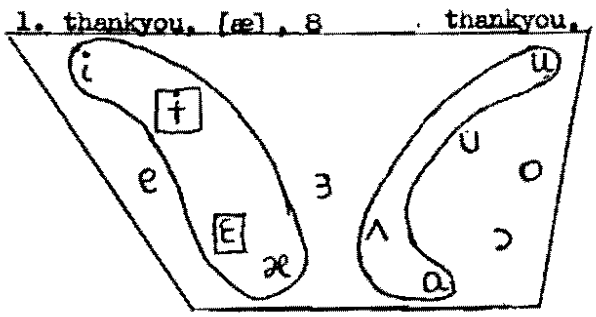
12.1 don't, 12
12.2 hello, 2
12.3 roll, 1; nose, 1;
12. [o], [õ] 12.3 uh-oh, 3; toast, 2



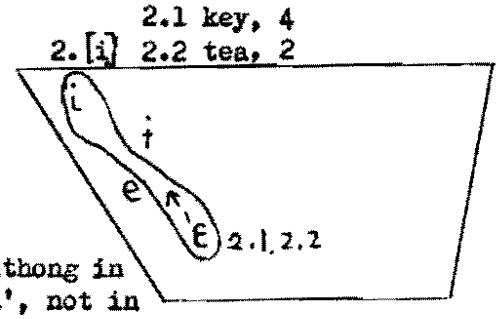
13. [ʊ] woof



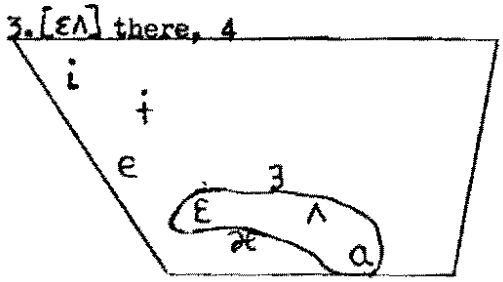
Figures 3.1 Vowel Charts Set #5, 16:30 - 17:25 Sessions 57 - 67

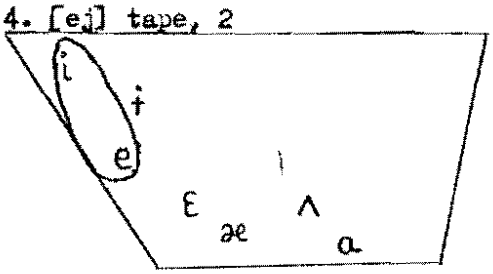


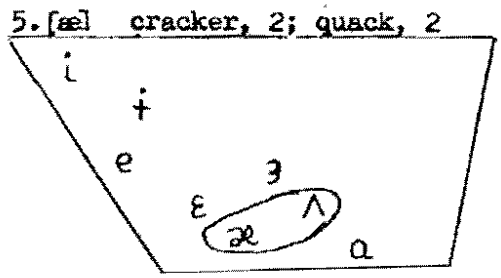
□ indicates reduplicated forms



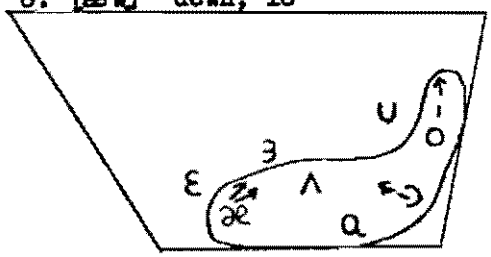
diphthong in 'tea', not in 'key'

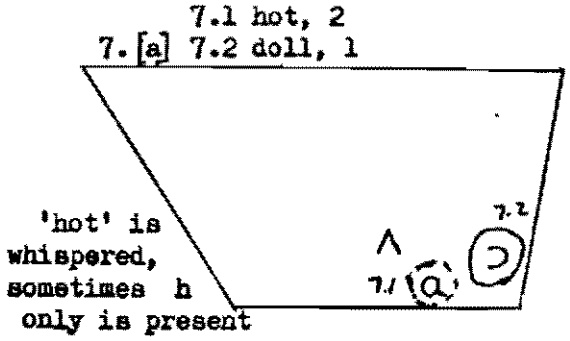


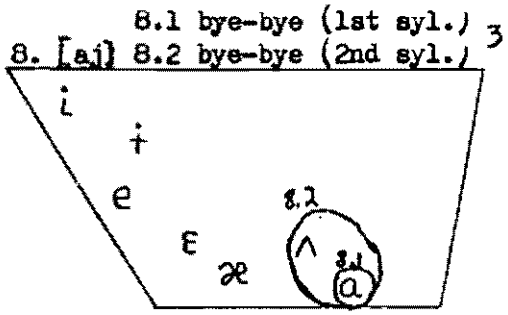


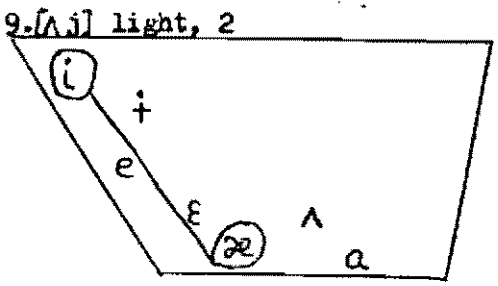


Figures 3.1 Vowel Charts Set #5, continued 16:30 - 17:25

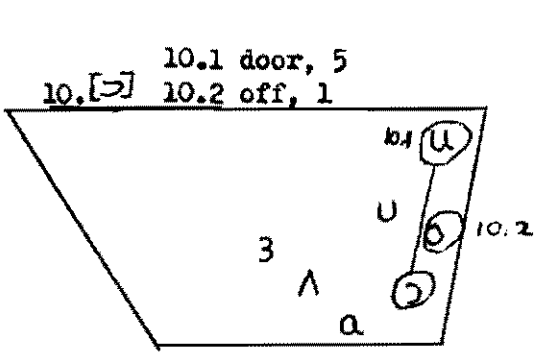


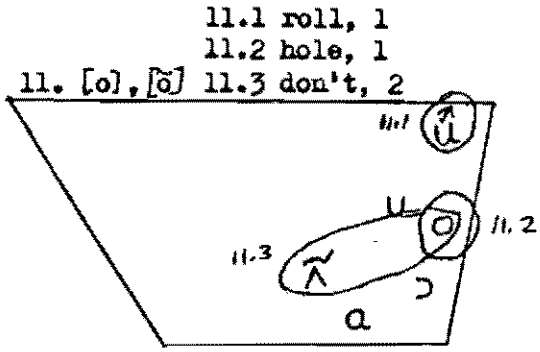


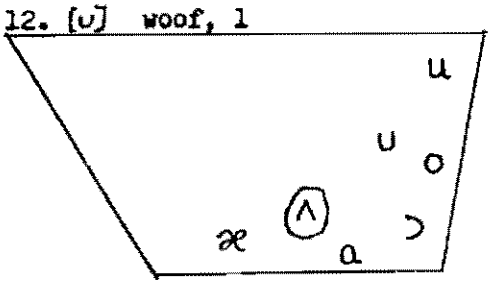


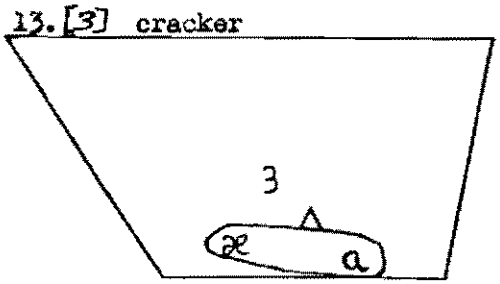


Figures 3.1 Vowel Charts Set #5, continued 16:30 - 17:25





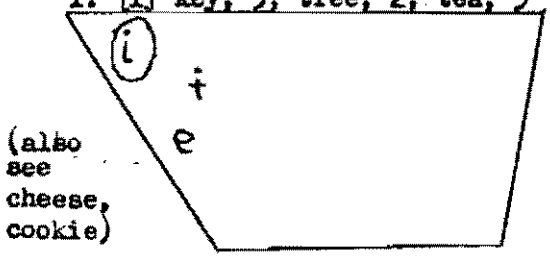




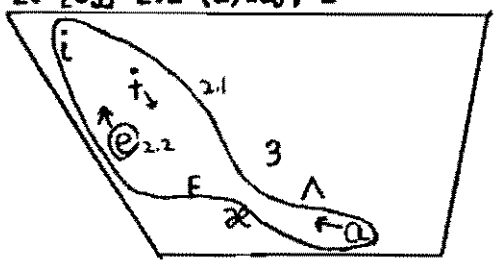
Not charted: 25 attempts at car/truck; see text

Figures 3.1 Vowel Charts Set #6, 17:27 - 18:25 Sessions 68 - 77

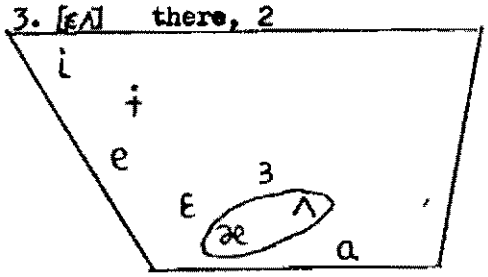
1. [i] key, 5; tree, 2; tea, 3



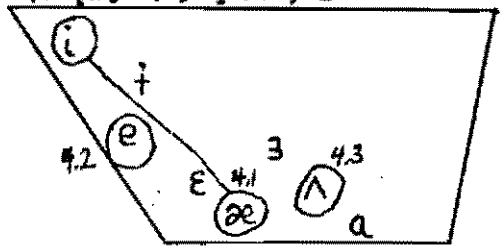
2.1 tape, 11
2. [ej] 2.2 (a)way, 1



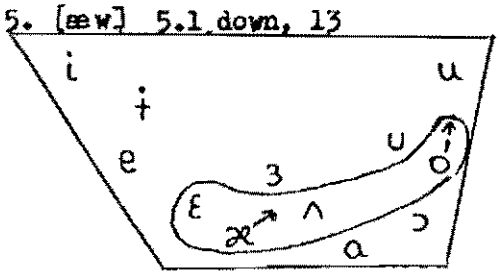
3. [ɛʌ] there, 2



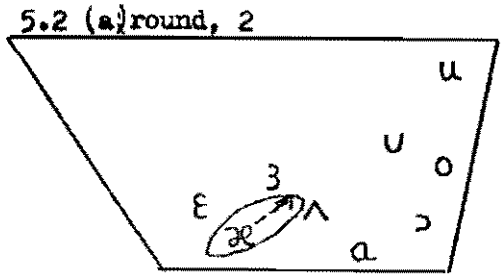
4.1 tractor, 2
4.2 cracker, 1
4. [æ] 4.3 quack, 1



5. [æw] 5.1 down, 13

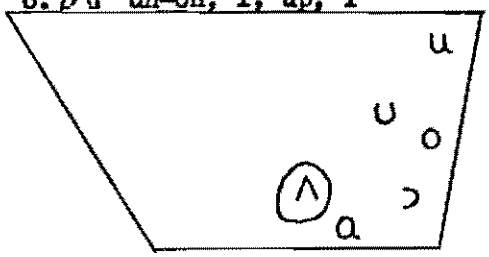


5.2 (a)round, 2

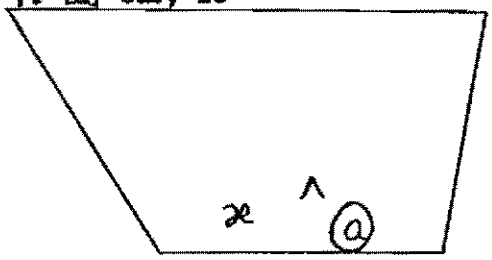


Figures 3.1 Vowel Charts Set #6, continued 17:27 - 18:25

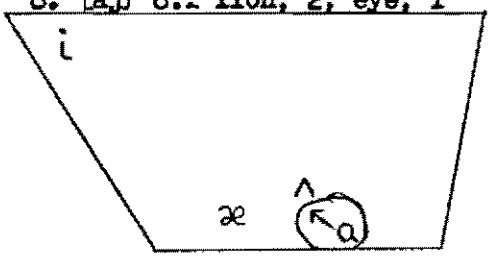
6. [ʌ] uh-oh, 1; up, 1



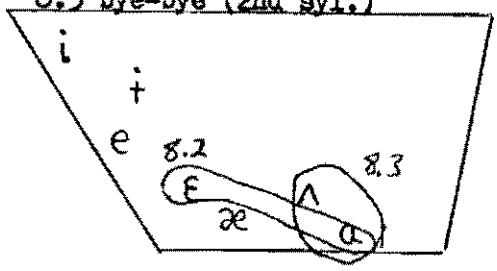
7. [a] car, 16



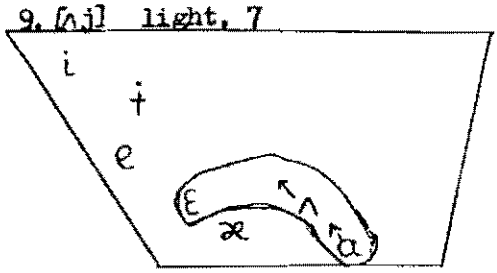
8. [aj] 8.1 lion, 2; eye, 1



8.2 bye-bye (1st syl.)
8.3 bye-bye (2nd syl.)

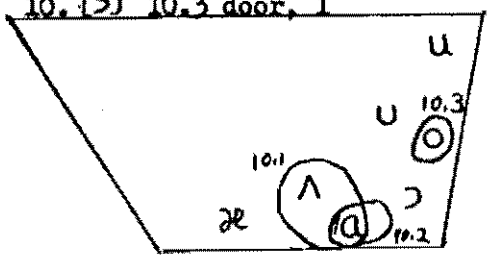


9. [ʌj] light, 7

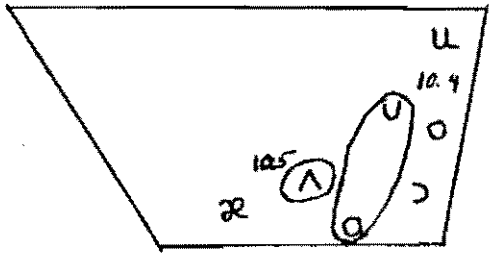


Figures 3.1 Vowel Charts Set #6, continued 17:26 - 18:25

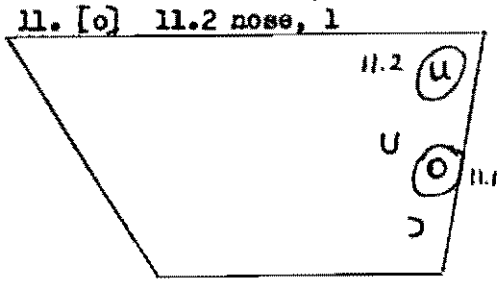
10.1 on, 4
10.2 dog, 1
10. [ɔ] 10.3 door, 1



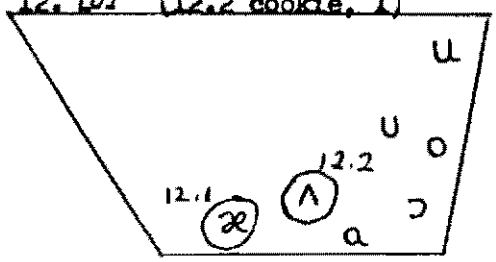
10.4 off, 2
10.5 cork, 1



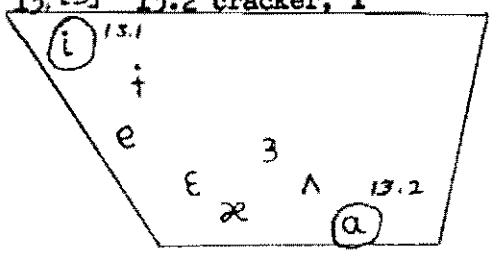
11.1 uh-oh, 1
11. [o] 11.2 nose, 1



12.1 woof, 1
12. [ʊ] (12.2 cookie, 1)

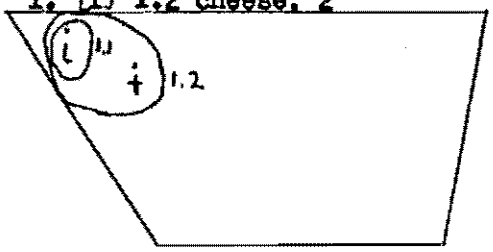


13.1 tractor, 2
13. [ɜ] 13.2 cracker, 1

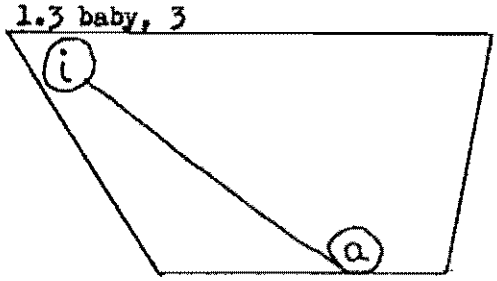


Figures 3.1 Vowel Charts Set #7, 18:27 - 19:24 Sessions 78 - 87

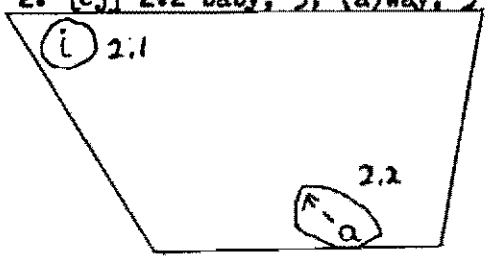
1.1 eat, 2; cottage cheese, 2;
1.1 key, 4; cookie, 3;
1. [i] 1.2 cheese, 2



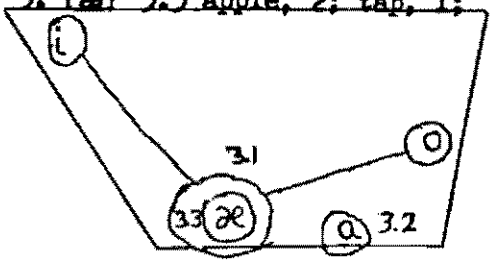
1.3 baby, 3



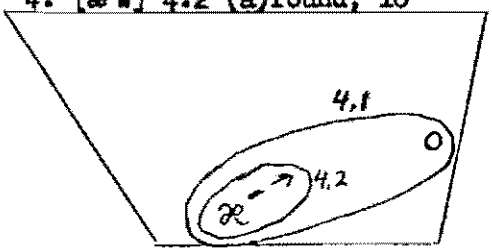
2.1 tape, 2
2. [ej] 2.2 baby, 3; (a)way, 3



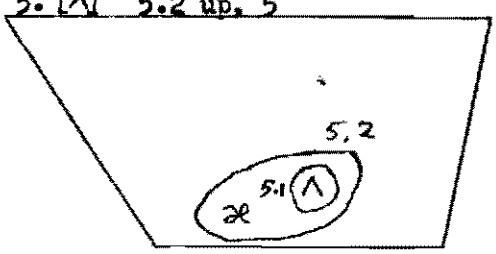
3.1 tractor
3.2 hat, 1
3.3 bang, 1;
3. [æ] 3.3 apple, 2; tap, 1;



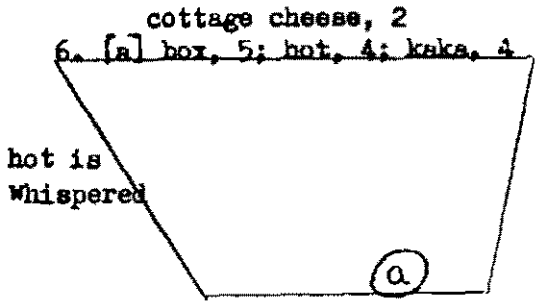
4.1 down, 13
4. [æ w] 4.2 (a)round, 10

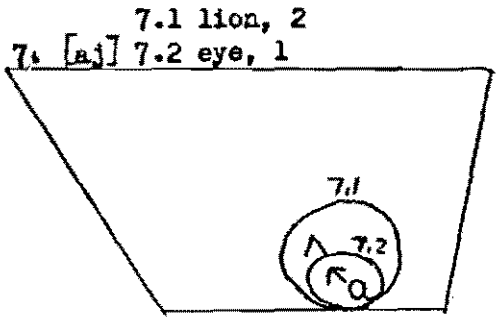


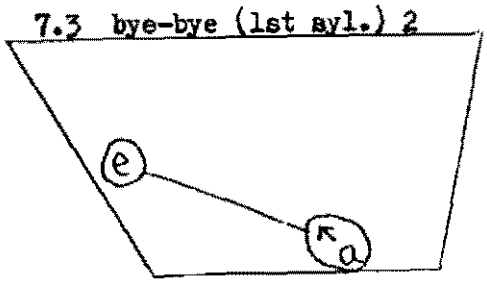
5.1 duck, 1; bus, 3
5. [ʌ] 5.2 up, 5

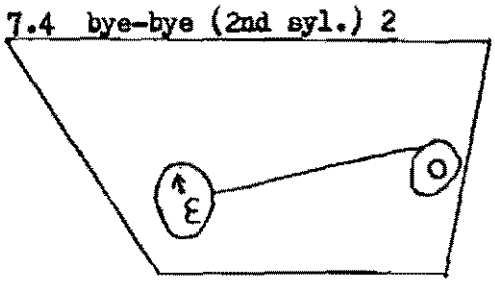


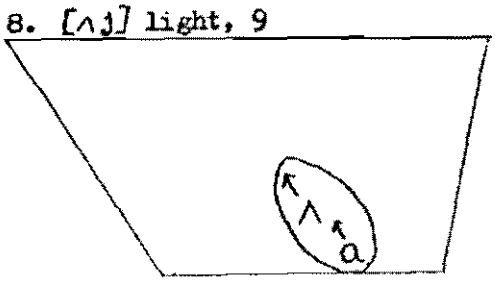
Figures 3.1 Vowel Charts Set #7, continued 18:27 - 19:24

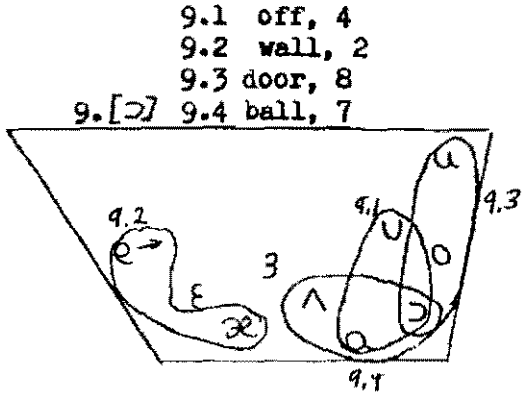






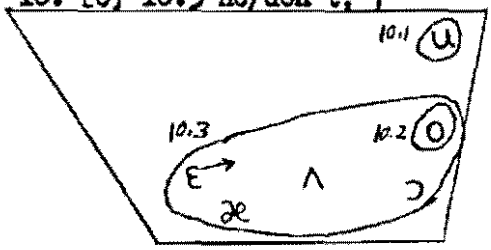




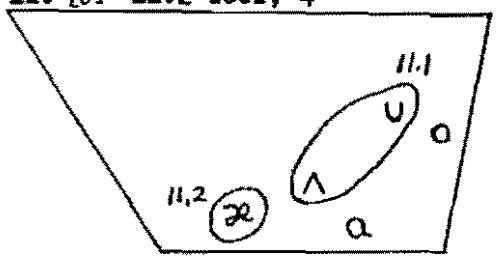


Figures 3.1 Vowel Charts Set #7, continued 18:27 - 19:24

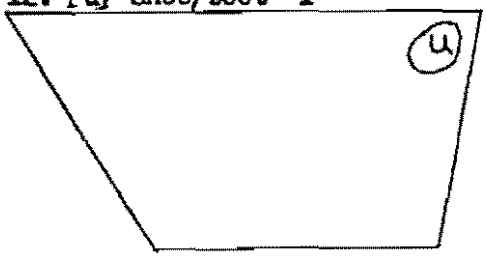
10.1 hole, 1
10.2 roll, 1
10. [o] 10.3 no/don't, 7



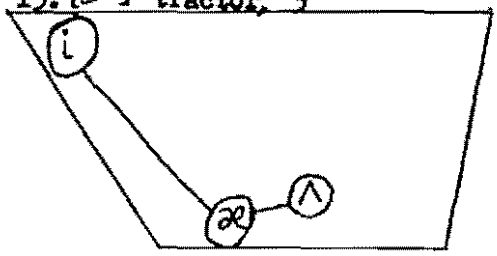
11.1 cookie, 3
11. [ʊ] 11.2 woof, 4



12. [u] shoe/boot 1

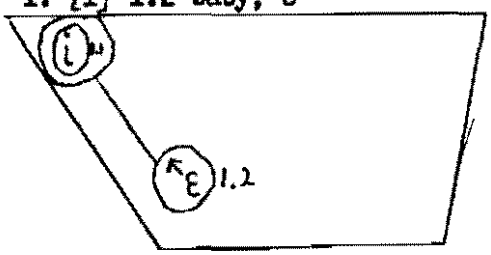


13. [ɜ˞] tractor, 3

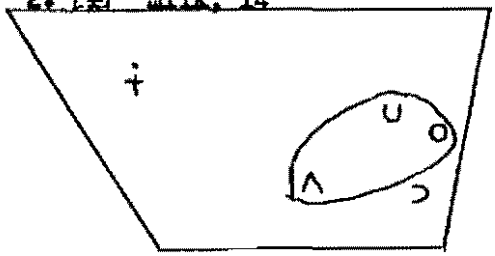


Figures 3.1 Vowel Charts Set #8, 19:29 - 20:22 Sessions 88 - 96

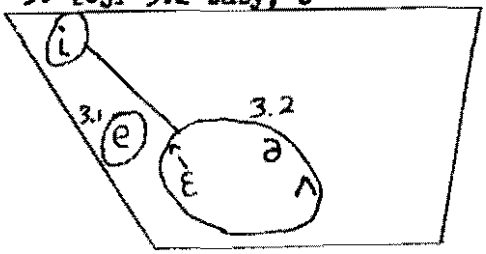
1.1 cookie, 7; horsie, 13;
1.1 cottage cheese, 2;
1.1 key, 8; eat, 5; daddy, 2
1. [i] 1.2 baby, 6



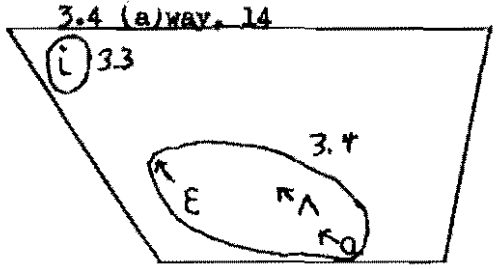
2. [ɨ] milk, 14



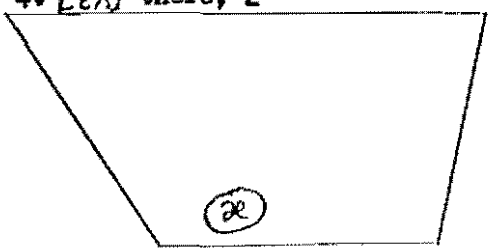
3.1 break, 2
3. [ej] 3.2 baby, 6



3.3 tape, 1
3.4 (a)way, 14

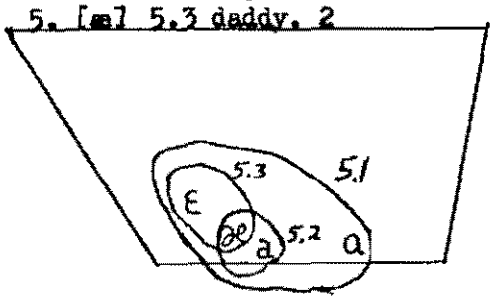


4. [ɛʌ] there, 2

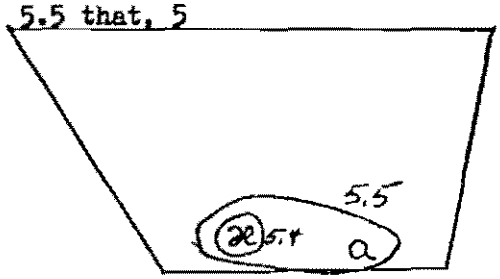


Figures 3.1 Vowel Charts Set #8, continued 19:29 - 20:22

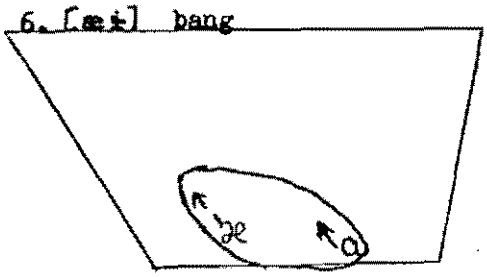
5.1 hat, 10
5.2 tap-tap, 2
5. [æ] 5.3 daddy, 2



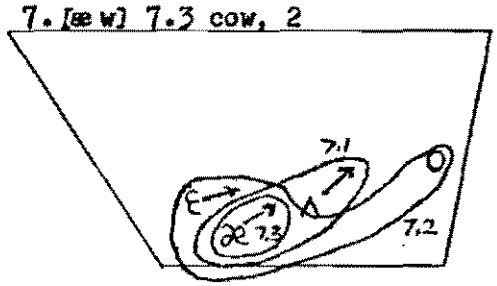
5.4 hammer, 2; cat, 4; apple, 1
5.5 that, 5



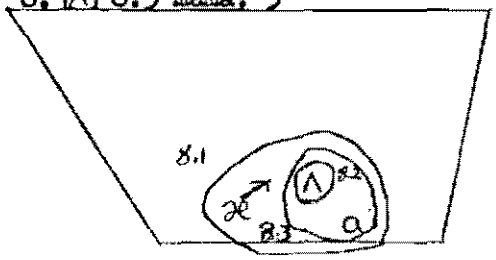
6. [æk] bang



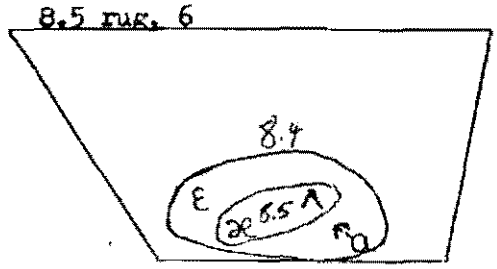
7.1 (a)round, 9
7.2 down, 11
7. [æw] 7.3 cow, 2



8.1 up, 3
8.2 duck, 2
8. [ʌ] 8.3 mama, 3

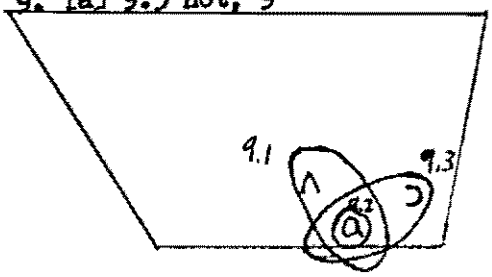


8.4 bus, 8
8.5 rug, 6

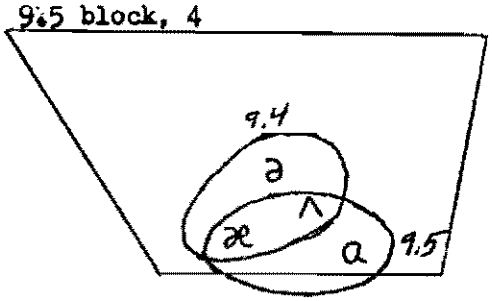


Figures 3.1 Vowel Charts Set #8, continued 19:29 - 20:22

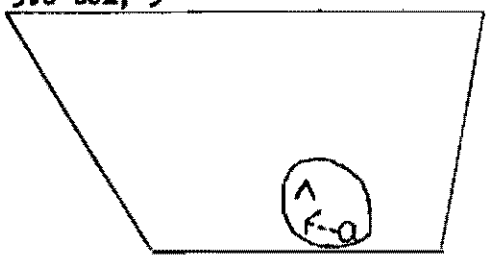
9.1 kaka (both syls.) 2; mama, 3
9.2 doll, 1; hot dog, 4
9. [a] 9.3 hot, 9



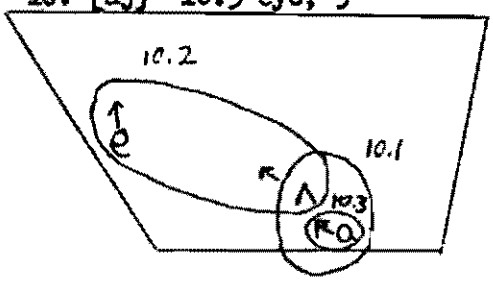
9.4 sock, 4
9.5 block, 4



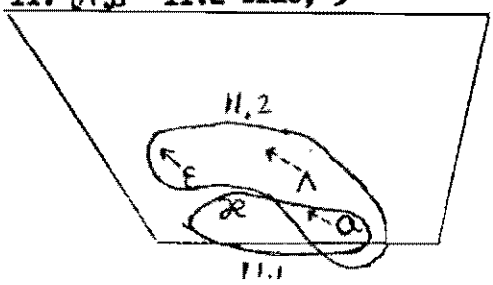
9.6 box, 5



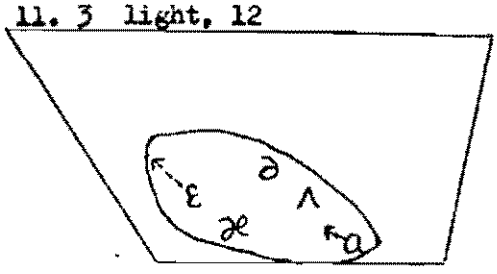
10.1 bye, 4
10.2 fly, 1
10. [aj] 10.3 eye, 9



11.1 ice, 3
11. [ʌj] 11.2 bike, 5

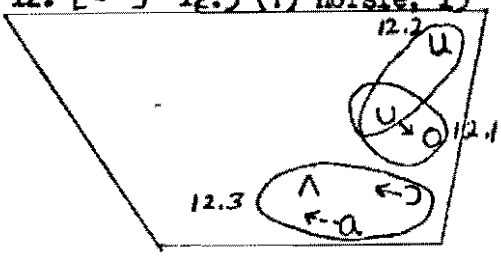


11. 3 light, 12

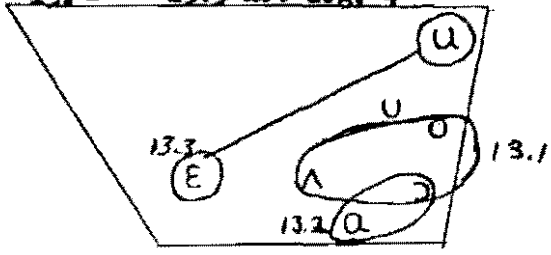


Figures 3.1 Vowel Charts Set #8, continued 19:29 - 20:22

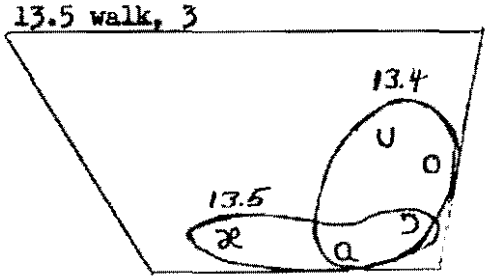
12.1 more, 2
12.2 door, 6
12. [ɔʷ] 12.3 (?) horsie, 13



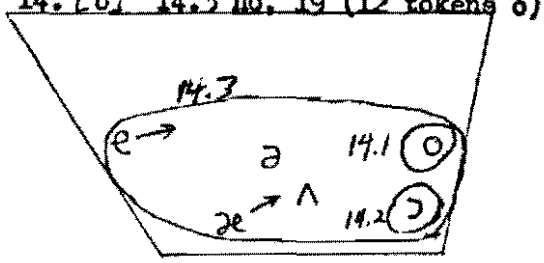
13.1 on, 8
13.2 off, 4
13. [ɔ] 13.3 hot dog, 4



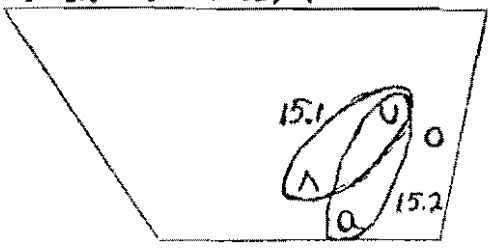
13.4, ball, 16
13.5 walk, 3



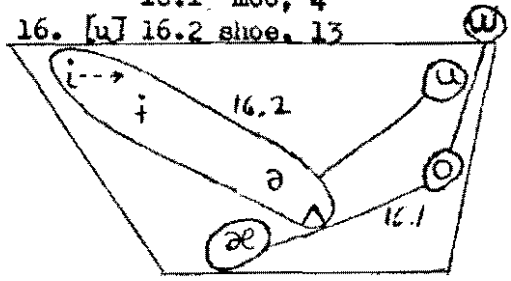
14.1 broke, 1
14.2 hole, 1
14. [o] 14.3 no, 19 (12 tokens o)



15.1 cookie, 7
15. [ʊ] 15.2 woof, 4



16.1 moo, 4
16. [u] 16.2 shoe, 13



It is a truism that we learn very little about the process of acquisition unless the child does something different from what the adults around him/her do. Jacob does some very interesting things with diphthongs and with the vowels in words of two syllables, but in the first four sets the simple vowels (by which term I will refer to monophthongs in words of one syllable) [æ], [a], [ʌ] appear quite on target; the [a] of 'doll' seems to be too far front and then in Set #5 it is too far back, but there is nothing there from which one can make a crucial argument. The worst of the simple vowels in Sets #1 - #4 is [o] -- not [o] in general, but specifically the [o] in 'no', which is frequently centralized. This is probably a lexical matter -- that is, the [o] in 'no' is not the same phone as the [o] in 'don't', 'roll', etc. The explanation for this is not likely to be internal to Jacob's vocalic organization, for 'no' turns out to be very variable in the ambient colloquial speech: [no], [nop], [nʌono], [new], and long strings of 'no's' in which the unstressed syllables are quite a bit centralized. In other words, to describe 'no' in the adult language, we also need lexical information. If we look at the complex vowels—dipthongs and words of two syllables, we do see shifts over time and other properties that suggest descriptions of output in terms of target -- and continuously -- described range instead of discrete features. We must go very carefully here, however, because so few cases are involved and consequently it is hard to rule out competing explanations. With the evolution of 'thank-you' the ranges of the two vowels do seem to slowly and smoothly pull apart like splitting amoebas. This could be a case where the change over time is due to gradually narrowing specification of the two vowels. But there could also be a more mechanical explanation -- that Jacob did not have any more trouble specifying the [æ] and [u] of 'thankyou' than he had in specifying simple vowels, but that in production the articulatory instructions for these two maximally distinct vowels got confused, and the progress we see was only due to increased articulatory motor skill.

The other case which may show specification of a vowel by target and continuous range is the problem of the relation between 'down' and 'round'. Here (unlike the case of 'no' *vs.* the other occurrences of [o]) there is no lexical reason in the adult language for 'down' to have a very wide range of variation while 'round' is under much better control. However, there are only the two words with [æ w] (until Set #8). Consequently, alternative *ad hoc* explanations of the difference between 'down' and 'round' that do not argue against a feature analysis can easily be made up. They are left as an exercise to the reader.

There remain two phenomena from which we can make interesting arguments in the face of the general inconclusiveness of this section.

The first of these argues for Jacob's having, by Set #5 (four and a half months after starting to talk) a rather strong internal organization to his vocalic system. They are no longer, if they ever were, merely a constellation of target points; they occupy regions in some kind of structured space, and they impinge on one another. This phenomenon is the disruption of the previously established phone (phoneme?) [o] by Jacob's attempts to master [ɔ].

In Sets #2, #3, and #4, Jacob seemed to have a well-established [o], even in the two-syllable word 'uh-oh', (although not in 'hello'). During Sets #5 and #6, Jacob tried a number of model words with [ɔ], both rounded and less-rounded (automatic) allophones: 'more', 'door', 'on', 'off', 'dog', etc. However, he very rarely managed to produce an [ɔ], and instead came out with [o], [a], [u], [ʌ]. Only during Set #7 did a fair proportion of attempts match the target vowel. While all this was going on, [o] was produced accurately only about half the time (excluding 'no') instead of almost all the time, and it appeared as [u] in most of the errors, something which had never happened before. It was as though Jacob knew that [ɔ] was a back vowel lower than [o], somehow 'in between' [a] and [o], and in trying to make the height distinction between two back vowels, which he had never had to do before, he pushed [o] up towards [u].

A second argument can be drawn from this same phenomenon. Here is the only case in which Jacob's acquisition of a simple vowel was a long process which can be studied. And in this case we do see that Jacob recognized [ɔ] as a different target from [a], [o], [u], [ʌ] long before he could hit this different target accurately. Not only that, but he was probably sensitive to the differences between the [ɔ^{w}] of 'door', and the less rounded [ɔ] of 'on', because the error patterns show more rounded vowels tried for 'more' and 'door' than for the other words with [ɔ] even at a time (Set #7, Set #8) when he actually produced an [ɔ] (rounded or not) on a minority of occasions.

The other phenomenon from which we can get some good arguments is Jacob's treatment of two-syllable words. Here we can show that Jacob probably did make a prosodic analysis of the vocalic sequence in 'thankyou' and 'Jacob', and we can also confirm that even though Jacob did not develop a rule of vowel harmony, or avoid CV_1CV_2 sequences, they presented a source of difficulty to him just as they do to other children in the literature (see especially N. Smith, 1973).

What we take as an indicator of difficulty for the child is the degree of variation of output. When we see the extraordinary variation in the [æ] of 'thankyou', as compared even with the diphthongized [æ] of 'down', since there is no unusual variability in the [æ] of 'thank'

in adult speech, we tentatively conclude that there is some source of difficulty for Jacob within the word. One possibility, which we shall not rule out, is that the consonants are the source of the difficulty -- not separately, but the fact that there are two distinct consonants in the word. In the next section we shall discuss the behavior of these consonants, but presently we can support the claim that a sequence of distinct vowels is in itself a source of difficulty by noting the scattered forms that show sporadic vowel assimilation: 'uh-oh', usually correct but once [o? -o] (Set #3-4, chart 10,2) 'earring', one token, [iʌi] (Set #3-4, chart 4), 'hello', always something like [ʌʌʌ] (Set #3-4, chart 12.2). A richer illustration from 'baby', which first appears in set #7, with tokens as [bajbi] [baba], [babaj], [bʌbi], [bɛbi], [bɛjbɛj], [bʷəbʷi], and [bibi]. There are probably three contributors to the miserable instability of this word: its lack of vowel harmony, the fact that one of the vowels is the diphthong [ej], which has been troublesome all along (see vowel charts and also section 4.4), and its similarity to 'byebye' (see 4.2, 4.4).

Included in Jacob's many tokens of 'thankyou' are several in which he had assimilated the second vowel to the first: in fact, after the end of Set #1, there are four tokens of front vowels for the [u]; one is the totally anomalous CoCɛ sequence, and the other three are assimilated: Cæ Cæ, CɨCɨ, CɛCɛ. (noted in □ boxes on the vowel
set #2 set #5
charts). Jacob, then, occasionally assimilated vowels, but usually maintained the adult distinctions, sometimes well as in 'uh-oh', sometimes crudely as in 'thankyou', 'Jacob', and 'tractor'. But there are also a few cases in which he *dissimilated* identical (or very similar) vowels in a sequence, and these provide us with an argument that Jacob had abstracted from 'thankyou' and 'Jacob' the pattern 'front vowel - back vowel'. There are two peculiar tokens of 'byebye', both quite late (Set #6, Set #7, as [dɛdə] and as [dedo]; they could represent overgeneralizations of the vocalic pattern of 'thankyou' and 'Jacob', and I see no other way to account for them. If that is indeed the case, Jacob had done a 'horizontal', prosodic analysis of those words, abstracting out the way their vowels changed over time.

3.2.2 Development of the consonants and glides

Let us begin this topic by setting up input/output displays as we did for the vocalic system. 'Thankyou' and 'Jacob' were special cases which pattern together; we will discuss them in detail in section 2.4, and for the present we will designate the initial and medial stops in those words by the cover symbol 'G'. In the tables

of the consonants below, if a word containing initial and final consonant (or glide) is found only in the column for initial consonants, it means that the final consonant is not produced, and conversely, if it is found only in the column for final consonants, it means that the initial consonant was always in (spontaneous) production.

For all the stop consonants, it turns out that the environment descriptor 'medial' is irrelevant; position in the word exerts very strong control over what segments appear, but the conditioning factor is syllable-initial *vs.* syllable-final environment. (This means that the syllable functions as a prosodic unit.) For liquids and glides it seems to be the case that 'medial' -- or rather 'intervocalic', 'word-initial' and 'word-final' are the positional conditioning factors, which is understandable in view of the fact that it is difficult to decide just where syllable boundaries are with respect to configurations like [wæwwæw].

In these tables, the feature descriptions given are only intended to suggest some properties of the model phones that Jacob, judging by his production or by inference (see section 4.3), was aware of. Note that he often seems to match phonetic detail which is subphonemic for English speakers and yet at the same time fails to show any production response to distinctions which seem very salient to us: compare the absence of distinction between initial /r/ and initial /w/ with this reaction, in Set #6, to the difference between the 'light' palatal [l˄] of the word 'light' and the 'dark' velar [l˅] of the word 'roll'. This should occasion no surprise, since there is no measure of magnitude of phonetic difference which predicts in advance that differences less than such-and-such will be subphonemic and differences greater than such-and-such will be phonemic. However, this fact directly implies that a simpleminded interpretation of the Jakobsonian approach, an interpretation under which children cut up the universe of speech sounds by first gaining control of one phonemic contrast after another and then proceed to the control of subphonemic variation, is untenable. Such a view is only held by straw persons, of course; certainly no phonologist could take it seriously, since there is no possible complete ordering of phonetic distinctions that predicts even an implicational hierarchy of the form 'if distinction A is phonemic in language L, distinction B must be phonemic also'. Jakobson's implicational hierarchy is only partial, that is, it only predicates such implicational relations among a subset of the phonetic features of the world's languages, and it is not vulnerable to this criticism.

Table 3.2 Treatment of Consonants and Glides Set #1, 12:2 - 14:21
Sessions 1 - 32

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G	thankyou Jacob (dɨgʌ)	>40 (many)	d~g				
dental -nasal	*t*oast *th*ere *d*own	1 8 18	d				
	*d*on't	2	d~n				
dental +nasal	*n*o	>10	n	dental +nasal labialized	*d*own (a)*r*ound	18 4	n~m~Ø m~Ø
liquid +round	(a)*r*ound	4	d~w	dental +nasal glottalized	do*n't* [dot$^{?}$]	2	(Ṽ)(ʔ)

Note: intervocalic G occasionally unvoiced

Table 3.2 Treatment of Consonants and Glides Set #2, 14:24 - 15:16
Sessions 33 - 40

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G	than*k*you (dɨgʌ)	>15	d~g				
dental -nasal	*d*on't *d*own *d*oll tap	2 12 1 1	d	dental +nasal labialized	*d*own	12	n~m~Ø
				dental +nasal glottalized	do*n't*	2	n~Ø
liquid +round	(a)*r*ound *r*oll	1 1	w	labial	up	1	?

Table 3.2 Treatment of Consonants and Glides Set #3, 15:22 - 16:12
Sessions 41 - 49

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G	*th*an*k*you	19	d~g				
	(d*i*gʌ)	1					
dental	*th*ere	1	d	dental	dow*n*	>30	m~n~Ø
-nasal	*d*on't	7		+nasal			
+voice	*d*own	>30		labialized			
	*d*oll	3					
	*d*uck	1		dental +nasal	do*n't*	7	(Ṽ)(ʔ)
dental -voice	tap-tap	4	t	glottalized			
				velar	duck	1	ʔ
				glottal	u*h*-oh [ʌʔ-o]	2	ʔ
labial +voice	*b*ye *b*ye	2	d				
glide	*h*ere	2	h				
glottal	*h*ot	3					
	*h*ello	?	Ø				
				liquid	do*ll*	3	w

Note: medial lateral liquid, he*ll*o, produced as velarized lateral liquid

Table 3.2 Treatment of Consonants and Glides Set #4, 16:14 - 16:28
Sessions 50 - 56

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G	*J*acob	1	d				
	*th*ank*y*ou	11	d~g				
dental -nasal +voice	*d*on't	5	d	dental +nasal labialized	do*wn*	2	m
	*d*own	2					
dental -nasal -voice	*t*oast	2	d	dental +nasal glottalized	don'*t*	5	(Ṽ)(ʔ)
dental -nasal -voice affricate	what'*s*'at	11	s(9)~z(2)	dental -voice (glottalized)	ligh*t*	3	ʔ~Ø
dental +nasal	*n*ose	1	d				
labial +voice -nasal	*b*ye-*b*ye	1	d				
liquid/glide +round	*w*oof	1	w				
	(a)*r*ound	1					
-round	*l*ight	3	l~Ø				

*There is no convenient descriptor for tr/dr clusters, which have palatal stop contact in casual speech but may be modeled for the child with /d/ or /t/ onset.

*coronal -voice affricate	*t*ruck	1	tç

Table 3.2 Treatment of Consonants and Glides Set #5, 16:30 - 17:25
Sessions 57 - 67

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G	*th*an*k*you	8	d~g~k				
dental	*d*on't	2	d	dental	dow*n*	10	n~n̩~Ø
-nasal	*d*own	10		+nasal			
+voice	*d*oor	5					
	*th*ere	4		(n̩ occurs once as final syllable of 'thankyou')			
	*d*oll	1	d^w				
dental	*t*ea	2	d				
-nasal							
-voice	*t*ape	2	t~d				
dental	what*'s*'at	6	s(5)~z(1)				
-nasal							
-voice							
affricate							
labial	*b*ye-*b*ye	3	$d~d^h$	labial	o*ff*	1	x
				fricative	woo*f*	2	f
velar	*q*uack	2	k	velar	qua*ck*	2	k~Ø
-voice	*c*racker	2		-voice			
+back							
velar	cra*ck*er	2	k				
-voice	*k*ey	4	k~x				
-back							
liquid/glide	*w*oof	2	w	liquid/glide	ro*ll*	1	w
+round				-round			
				+back			
-round	*l*ight	2	l				
-back							
glottal	*h*ot	2	h (whisper)				
	*h*ole	1	Ø				

Table 3.2 Treatment of Consonants and Glides Set #6, 17:27 - 18:25
Sessions 68 - 77

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
G(?)	*th*an*k*you	2	d/ g~k				
(?)	tractor	2					
dental	*d*own	13	d				
-nasal	*d*oggie	1					
+voice	*th*ere	2					
	*d*oor	1					
dental	tea	3	d~t				
-nasal	tape	11					
-voice							
dental	what*'s*'at	1	s				
-nasal							
-voice							
affricate							
dental	*n*ose	1	n	dental	do*wn*	13	n~ⁿ~n̥~Ø
+nasal				+nasal			
				labialized			
*coronal	tree	2	d^h~t				
-voice							
affricate							
palatal	*ch*eese	1	č				
-voice							
affricate							
labial	*b*ye-*b*ye	3	d	labial	u*p*	1	h
-nasal				-voice			
+voice							
				labial	*off*	2	x
labial	meow	1	mw	-voice	woo*f*	1	f(?)
+nasal	(*mw*æ*w*, close imitation of cat's meow)			fricative			

*see note, Set #4

Table 3.2 Treatment of Consonants and Glides Set #6, continued 17:27 - 18:25

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
velar	*q*uack	1	k	velar	qua*ck*	1	k
-voice	*c*ork			-voice			
+back					cor*k*	1	
	*c*racker	1	g				
	*c*ookie	1					
velar	coo*k*ie	1	k				
-voice	cra*ck*er	1	k				
-back	*k*ey	5	k~x				
liquid/glide	(a)*w*ay	1	w	glottal	u*h*-oh	1	?
+round	(a)round	2					
-round	*l*ight	7	ʌ~l̇				
	*l*ion	2	w~Ø				

The cover symbol ʌ represents a lateral phone or set of phones different from either American English front [l] or back [lv], but which I was unable to characterize in a positive way.

Table 3.2 Treatment of Consonants and Glides Set #7, 18:27 - 19:27
Sessions 78 - 87

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
dental	*d*on't	2	d				
-nasal	*d*uck	1					
+voice	*d*oor	8					
	*d*own	13					
dental	*t*ap	1	t^{-asp}	dental	hot	4	
-nasal				-nasal	hat	1	
-voice	*t*ape	2	t~d	-voice (glottalized)			
dental	what*'s*'at	1	Ø				
-nasal				dental	don*'t*	2	n
-voice				+nasal			
affricate				glottalized			
dental	*n*o	5	n	dental	dow*n*	13	m
+nasal				+nasal labialized			
palatal	*ch*eese	2	tç~s				
-voice	cottage *ch*eese	2	ç~t				
affricate							
labial	*b*ye-*b*ye	1	d (18:27)	labial	u*p*	5	p~pf~ʔ
-nasal	*b*ang	1	d (19:10)	-nasal	a*pp*le	2	p
+voice	*b*all	7	d (thru 19:27)	-voice			
	*b*ox	1	d (19:9)	labial	woo*f*	4	f
	.....			-voice fricative			
	*b*ye-*b*ye	1	b (19:17)				
	*b*us	3	b (19:20..)				
	*b*aby	3	b (19:13..)				
	*b*ox	4	b~p (19:9..)				
labial	*m*eow	2	m				
+nasal							
velar	*c*racker/ *c*ookie	3	k	velar	ba*ng*	1	ŋ
-nasal				+nasal			
-voice	*k*ey	4					
	ka*k*a	4					
	*k*aka	4	k~g				

Table 3.2 Treatment of Consonants and Glides Set #7, continued 18:27 - 19:27

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
liquid/glide +round	*w*all	2	w	liquid/glide +back	apple	2	m̥~ʌ
	(a)*r*ound	10					
-round	*l*ion	2	ʌ~w				
glottal	*h*ot	4	h				
	*h*at	1					

Table 3.2 Treatment of Consonants and Glides Set #8, 19:29 - 20:22
Sessions 88 - 96

Syllable-Initial

Model		no. tokens	Output
dental	*d*addy	2	d
-nasal	*d*own	11	
+voice	*d*oor	6	
	*d*oll	1	
	*d*uck	2	
	da*d*dy	2	d~ɣ
dental	*t*ap	2	t
-nasal	*t*ape	1	
-voice			
dental	*th*ere	2	
-nasal			
+voice	*th*at	5	d(4),ð(1)
fricative			
dental	what's*'*at	3	s~z
-nasal			
-voice			
affricate			
labial	*b*ike	5	b
-nasal	*b*ox	5	
+voice	*b*us	8	
	*b*ang	8	
	*b*aby	6	
	*b*all	3	d(before 20:5)
		13	b(12)~d^w(1) (after 20:8)
	*b*ye	4	b(3)~m(1)

Syllable-Final

Model		no. tokens	Output
(note : t^h, k^h are very highly aspirated stops)			
dental	li*gh*t	12	t~t^h~ø
-nasal	ho*t*	9	t~t^h~ʔ
-voice	ha*t*	10	t~t^h~ts
(glottalized)	ea*t*	5	t~ø
	tha*t*	5	ø~k^h
	ca*t*	4	ʔ~ø
dental	dow*n*	11	n~ɱ~ø
+nasal	o*n*	8	
labial	u*p*	3	p
-voice	a*pp*le	1	
(note: one token of 'up' as ʌbʌ)			

Table 3.2 Treatment of Consonants and Glides Set #8, continued 19:29 - 20:22

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
labial -nasal +voice liquid release	*b*roke/ *b*reak	3	b~bw	labial fricative	o*ff*	4	f~z~ø
	*b*lock	9			woo*f*	4	f
labial fricative liquid release	*fl*y	2	ŋw~w̃				
labial +nasal	*m*oo	4	m				
	ha*mm*er	2					
	*m*ama	3		(one token of 'hammer' as hæhm̥)			
	*m*ore	2					
	*m*ilk	14					
(one token of 'milk' as mvk)							
labial +nasal (liquid release)	meow [mwæw]	8	m~mw				
dental +nasal	*n*o	19	n				

Table 3.2 Treatment of Consonants and Glides Set #8, continued 19:29 - 20:22

Syllable-Initial				Syllable-Final			
Model		no. tokens	Output	Model		no. tokens	Output
velar -nasal -voice	ka*k*a	2	k	velar -nasal -voice	wal*k*	3	k
	coo*k*ie	7			duc*k*	2	k^h
	*c*ow	2	$k\sim k^j$		broke/ break	3	$k\sim k^h\sim\emptyset$
	*k*ey	8	$k\sim k^h\sim x\sim t$		bi*k*e	5	
	*k*aka	2	k~g		so*ck*	4	k~Ø
	*c*at	3					
	*c*ookie	7	k(5)~ʔ(1)*				
				velar -nasal +voice	ru*g*	6	$k^h\sim\emptyset$
				velar -nasal -voice cluster	bo*x*	5	$k^h\sim k\sim t\c{c}$
				velar +nasal	ba*ng*	8	n~ŋ~ŋkh
	(final velar in metathesis, switching syllable-position: hot dog	4	ha*k*u, xa*k*u, hak^wc)				
					bu*s*	8	$s\sim\emptyset\sim k^h$
sibilant -voice	*s*ock	4	s~sj	sibilant	shoe(*s*)	13	$\c{c}\sim z\sim t^h\sim s$
	hor*s*ie	13	$s\sim\grave{s}\sim t\sim\c{c}$		eye(*s*)	9	ç
	*sh*oe(s)	13	$\check{s}\sim s\sim\hat{s}$		i*c*e	3	x~ç
					(?)hor*s*e	1	s
liquid/glide +round	*w*alk	3	w	liquid/glide +round	doo*r*	6	r~Ø
	(a)*w*ay	14					
	(a)*r*ound	9					
-round	*l*ight	12	ʌ~l	+back	app*l*e	1	ɰ
glottal	*h*ammer	2	h				
	*h*orsie	14					
	*h*ot	9					
	*h*at	10					
	*h*ole	1					
	(*h*ot dog, see above)						

*one strange item, apparently a token of 'cookie', recorded as pʌgih.

The overall impression of the preceding eight tables is one of orderly progress with a few bad points. If the reader cares to try the experiment, however, he/she will find that inverting the table so that Jacob's output is more salient than the adult model gives a much less orderly picture. This is a crude way of supporting the claim that the child's system is not really comprehensible unless it is seen as derived from the adult system.

On the other hand, the child does *have* a system, and some of the output forms are quite inexplicable if that fact is not taken into account. We have already discussed the influence of the vocalic pattern of 'thankyou' and 'Jacob' on two anomalous utterances of 'bye-bye', and we will be concerned with many more examples in the course of this chapter and the next.

A striking characteristic of Jacob's output is the number of gaps in it. Some of them were produced by his deletion or reduction (to [ʔ]) of final stops, some were the results of changes he made in initial stops and clusters, and some appear to be consequences of the distribution of the set of adult words which he attempted to say. For example, he attempted no g-initial words and only two g-final ones during the entire study, no p-initial words, and virtually no b-final words. In the next chapter we shall see if these distributional gaps in the set of model words were accidental or whether they might have been due to avoidance of model words containing certain sounds.

A phenomenon that cuts across purely phonological analysis, sometimes illuminating Jacob's system and sometimes confusing it beyond my ability to analyze, is the following: When two words were close in sound and meaning, Jacob's speech seemed to reflect that fact very strongly. In some cases he used one word and then replaced it by the other: for example, 'don't' replaced 'no' during Set #2. This choice neatened up his consonant system (compare Set #1 and Set #2) so that [d] was the only initial stop, and nasals only appeared word-finally.

'Cracker' and 'cookie' had an intimate relationship, which is detailed in table 4.4; it is quite easy to follow and probably did not involve any confusion of sounds. The case that presents a problem is that of 'car' and 'truck'. It is often impossible to tell which word Jacob was trying to say; initially they seemed to be separate phonetic entries for him, but he clearly had no semantic distinction between them, and before he chose to call everything with wheels that was not a bus by what seemed to be the name 'car', there was a very long period of confusion of both the vowels and the consonants. Phonologically this is very sad, since 'truck' is a challenging word for a beginning speaker and it would have been interesting to see what Jacob did with it.

Jacob's acquisition of final consonants follows an interesting course which was affected, probably heavily, by my use of the glottal allophone of final /t/. To say when he 'acquired' final *t* as a phoneme is not possible without a long discussion of what it is to acquire a phoneme; he acquired the glottal allophone of it early (don't, Set #1) without having any dental tokens of it, as far as I can tell, until Set #8.

His first labial stops were the syllable-final [p] in 'up', which he had been saying occasionally without final closure or with a final glottal stop, and the syllable-final stop in 'apple', usually æpm. The initial b's followed them after a few days.

That the first (and only) p-final syllables were VC rather than CVC is probably not a coincidence. Jacob never developed any consonant-assimilation rule, and words with unlike consonants (and/or consonant clusters) continued to pose difficulties for Jacob throughout the study. In a VC syllable there was no initial stop to interfere with work on the final stop. Thus, if there were to be cases such as the present one of the labials, in which a position of stop articulation was first mastered for syllable-final output and only later for syllable-initial output, a VC syllable would be the optimal environment for the innovation rather than a CVC syllable. ('Optimal', of course, does NOT mean 'inevitable'.)

Before we continue with an exploration of those difficulties, we should make a few more general observations from the consonant tables: 1) fricatives appeared in final position before they appeared in initial position, 2) no general statement about place of development can be made for nasals, 3) voicing *contrast* was only evidenced for dentals, but voicing *control* was clearly present for all phonemes in initial position. In final position, the only voiced sounds were nasals; Jacob developed a final-devoicing rule by Set #8, where 'rug', 'hotdog', and some reflexes of the plural in [z] show its effect.

3.2.3 Complications due to co-occurrence of unlike consonants

'Thankyou', 'Jacob' (and later 'tractor'), in which words both the consonants and the vowels change from the first syllable to the second, displayed extraordinary variability, which we have been taking as prima facie evidence of phonetic difficulty. We have already argued that the vocalic shift alone caused difficulties and we can show by a different argument that a shift in the stops within a word also was a problem.

We have already noted that the first final full stop appeared in 'quack', which happened to be the first C_1VC_1 word; Jacob deleted or weakened final stops to [ʔ] in C_1VC_2 words except for the final velars of Set #8. (By 'full' stops I mean non-continuant obstruents, and C will refer only to such consonants unless there is a note to the contrary.) This is not overwhelming evidence of difficulty with C_1VC_2 words, given the near-replacement of final *t* by [ʔ] in my own speech, which I have already mentioned, but we have better evidence from comparing C_1VC_2V (including 'thankyou') with C_1VC_1V. There are a fair number of words of the latter form attested, and none of them manifest any instability in the consonants even if there were problems with the vocalism: 'cracker', 'cookie', 'kaká', 'taptap'(here the p was deleted) 'byebye' (in both its dental and labial forms, which are entirely separate from one another in time), 'bəby', and also 'mama'.(The three bad points are a single weakened medial 'd' in 'daddy', which could adhocly be explained as an attempt to get the flapped 'D' of the model word and an inexplicable [p] and an isolated [ʔ] for the first [k] in 'cookie'.) In contrast, besides the three words already mentioned, Jacob made 'hotdog' into [haku], [hakwɛ], and he completely lost hold of what should have been a routine initial [k] in 'cottage cheese' ([datčis], [ǵačɪ]) in Set #7 and Set #8.

When we discussed the variability of the vowels of 'thankyou', we did not identify its first one with the [æ] of 'tap' or take the back vowel as being comparable with the later vowel of 'shoe', but phonology gives us the tools to do so. We could have set up underlying [æ] and [u], and then described Jacob's attested forms in terms of conditioned variation -- in this case, caused by the vowels interfering with one another. We could have expressed the highly variable output by rules erasing some of the specifications on the underlying vowels -- we might call such rules 'unhinging rules'. The argument between such an approach and just treating the vowels of 'thankyou' as underlyingly underspecified is not really empirical, and, as the reader will recognize, choices between notational variants must be made on their heuristic value; I presently have insufficient grounds for argument one way or the other here.

Similarly, we could assume that the underlying consonants of 'thankyou' and 'Jacob' are something close to the adult consonants, and describe the dental - palatal - velar output as being the output of unhinging rules. Such a treatment would have the advantage of representing directly the putative origin of the attested variation. We would need unhinging rules rather than, say, conflicting consonant assimilation rules, because it is not the case that the output was always dVdV, gVgV; mixed forms like dVgV were equally common.

There is a disadvantage to this account, however. Jacob had no velars or attempts at velars in his output during Sets #1 through #4, except the syllable-final one in 'duck' which was produced as [ʔ]. In Sets #1 and #2, if we use the unhinging rule solution, we will have to assume that Jacob made his first attacks on velars in the most difficult environments, instead of starting out with 'key' and the like. It is possible, of course. But there is a further objection. We have no way of knowing how Jacob's representation of a velar stop would look before the unhinging rule applied to it. We will have good reason (sec. 4.3) to argue that during Set #3, and probably much earlier, Jacob had a rule taking adult [b] to [d]. We cannot really assume that the input to the unhinging rule would have been velar at all.

There is an alternative way of accounting for 'thankyou' and 'Jacob' which may be preferable. Perhaps what we have been designating by the cover symbol 'G' was an underlying unspecified consonant which could range over the whole tongue-against-roof-of-the-mouth spectrum from [d] to [g]. There is one serious objection to that suggestion as it stands: if there was this special consonant G, it only appeared in GVGV sequences, not in 'duck' or 'dog' or 'cat' where it might have also been expected. It was not 'just another segment', and a proper treatment of it ought to recognize that fact. Here is where a prosodic analysis is unequivocally called for if we are not going to use the unhinging rule solution. If we prefer the underspecified-segment solution because it does not require us to credit Jacob with hypothetical velars, it should be done by taking as a unit not the segment G, but the prosodic unit G_G_ into which the vowels can be inserted.

3.3 The case of [ioio]

Let us now look at the most unusual item in Jacob's lexicon, [ioio], as we referred to it in Chapter 2. Semantically, we argued, there was no reason to deny it 'word' status; what was problematic about it was the variety of phonetic guises in which it appeared. A representative sample:

Set #2: [ioio] [wiwio] [wejaweja]

Set #3: [wiʌ] [weʌwiʌwiʌ] [iʌ́iʌ́iʌ́] [wijuwiju] [ĩʌĩʌ]
[ɛio] [ɔijo]

Set #4: [wiʌwiʌ] [jajajaj] [iaia]

Set #5: [eoio] [jejʌ] [ɛjʌɛjʌ]

Set #6: [ajaj] [ioio] [iaia]

Set #7: [ajajaj] [ioi] [ɛjaja] [aj^aj^]

If we look at these utterances with a commitment to cut them up into segments, allowing diphthongal units, we can extract the alternating pattern which these tokens have in common (table 3.3). We will refer to it as a front-back alternation, (though that is slightly inaccurate -- more precisely it is $\begin{bmatrix}\text{front}\\ \text{-low}\end{bmatrix}$ alternating with [-front], with rounding being automatic for back vowels.

	i	o	i	o
w	i	uw	i	
w	ej	aw	ej	a
	ej	^	ej	^
	jej	^		

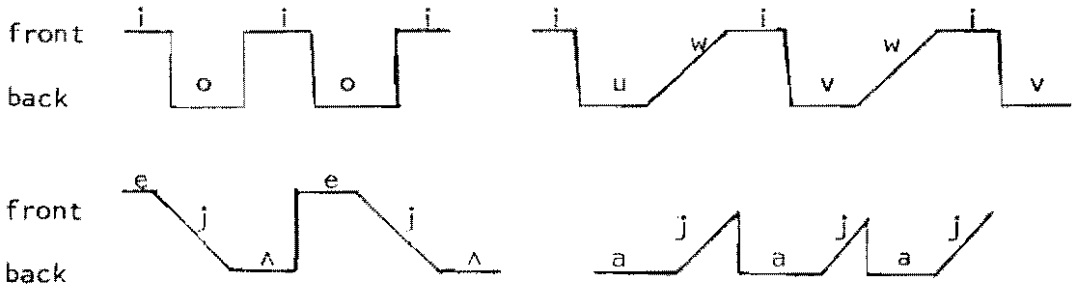
Table 3.3
Front-back alternation pattern

and so forth. But we get into some very peculiar-looking correspondences between syllabic elements like [u], [aj] and non-syllabic elements like [w], [j] respectively. We also do violence to the very repetitive nature of the pattern if we regard the initial [w] of, e.g. [wejaweja] as an initial glide but the second [w] as the second element of a diphthong.

Perhaps we can find an analysis that shows more plainly the essential simplicity and unity of all these tokens, for saying them aloud certainly gives one the feeling that kinesthetically and auditorily they are much more similar than the segmental display makes them appear to be. Besides that, we have already had occasion to note that for Jacob, syllable boundaries at glides are not very well defined. What we have just had to write as w - i - uw - i - o in order to bring out the front-back alternation did not have a clear syllable break at the indicated segment break between w and i; it was as much or more accurately syllabified as wi - uw - wi - o or wi - u - wi - o. We need a notation that not only unifies ^-i-^, w-ij-^w- ij-^ and ^-ij-^, such as we already have, but which also brings ^-wi-^, ^-wi-j^, etc. together with them. To do this, the main thing we need is a notation that allows the syllable boundary to vary freely with respect to the vowel-glide and glide-vowel boundaries, or which ignores syllable boundary.

Looking back at the transcriptions, we note that the [w] appears initially or in a front-to-back vowel transition, while the [j] appears initially (once only), between back vowels, and in transition from front to back vowels. Setting aside the one initial j, the glides are then completely predictable (and pleasantly 'natural'

as well -- in adult language, an epenthetic glide between [i] and [o] is likely to be [j], while one inserted between [o] and [i] is likely to be [w]). The whole pattern can thus be described as consisting of articulatory alternations between front-vowel and back-vowel configurations; if the transition between these two configurations is slow, glides are produced. In other words, all these utterances are produced by variations in the timing of a single alternating articulatory pattern; and within a given long utterance, the timing of the pattern is held essentially constant. (There is no [wejalo].) We can represent this diagramatically:



and ignore syllable boundaries entirely. Whether the 'back' vowel is [a], [ʌ], [o], [ʊ], or [u] and whether the front vowel is [ɛ], [e], or [i] seems to be indeterminate; Jacob's control here seems to be comparable to his general rough regulation of vowel height in words with distinct vowels. (One might add that since [ioio] is not closely modeled on an adult word, we have no reason to assume that closer specification of vowel height was involved in what Jacob was trying to say at all.) The remaining variable was stress, which could be on either vowel.

Jacob, then, was indulging in simple variations of timing of change of articulatory position. Since a standard segmental analysis obscures this fact, I argue that Jacob's own analysis of this pattern was not segmental, but 'horizontal', prosodic, although unlike any prosodic phenomena of adult language I know of.

3.4 Conclusions

We have treated the more remarkable variabilities in Jacob's output as symptoms of difficulty with complicated vowel or consonant configurations (e.g. discussions of 'thankyou', 'baby') or as showing that he was not analyzing a word in a fashion we are familiar with ([ioio]) or as showing that he was hard at work 'getting' a new phone ([ɔ]). Some variation reflects lexical ('no') or allophonic (final /t/) or morphological ('eye'/'eyes') variation in the adult model.

We have not discussed it explicitly, but presumably the variability through Sets #3 - #7 of initial /t/ showed that Jacob was at work on the control of voicing lag, which he had seemed to disregard in Set #1 and Set #2; by the time he started to say /k/, he had voicing lag under considerable control, but it was scarcely perfect. (see Kewley-Port and Preston, 1969).

So far we have dealt matter-of-factly with variations as being genuine and having significance. We have also treated some inexplicable variants as just being 'bad points'. Presumably children have slips of the tongue.

But I have evaded the theoretical and methodological question set, as it were, by tradition, and sharpened by Ferguson and Farwell: if tokens vary so much, how shall we decide what phones the child has, and what phonemes the child has? A full answer to this question would probably be a dissertation in itself. But what has been implicit in this chapter is the following: if similar sounds have different distributions in the sets of tokens of two words -- e.g. if the initial dental of 'down' is always [d] but the initial dental of 'tap' is sometimes [d] and sometimes [t], and these distinct distributions are not statistical accidents or due to non-systematic error by the child, then we have two putatively distinct phonetic units, regardless of their overlap. If we prefer, for theoretical or methodological reasons, to reduce the number of underlying phonemic units, we can collapse those which can be described as conditioned variants and then derive the surface forms by rules. Some of these rules may be very similar to adult rules (for example, if we chose to handle the conditioning of the roundness of [ɔ] by rule, or the free variation between final released and unreleased full stops). Other rules will be of types that seem to be peculiar to child language -- unhinging rules which might be set up for Jacob, or the consonant assimilation rules which many other children have.

(It is painfully clear that the analysis of child phonology is more art than science, and possibly more divination than either, at present. There are generally, even in so large a corpus as the present one, insufficient tokens of each word for us to make sure that 'distinct distributions are not statistical accidents'. Many decisions are actually based on one's 'feeling' about language, and this must be so, in the present state of the art. That is one of the main reasons why such a large quantity of relatively raw data has been presented in this chapter -- so that the reader may have some check on the investigator's intultings.)

The notion 'acquisition of a phoneme' is very complex, the more so because the theoretical status of the 'phoneme' itself is a matter of intricate debate. Rather than double the length of this chapter,

I will leave it to the reader to stare at the tables and try to decide how many different answers could be given to the questions 'When did Jacob acquire /n/?' 'When did Jacob acquire the contrast labial/dental?' My opinion is that these traditional questions are improper. They presuppose that there is a well-defined point at which a phoneme or a contrast is 'acquired', whereas frequently this is not the case. More precisely, it is possible to invent definitions of what it is to acquire a contrast, but in doing so one limits oneself to a very superficial description of events, just as would be the case in developmental psychology if one asked 'When does the child acquire the concept of 'quantity'?.

There is one more major question that must be addressed directly. Is it features *per se* as Jakobson's model has it, or phones (feature complexes) that are acquired? Acquisition theory is still so weak that crucial arguments probably cannot be made, but it is obvious that having the velar [k] and the voiced [d], both even in initial position, did not give Jacob the voiced velar [g]; nor did having the high vowel [i] and the back vowel [o] give Jacob the high back [u]. Features do not simply come in 'across the board' for Jacob. Nevertheless, distinctive features play as much of a role in child phonology as they do in adult phonology, for having /o/ (round) and /e/ (front) does not give English /œ/ (front round), either. Features do not combine freely; they are not like atoms, either for children or for adults. I think the correct approach is to say that features are used, by both children and adults, in analysis, but not in synthesis. We must learn to say phones individually, as motor accomplishments, but soon after we can recognize them, we can analyze them at least partially into features. It must be the general case that we can analyze sounds before producing them since phones which the child cannot produce may be acted on by phonological rules which utilize feature information, e.g. rules like 'replace fricatives by the corresponding homorganic stops'.

Another kind of evidence for analysis being a separate matter from synthesis comes from the present case, where Jacob could not combine the 'back' of [o] and the 'low' of [a] to get [ɔ] in production, although, as we have argued, he must have recognized [ɔ] as a back vowel lower than [o]. He could analyze [ɔ], but not synthesize it.

CHAPTER IV

Canonical Forms, Selectivity, and the Origin of Rules of Child Phonology

4.1 Canonical forms and word 'recipes'

In this chapter we shall look at the structure of Jacob's output, and try to see how such a structure arose or could have arisen. From the tables 3.2 of consonants in chapter 3, it was apparent that Jacob started with a small repertoire of output word-forms, that he added to them slowly.

Data from many children (Ingram 1974, Menn 1974) suggests that they tend to minimize the variety of syllable shapes they produce. If a child is to have only a small variety of syllable types compared with those presented in the model language, there are only two ways he/she can accomplish this: by electing to say only those words which have shapes in the adult language similar to the shapes of those words already in his/her output repertoire, or by modifying the words of the adult language to make them fit his/her output forms.

It makes good functional sense for the beginning speaker to have few output forms, as long as he/she can be understood, for it means that there are fewer kinds of instructions that have to be given to the articulators -- speaking can be done with less attention to the motor act. But this is a teleological reason for there to be a small set of output shapes. It justifies the end, but does not begin to explain how the child achieves it, since it seems unlikely that the child has any such end in view.

During this chapter we shall try to elaborate hypotheses as to what the child is doing as he/she selects or distorts adult words to fit into a limited output repertoire.

Let us begin by developing an appropriate descriptive device, the notion of *canonical form*. David Ingram (1973/1974) is responsible for the good use made of this notion in recent work in child phonology.

A canonical form is a partial specification of a string of phonemes (or other representation of the sound of a word) which encodes the output restrictions obeyed by a set of words: it shows what they have in common, and therefore what restrictions another word would have to obey in order to be counted as 'having the same shape'. With it, we can make more precise the notion of 'limited output repertoire'. For example, suppose a child only produced CVC words which obeyed

the restriction that the second consonant was the unvoiced counterpart of the first consonant. 'dot' and 'tot' might be found in the child's output, but not 'pot' or 'top'. We could encode this information by saying that the child's output repertoire included words of the form $C_{[1]}{}^{VC}{}_{[1,-voice]}$, (or some similar notation to that effect), or that he/she had words belonging to the *canonical form* $C_{[1]}{}^{VC}{}_{[1,-voice]}$.

In order to give an interesting picture of the output restrictions that are obeyed by the child's words, one attempts to describe the output by as small a set of canonical forms as possible, and each of these forms is furthermore given in a way which is as highly specified (restricted) as possible. In writing a set of canonical forms to exhaustively describe an output corpus, in other words, one is formally writing an output grammar, and if it is appropriate for one's purpose to consider only formal properties, one restricts the power of that grammar as much as possible consistent with the data, in the usual fashion. For example, if the only consonant clusters produced by the child are initial [st] clusters, one does not write C(C)VX in the set of canonical forms, but CVX and stVX.

This notation permits us to display perspicuously the structure of a very limited output range with heavy restrictions on what sounds can co-occur; both 'horizontal' and 'vertical' -- that is, both prosodic and segmental -- restrictions are shown. The major disadvantage is that there can be several correct ways to describe a given corpus by sets of canonical forms, and these sets may differ in what they imply could be added to the child's output within the existing restrictions. However, in the present context we will not be concerned with such problems. We will utilize canonical forms to lay out the data in a fashion that displays the aspect of their structure that we are presently trying to account for, namely, the limited output repertoire, so that we can study it.

The following tables show sets of canonical forms that describe Jacob's active vocabulary, broken up for convenience into the eight time blocks used in chapter 3. I have occasionally stopped short of the formal goal of maximally restrictive description where I felt that the added detail would be more cumbersome than illuminating. The feature descriptors used are intended to be suggestive of the sounds produced; I in no way intend to imply that Jacob had a feature system, (which I presently consider a very difficult question) or that these would be the right descriptors to label his features with if he had one.

For the cover symbol G, see section 3.3; 'N' denotes $\left\{[m,n]\right\}$, 'D' and 'K' denote dental and velar stops, whether voiced or unvoiced. Parentheses and braces are used in the standard manner: optional (or variable) elements are in parentheses, and braces enclose alternative choices. Iterated elements are also parenthesized, with an exponent showing number of iterations. Words in any set which do not seem to be subsumed by any of the canonical forms proposed for that set are simply listed in phonetic transcription. 'Optional', in dealing with canonical forms, may mean either that the element in question is found in some words considered to fall under a given form, but not others, or that the element is actually variable in those words in which it appears. In the long run, it may prove necessary to distinguish these cases, but I have not thought it worthwhile to do so here. The information may be recovered from the appendix.

Table 4.1 Canonical Forms Set #1, 12:8 - 14:21 Sessions 1 - 32

Form	Exemplar Tokens (with appendix reference numbers)	
GVGV	7. Jacob	dikʌ, geikʌ (and 5. dɨgʌ -babble)
	1. thankyou	gædu, dɛtæ
dV		
-high(N) (+nasal)	27. (a)round	d_ja
	4. don't	dõ
	8. down	dæ, dæn
	3. there	da
	2. toast	dõʌ
Other tokens (sampled)	27. (a)round	wæmbwæ
	4. no	nʌnʌ, ŋɛʌ

Set #2, 14:24 - 15:16 Sessions 33 - 40

Form	Examplar Tokens (with appendix reference numbers)	
G_1V_1 front $\begin{Bmatrix} G_2V_2(m) \\ G_1V_1 \end{Bmatrix}$	1. thankyou	dædum, gaka (and 5. dɨgʌ -babble)
		dædæ
$dV_{-high}(N)$ (+nasal)	4. don't	dæm, dæ
	8. down	dõn, de
$(dV)^{1,2}$	20. doll	da
	32. taptap	dædæ
vowel/glide patterns	26. [ioio]	ioio
	27. (a)round	æwæw
	40. roll	wo:
Other tokens	30. up	ʌʔ

Table 4.1 Canonical Forms Set #3, 15:22 - 16:12 Sessions 41 - 49

Form	Exemplar Tokens (with appendix reference numbers)	
$GV_{front}{}^{G}\begin{Bmatrix} V_{back} \\ N \end{Bmatrix}$	1. thankyou	daita, $day\overset{m}{n}$ (and 5. dɨgʌ-babble)
$dV_{-high\ (+nasal)}\left(\begin{Bmatrix} N \\ ? \end{Bmatrix}\right)$	4. don't	?ʌ?, dõ
	8. down	dom, dæw
	42. duck	$d_{j}ʌ^{?}$
$(DV)^{1,2}$ +low +front	13. bye-bye	dada
	20. doll	daw
	32. tap-tap	tata
	3. there	dɛ
h(V)	49. hot	hɛ
	51. here	hi
vowel/glide patterns	26. [ioio]	wiʌ
Other tokens	53. hello	ʌʌ̃ʌ
	71. off	ʌ
	61. uh-oh	Dʌ?o, o?o

Table 4.1 Canonical Forms Set #4, 16:14 - 16:28 Sessions 41 - 49

Form	Exemplar Tokens (with appendix reference numbers)	
G_1V_1 $\begin{cases} GV_{back} \\ G_1V_1 \end{cases}$ front	1. thankyou	gigʌ, dɨdɨ
	7. Jacob	deda
dV $\begin{cases} N \\ ? \end{cases}$	4. don't	do?, dõ?
	8. down	dʌm
	2. toast	do?
$(dV_{-high})^{1,2}$	13. bye-bye	dædæ
	7. Jacob	deda
	66. nose	do
	3. there	d_jæ
	2. toast	$_j$ do:
vowel/glide patterns	27. (a)round	wæwæ
	45./39. ear/earring	ijʌ
	26. ioio	jajajaj
	47. woof	wʌ
hV	62. hat	hæ
Other tokens	67. what's'at	esa̰
	69. light	aj?
	64. siren	esa̰
	91. truck	tçʌ
	61. uh-oh	ʌo

Table 4.1 Canonical Forms Set #5, 16:30 - 17:25 Sessions 57 - 67

Form	Examplar Tokens (with appendix reference numbers)	
G_1V_1 front $\{G_1V_1 \mid G_1V_{back}\}$	1. thankyou	gigu, dɨdɨ
dV_{-high} (N) (+nasal)	4. don't	dʌ̃
	8. down	do, dɔn
$(DV)^{1,2}$	20. doll	$d^{w}ɔ$
	95. door	dɔ
	13. bye-bye	dada
	97. tape	te
	79. tea	dɛi
	3. there	dɛ
kV(k(V))	90./91. car/truck	ka
	37. cracker	kaka
	10. key	$k^{h}i$
	68. quack	kʌk, kæ
vowel/glide patterns	26. [ioio]	ɛjʌɛjʌ
	65. whistle	wɔ
h(V)	49. hot	h (whisper)
Vowel/fricative patterns	27. what's'at	esà, sà
	71. off	ox
	64. siren	esà
	47. woof	wʌfwʌ:f
Other Tokens	69. light	ʌʌæ
	90./91. car/truck	gʌx, ɛtʌ

Table 4.1 Canonical Forms Set #6, 17:27 - 18:25 Sessions 68 -77

Form	Examplar Tokens (with appendix reference numbers)	
$C_1V(C_1(V(C_1)))$	13. bye-bye	dædʌ
	90./91. car/truck	ka ga
(C may be weakened to ?)	34. close (?)	do
	52. cookie	kikʌ
(C not labial)	72. cork	kʌ$^{?}$
	37. cracker	gega
(C# = [k])	16. dog(gie)	da
	95. door	do
	8. down	do
	10. key	ki
	68. quack	ŋʌkʌk
	97. tape	tej, di
	79. tea	ti
	1. thankyou	dejda
	3. there	da
	96. tractor	dit^{h}i
	12. tree	d^{h}i
dVN	8. down	dm̩, dʌm
vowel/glide patterns	27. (a)round	æwʌæwʌ
	98. (a)way	we
	138. eye	aj
	26. [ioio]	ajaj
	136. lion	aj
vowel/fricative patterns	67. what's'at	za
	69. light	ž̆ʌ
	71. off	ʌx
	47. woof	æf
Other Tokens	120. cheese	ci
	69. light	ʌʌi
	108. meow	hmæw
	66. nose	nu
	71. off	a
	24. on	ʌn
	79. tea	tijʌ
	1. thankyou	gekm̩
	61. uh-oh	ʌ$^{?}$oh
	30. up	ʌ

Table 4.1 Canonical Forms Set #7, 18:27 - 19:27 Sessions 78 - 87

Form	Examplar Tokens (with appendix reference numbers)	
VCV	140. apple	æpa
$C_1V(C_1(V))$	181. baby	bajbi
(C now includes affricates)	101. ball	dɔ
	125. box	ba, da
	119. bus	ba
	13. bye-bye	dedo, bajbaj
	90./91. car/truck	k^ha, etsa
	120. cheese	tɕiɕ
	192. cottage cheese	ǰaǰi
	37./52. cracker/ cookie	kʌki
	95. door	do
	8. down	dæ
	42. duck	dʌ
	177. kaka	káka, gak'
	10. key	ki
	56. shoe/boot	du
	32. tap	t'æ
	97. tape	ti
	96. tractor	gogi, itʌ
$dV\{N, ?\}$	172. bang	dæŋ
	4. don't	don, do?
	8. down	dæwn
vowel/glide patterns	27. (a)round	(w)æw, wæwæw
	98. (a)way	ɛwaj
	45./39. ear/earring	aj
	138. eye	aj
	69. light	wʌj
	40. roll	ow
	175. wall	wæ
	65. whistle	wi
	47. woof	wæw
vowel/continuant patterns	120. cheese	s:ɨ
	69. light	wajc
	71. off	ʊx
	47. woof	æfæf
hV(?)	58. hole	hu
	62. hat	hæ?
	49. hot	ha?

Table 4.1 Canonical Forms Set #7, continued 18:27 - 19:27

Form	Exemplar Tokens (with appendix reference numbers)	
Other Tokens	140. apple	æpm̩
	27. (a)round	wæn
	125. box	ba·kh
	90./91. car/truck	ʌtʌk
	192. cottage cheese	datix
	37./52. cookie/ cracker	kʌkiˊ
	142. eat	iˀ
	67. what's'at	ea
	177. kaka	kakaˊ
	108. meow	mæow
	71. off	ah
	96. tractor	'sætæ
	30. up	ʌp, ʌpf, æˀ
	69. light	lat

Table 4.1 Canonical Forms Set #8, 19:29 - 20:22 Sessions 88 - 96

Form	Exemplar Tokens (with appendix reference numbers)	
$(C_1)V(C_1(V(C_1)))$	140. apple	æpʊ
	181. baby	bibi
(final C un-	101. ball	do, ba
voiced)	275. bib	bip
	257. bike	bʌj
C may be weakened	29. block	bwæ
to ?	216. break/broke	bʌ
	119. bus	ba
	13. bye-bye	baj, ʌbʌ
	90. car	ka
	134. cat	kæ?
	52. cookie	kʌki
	36. cow	kjæ
	186. Daddy	dædi
	20. doll	d^ha
	8. down	dæ
	95. door	du
	142. eat	it
	177. kaka	kaka
	10. key	k^hi
	32. tap-tap	tata
	97. tape	ti
	3. there	dæ
	30. up	ʌbʌ, æwp
{w, d, b} VN	27. (a)round	wæn
	172. bang	bæŋ
	8. down	don
vowel/nasal	13. bye	maj
patterns	97. fly	ŋwʌj
	197. mama	mamʌm
	260. milk	ʌmʌ
	108. meow	mwæw
	35. moo	mæ
	193. more	muɔij
	4. no	nʌ, ŋjew
	24. on	ɔmɔ:
vowel/glide	27. (a)round	wæ
patterns	98. (a)way	wʌj
	138. eye(s)	aj
	25. [ioio]	ajʌʌjʌ
	71. off	aʌ
	239. rug	ʌwʌ

Table 4.1 Canonical Forms Set #8, continued 19:29 - 20:22

Form	Exemplar Tokens (with appendix reference numbers)	
XVk	172. bang	bæɨŋkʰ
	257. bike	bʌkʰ, bajk
	29. block	bʌk
	125. box	bakʰ
	216. break/broke	bekʰ
	119. bus	bɛkʰ
	42. duck	dʌkʰ
	260. milk	mʌk
	239. rug	wækʰ
	26. shoes	jowk
	123. that	dækʰ
	145. walk	wɔk
$^{h}_{s}$ V ^{t} (v)	62. hat	hætʰ, hɛtɛ
	58. hole	hɔ
	237. horsie	hʌti
	49. hot	hɔtʰ, haˀ
	56. shoes	sʌtʰ
(X)VC$_{\text{fricative}}$(V)	119. bus	baɨs:
	138. eye(s)	ajç
	259. ice	æx, ajç
	10. key(s)	kiç
	71. off	ɔx, af
	47. woof	af
	237. horsie	hajçi
	56. shoe(s)	išu, sɨs
	67. what's'at	sæ, ʌzæ
	186. Daddy	dɛɣi
Other Tokens	125. box	bajtç
	192. cottage cheese	dætsi, datčis
	95. door	du:r
	188. hammer	hæhmæ, hæhm̩
	256. hot dog	haku, hakwe
	155. salt	ɔˀ

One major difficulty with a word is in learning to say it spontaneously, in learning to perform it as a motor act. Once the child has a way to say a word learned, he/she uses it confidently, even if with as many variations as Jacob's 'thankyou', until it is modified in the course of the maturation of speech. As adults, when we learn a new word, we make use of our knowledge of the patterns usually found in our language, with the result that, to take the standard example, a nonsense word like 'blick' is easier for English speakers to hear and say than 'bnick'. Let us assume that sound patterns aid the child as they do the adult. What good are patterns?

In other types of skilled performance, variations within familiar patterns are easier to master than whole new patterns. For example, one can vary a known dance step or swimming stroke without having to learn the variant as though it were a whole new Gestalt. In fact, studying what sorts of variation are easy to learn and what sorts seem to require 'starting from scratch' should give us clues to the internal organization of skilled performances. Patterns, if recognized and utilized, reduce the complexity of a novel task by helping us break it down into a familiar aspect, which needs less attention to carry out, and an unfamiliar aspect, on which we can concentrate.

Let us assume that we are dealing with a child who is trying to match a particular phonetic model, a word; once he/she has learned to say it to his/her satisfaction, a complex set of articulatory instructions have been associated with the sound of the word. For the sake of a convenient name, we shall say that the child has found a 'recipe' for making the word. Now when he/she tries to say another word which is perceived as being similar to the first word, a small variation on the recipe may give success on the second word. Recipes for saying words are not neatly laid out in lines; they are complexes, and what elements in them are independently manipulable by the speaker is completely obscure. But if children in learning to speak do use a strategy of varying old recipes to reduce the difficulty of the task of dealing with new words, the observed adherence to surface canonical forms will be explained.

The basic picture, then, is of the beginning speaker as having a limited set of word-recipes, attempting to make use of them wherever he/she perceives an appropriate situation. It is a familiar strategy -- reduction of a new problem, so far as possible, to one already solved, -- and another case of it has already become familiar in developmental psycholinguistics in Slobin's now-classic formulation 'old form, new function'.

4.1.1 Selective Avoidance

As we said at the beginning of this chapter, one way in which a child may maintain an output repertoire of a small set of word shapes is by avoiding adult words that do not conform to any of those shapes. In this section we shall show that the small set of canonical forms Jacob used, even though he had very few phonological rules, was not due to chance. He really did avoid certain adult words because of the sounds they contained; he exercised phonological selection.

Two important points follow from a demonstration that a child exercises phonological selection. First, and simplest, if a child avoids certain sounds, he/she must be discriminating them from the sounds not avoided. Data on phonological selectivity provide a natural-environment counterpart to laboratory data on the ability to discriminate sounds which are being used to convey linguistic information (Garnica 1973).

Second, if a child attempts to say words similar to ones he/she can already say, and avoids others, then the child must have some awareness of whether he/she has the ability to say certain sounds or sequences of sounds.

Let us look again at the sounds and sound patterns of Jacob's active vocabulary (table 4.1, table 4.2) and compare their distribution with the distribution of the sound patterns in his passive vocabulary, in table 4.

For Jacob, position of articulation of the initial stop of a word seems to be the most important selection factor; this is probably very common, but some children attend to final stops for other phonological purposes (Menn 1971, Smith 1973), so some probably attend to final stops for selection.

Table 4.2 Active Vocabulary

	Word	Active Use Session	Active Use Age	Imitation/shadow use Session	Imitation/shadow use Age	Appendix ref. no.
1.	thankyou	1	12:8	prior to beginning of study		1
2.	toast	3	12:12	?		2
3.	there	4	12:15	?		3
4.	no	7	12:22	6	12:19	4
5.	Jacob	15	13:10	13	13:6	7
6.	don't	16	13:13	16	13:13	4
7.	down	22	13:27	20	13:22	8
8.	(a)round	24	14:0	24	14:0	27
9.	up	33	14:24	24	14:0	30
10.	ioio	33	14:24			26
11.	doll	34	14:26	23	13:29	20
12.	tap-tap	35	14:28	25	14:3	32
13.	hello	41	15:22	41 ?	15:22	53
14.	here	41	15:22	41	15:22	51
15.	hot	41	15:22	41	15:22	49
16.	roll	44	15:29	32	14:21	40
17.	duck	44	15:29	32	14:21	42
18.	woof-woof	44	15:29	35	14:28	47
19.	uh-oh	44	15:29	44	15:29	61
20.	bye-bye	46	16:2	17	13:15	13
21.	ear/earring	50	16:14	33	14:21	45/39
22.	siren	52	16:19	52	16:19	64
23.	nose	53	16:21	52	16:19	66
24.	esa (what's that)	53	16:21	53	16:21	67
25.	truck	53	16:21	47	16:5	91
26.	light	56	16:28	56	16:28	69
27.	door	57	16:30	57	16:30	95
28.	quack	57	16:30	55	16:26	68
29.	car	59	17:4	55	16:26	90
30.	hole	63	17:13	40	15:16	58
31.	cracker	63-A	17:15	31	14:19	37
32.	tea	65	17:18	51	16:16	79
33.	key	65	17:18	13	13:6	10
34.	hat	65	17:18	44	15:29	62
35.	tape	65	17:18	58	17:2	97
36.	meow	68	17:27	68	17:27	108
37.	tractor	73	18:13	57	16:30	96
38.	cookie	74	18:18	52	16:19	52
39.	(a)way	75	18:20	58	17:2	98
40.	lion	75	18:20	75	18:20	136
41.	off	76	18:23	47	16:5	71
42.	on	76	18:23	30	14:17	24
43.	eye	76	18:23	71	18:9	138
44.	shoe(s)	78	18:27	38	15:5	56

Table 4.2, continued

	Active Use		Imitation/shadow Use		
Word	Session	Age	Session	Age	Appendix ref. no.
45. apple	78	18:27	78	18:27	140
46. eat	78	18:27	78	18:27	142
47. wheel	79	18:30	52	16:19	77
48. box	79-B	19:9	65	17:18	125
49. bang	80	19:10	77	18:25	172
50. ball	81	19:13	63	17:13	101
51. baby	81	19:13	80	19:10	181
52. kaká	83	19:17	78	18:27	177
53. fly	84	19:20	58	17:2	97
54. bus	86	19:24	63	17:13	119
55. block	86	19:24	24	14:0	29
56. hammer	86	19:24	86	19:24	188
57. cheese	86	19:24	63	17:13	120
58. cottage cheese	87	19:27	86	19:24	192
59. hot dog	89-A	20:5	89-A	20:5	256
60. bike	90	20:8	90	20:8	257
61. ice	90	20:8	90	20:8	259
62. horsie	91	20:12	87	19:27	237
63. rug	92	20:13	89	20:1	239
64. milk	92	20:13	92	20:13	260
65. bib	93	20:15	93	20:15	275
66. broke(n)	95	20:20	85	19:22	216
67. salt	96	20:22	73	18:13	155

Tables 4.3 Estimated passive vocabulary (to 20 months)

Note: This list is a conservative estimate of Jacob's ability to differentiate verbal cues in the fashion which adults respond to as his 'having understood a word'. The experienced child observer needs no reminder of the fact that the very young child is quite likely to respond to a verbal suggestion only when it fits in well with what he/she is already interested in doing, in which case the verbal cue may be consequently so redundant that no true test of the child's verbal comprehension has been made. This list is a conservative estimate in that I did not enter words in it until I had reasonable evidence that the spoken message had exerted an appropriate differential effect on Jacob's action (e.g. when he correctly gave me an object which I had asked for out of a selection of equally attractive objects).

The reader should be warned that in many cases control for non-verbal cues was rough; these data are broadly trustworthy for illustrating the absence of phonological selection in Jacob's passive vocabulary, but I would consider that much greater information about the eliciting situation would be necessary in a proper study of the growth of a child's understanding of words.

Table 4.3 a) Chronological listing

12:10	no
12:17	peekaboo
13:1	ring
13:3	bang
13:3	Jacob (as his name)
13:3	where'sa?
13:6	nice(= 'pet')
13:8	fish
13:13	box
13:17	knock-knock (accompanies action)
13:17	wheel
13:22	hose
13:22	all gone
13:22	get
13:24	up (invitation to game)
13:29	clap hands
14:0	ear
14:3	not-good-to-eat
14:3	slide (at playground)
14:3	swings (at playground)
14:5	give me
14:5	hug
14:5	dog
14:7	push (in game)
14:7	bounce (intransitive)
14:7	do-it-in-the-mortar
14:10	rock (verb, intransitive)
14:12	make...go 'round
14:17	close (book)
14:17	open (book)
14:17	bye-bye
14:17	tap-tap (accompanies action)
14:17	on (in context)
14:19	wanna get out? (of stroller)
14:19	pump (noun)
14:21	foot
14:21	up/down (= operate zipper)
14:24	not (embedded in sentence)

Table 4.3 a) continued: chronological listing of estimated passive vocabulary up to 20 months

15:1	don't (without context)
15:1	roll (trans. vb.)
15:1	hot
15:3	ball
15:3	pen-cap
15:3	eye (later evidence of eye-nose confusion)
15:5	glasses
15:5	cookie
15:5	keys
15:5	bring-back
15:11	pull
15:16	pen
15:22	block
15:22	bottle
15:22	breakfast (in context)
15:22	come
15:24	where...go
15:29	nose
16:0	bring me a book
16:2	kiss
16:2	earring
16:5	throw
16:7	gently
16:14	cracker
16:16	gun/snap (noise of gun)
16:16	sleep(ing)
16:16	take sock off
16:16	put X in Y (in context)
16:19	jingle (verb)
16:21	wanna sit in my lap?
16:21	use the spoon
16:21	want me to help?
16:21	turtle
16:21	put X on Y
16:21	chest
16:21	in mouth
16:23	bell
16:26	fork
16:26	belly button
16:26	blow (of whistle)
16:30	dancing
17:4	bump
17:4	oops
17:6	tractor
17:6	wet
17:6	change
17:6	door
17:6	milk
17:11	tea
17:13	jacket
17:13	some more
17:13	eat
17:15	cat
17:16	spool
17:18	boot
17:18	shall I come sit?
17:18	sit on the chest
17:18	bus
17:18	telephone
17:18	head
17:18	meat
17:18	finger
17:23	hat
17:25	your
17:25	my
17:25	rug
17:25	whistle
17:27	cereal
18:4	tongue
18:4	fly
18:4	hole
18:4	toe
18:4	turn (verb)
18:9	hair
18:13	thumb
18:18	stroller
18:18	beard
18:18	hand
18:20	handle
18:20	pocketbook
18:20	(?) show *or* out
18:20	magnet
18:20	cup
18:23	what's that?
18:25	touch
18:25	play
18:25	just a second

Table 4.3 a) continued: chronological listing of estimated passive vocabulary up to 20 months

18:27	light (noun)
18:27	leave
18:30	leak (urinate)
18:30	whatcha doin'?
19:10	trash truck
19:10	clock
19:10	make
19:17	drinking
19:17	closet
19:20	hit
19:20	lady (?)
19:20	window
19:22	couch
19:22	pick up
19:24	pin
19:24	mail box
19:27	tail
19:29	shut
19:29	put back
19:29	egg
19:29	there goes
19:29	bite

Table 4.3 b) alphabetical listing of estimated passive vocabulary up to 20 months

all gone	13:22	bye-bye	14:17	don't	15:1
(a)round	14:5			door	14:17
		cat	17:15	drink(ing)	19:17
back (put..)	19:29	cereal	17:27		
ball	15:3	change	17:9	ear	14:0
bang	13:3	chest	16:21	earring	16:2
beard	18:18	clap hands	13:29	eat	15:11
belly button	16:26	clock	19:10	egg	17:27
		close (book..)	14:17	eye	15:3
bite	19:29				
block	15:22	closet	19:17	finger	17:18
book	16:0	cookie	15:5	fish	13:8
boot	17:18	come	15:22	fly	18:4
bottle	15:22	couch	19:22	foot	14:21
bounce	14:7	cracker	16:14	fork	16:26
box	13:13	cup	18:20		
breakfast	15:22			gently	16:7
bump	17:4	dancing	16:30	get	13:22
bus	17:18	dog	14:5	give	14:5

Table 4.3 b) continued: alphabetical listing of estimated passive vocabulary up to 20 months

glasses	15:5	off	16:16
gun (?)	16:16	on	14:17
		oops	17:4
hair	18:9	open	14:17
hand	18:18	out	17:4
handle	18:20		
hat	17:23	peekaboo	12:17
head	17:18	pen	15:16
help	16:21	pen-cap	15:3
hit	19:20	pick up	19:22
hose	13:22	pin	19:24
hot	15:1	play	18:25
hug	14:5	pocketbook	18:20
		pull	15:11
(I)	15:22	pump	14:21
(in)	16:21	push	14:7
		put	16:21
jacket	17:13		
Jacob	13:3	ring	12:12
jingle	16:19	rock (vb)	14:10
just a second	18:25	roll	15:1
		rug	17:25
key(s)	15:5		
kiss	16:2	show me	17:25
knock	13:17	shut	19:29
		sit	16:21
lady	19:20	sleep(ing)	16:16
lap	16:21	slide	14:3
leak	18:30	snow	18:20
leave	18:27	sock	16:16
light	18:27	spool	17:16
		spoon	16:21
magnet	18:20	stroller	18:18
mailbox	19:24	swings	14:3
make	19:10		
meat	17:18	tail	19:27
milk	17:6	tap-tap	14:17
mortar	14:7	tea	17:11
mouth	16:21	telephone	17:18
my	17:25	there goes	19:29
		throw	16:5
nice	13:6	thumb	18:9
no	12:10	toe	18:4
nose	15:29	tongue	18:4
not	14:3	touch	18:25

Table 4.3 b) continued: alphabetical listing of estimated passive vocabulary up to 20 months

trash truck	19:10	whatcha doin'?	18:30
turn	18:4	wheel	13:17
turtle	16:21	where'sa	13:3
		whistle	17:25
up	13:24	window	19:20
wet	17:9	your	17:25
what's that	18:23		

Jacob's first seven words all had adult models with initial coronals of one sort or another, and in addition we had the striking replacement of 'no' by 'don't', making the set of model words even more uniform in initial consonant.

Jacob then started adding words with vocalic onsets and rounded-glide onsets; next, on session 41, at 15:22, there were three words recorded as new to the active vocabulary, and all three began with /h/ in the model. Until 15:29, NO word with either labial or velar onset was found among the nineteen then in the active vocabulary, yet such words were amply attested in the passive vocabulary at that time.

At 16:2, Jacob added 'byebye' to his active vocabulary. As we have seen, he said it with initial 'd', which is also the form in which he had occasionally shadowed it earlier. He did not, however, proceed to add more words whose models had labials; 'byebye' remained the only one until he learned how to produce a labial output three months later.

Instead, he added steadily to his existing groups, with dentals, vowel, and glide initials. At 16:30 he added his first velar-initial word, 'quack', and within three weeks he had learned five of them. Finally, after succeeding with syllable-final /p/ on 18:27, he mastered the /b/ of 'box' on 19:9, and within three weeks, six words beginning with /b/ had been added.

A tally of adult words which had been learned by the last session, on 20:22, no longer shows selection from the adult universe of words by position of articulation but instead selection by position and voicing. Jacob attempted no adult words which began with either /p/ or /g/, although he had ten which began with /b/ and six or seven which began with /k/. However, his passive vocabulary had such words as, 'pin', 'pen', 'pull', 'pump', and 'peekaboo', with /p/, and 'give', 'get', 'glasses', 'gun' with /g/. Clearly, in order to refrain from attempts at these words beginning with /p/ and /g/, he must have known that they were different from words beginning with /b/ and /k/.

In word-final position, there is not a lot of evidence, but Jacob seemed not to avoid words just because of their final consonants. He was willing to use [p] for final /b/ in 'bib' and [k] for final /g/ in 'rug'.

Jacob's output resembles Joan Velten's at least for labials: only [b] appears initially and only [p] appears finally. But Velten represented both adult initial /b/ and adult initial /p/ by her initial [b] giving a true merger of the distinctions, whereas

Jacob seemed to know that he could say only initial /b/ correctly. (In shadowing 'puppy', he produced one [pʌpi] and one [babi].)

4.2 Overgeneralization of canonical forms

When we as adults confront foreign words, even in trying to say them accurately we tend to slip into familiar articulatory habits. For example, English speakers slip into saying French unaspirated unvoiced initial stops with aspiration, which accompanies unvoiced initial stops in English. From a French-speaking point of view, one would describe the speech of a beginning American student of French as having a rule aspirating French initial unvoiced stops; a more skilled student who managed the correct pronunciation part of the time could be described as having a variable or optional rule of aspiration.

One aspect of canonical forms is as representations of Jacob's principal articulatory habits. These habits carry over, to some extent, from the words where they were formed in the original act of learning to say the word, into new words, and in those new words those habits may be totally out of place. We have seen one such case already, in the two tokens of 'byebye' that had the front-back vocalic pattern of 'thankyou'. There are several other sporadic cases of this carryover: one token of 'uh-oh' as [DʌʔO], where D was some sort of dental stop; and the first two recorded attempts at 'round', which sounded exactly like tokens of 'down' and would not have been recognized for what they were if Jacob had not been rotating an object at the time. In the latter case, the reason for the extraneous [d] is very clear, since ALL the other words in Jacob's active vocabulary at the time those first two attempts at 'round' were made began with coronal consonants, and almost all of them with [d].

Whether one describes these prothetic [d]'s as having been inserted by a rule like $\emptyset \rightarrow$ d/#__[-son] or whether one prefers to reserve the term 'rule' for more regular modifications of adult model words, it seems that the [d] results from the same sort of persistence of a familiar articulation pattern -- the same sort of habit, to use a dirty word -- as the presence of aspiration on unvoiced initial consonants in American-accented French.

In other cases, the articulatory habit represented by a canonical form does not introduce wholly extraneous elements into the production of a word, but instead causes rearrangement. The occasional final nasal found in some tokens of 'thankyou', for example, is probably triggered by the nasal in the model word, for it does not occur in tokens of 'Jacob'. But its position is anomalous, and could be ascribed to carryover from two very common words 'don't' and 'down',

with nasals in word-final position, and no other nasals. (If this explanation is accepted, the statement in the last chapter, that position with respect to word-boundary did not have to be taken into account as a conditioning factor, obviously must be modified.)

4.3 On the internal representation of words

We saw in section 4.1 that Jacob avoided adult words with initial labial consonants, and that 'byebye', rendered [dVdV], was for a long time -- three months -- a conspicuous exception.

Jacob began to shadow 'byebye' at 13:25, and he made transient attempts at a number of words with labial onsets during the period 13:29 to 14:3 (see appendix). But these, and subsequent attempts at labial-initial words, were relatively rare, never more than one token of each type per session. The outputs usually showed deletion or weakening of the labial, or else assimilation of it to the articulatory position of another stop in the word: [dɛ̈itɛ], 'diaper', [gʌgʌ] 'bottle' (from [ba$^{?}$ɪ]). In Jacob's nineteenth month, successful shadowing of labials increased, and at 18:27, as we have mentioned, he mastered syllable-final [p] and soon after, at 19:9, syllable-initial [b]. (See ch. 3, consonant table Set #7.) No substitution of dental for labial was found in new words (bus, baby) after that time, with one striking exception which we are about to discuss, and the long-established dental 'byebye' was replaced by a labial output at 19:17.

The overall picture, then, is that for one word, 'byebye', there was replacement of labial by dental initial stop, and in all other cases, Jacob simply avoided spontaneous production of labial-initial words until he had learned how to produce labials correctly at about the age of 19 months. From then on, he used labials where they belonged. Let us now turn to the major exception to this picture, the word 'ball'.

'Ball' was an important word in Jacob's passive vocabulary (attested since 15:7), since he enjoyed throwing things. In almost every session of the later months one finds "No, Jacob, that's not a ball. Don't throw it. *Balls* are to throw. Get a *ball*." (etc.) -- a litany which will be familiar to many adults. Jacob made just one utterance ([bo], 17:13) that might have been an attempt to say 'ball' in the presence of any adult or tape recorder (and that one was heard at the time as 'throw') over all the months until 19:13, in spite of dozens of very clear adult models whose referent he understood.

Consider the state of affairs at 19.13. Jacob had 'baby', 'up', and 'apple' in his active vocabulary, and had given a first spontaneous [ba] for 'box'. He had been regularly shadowing and imitating labials accurately for two weeks. Yet on this date, 'ball' appeared with a completely unexpected dental initial, and remained stable as [da], [dɔ], [dɑ], for several weeks after the last appearance of dental 'byebye' and at least *ten days after* the establishment of labial 'byebye'. How could this 'new' word have a /b/ → [d] substitution when the initial [b] seemed so firmly under control? How could it remain dental even after 'byebye', which had been dental for more than three months, had switched over to labial?

If there was a 'live' rule of /b/ → [d] substitution, why didn't it work on 'baby', and why did Jacob try 'box' with a [d] just once and then switch to [b] (once [p]) thereafter? For a rule that affected 'byebye' to skip over 'baby', the most similar word to it in Jacob's speech, and operate regularly on 'ball' is very unlikely, if both 'baby' and 'ball' were new words (see sec. 4.4 concerning rule growth). We have a much more attractive explanation.

We have seen how Jacob avoided words with labial onset until he learned how to say them correctly; we have argued that avoidance of a sound implies the ability to discriminate it from sounds one does attempt to say; and it seems reasonable to assume that the reason a child avoids a sound is because he/she finds it difficult to say to his/her satisfaction.

Suppose, then, that one thing Jacob 'knew' about labials was that he couldn't say them correctly. For some reason, he said 'bye-bye' as [dVdV], but he gave no other sign of finding a dental output to be a satisfactory rendition of a labial model. Above all, he was certainly aware that 'ball', 'box' etc. did not begin with dental stops.

Here is a model which accounts for Jacob's behavior: The words in the passive vocabulary which Jacob never said and which begin with /b/ in adult speech are to be considered as having had 'input representations' for Jacob which begin with a /b/. We further assume that Jacob had formed a *latent* 'recipe' for saying 'ball' -- that is, a mental encoding of the necessary output instructions -- at a time near that at which he started to say his dental 'byebye'. However, he realized that [d] was an unsatisfactory approximation to /b/, and he decided that 'ball' was too hard to say; that became part of his knowledge about the word 'ball'. (He could easily have actually tried a dental version of it a couple of times, back when he was first saying 'byebye', and have gotten the adult reaction that he was saying 'down' or 'there'.) He stored similarly depressing information in his lexical entries for the other familiar words that he never was heard to say ('bang', 'box', 'bucket', 'bead'...).

After some point in time, he must also have had 'hard to say' included with his general phonological information about labials, since his inhibition against them extended to new words for so long.

Now, when Jacob finally learned to say initial /b/, he must have learned simultaneously the fact THAT HE COULD(at last) SAY INITIAL B. If we assume that he learned this as a general fact, and could apply it to all words beginning with /b/ in his input vocabulary, just as he had once learned that he couldn't say them, then we can understand what happened to 'ball' (and what happened to 'bang', which is less richly attested and which we have left out of account up until now): Jacob, in his new confidence about words beginning with /b/, had not bothered to listen to the quality of his rendition of 'ball'. The old long-latent output representation -- the encoding of articulatory instructions -- with [d] was still in his lexical entry for 'ball', and so he said it as [d]. In the same way we account for the dental on 'bang' on 19:10 (and also a dental in a shadow attempt of 'bang' at 18:25, when labials in shadowing were usually produced accurately), and for the transient dental on Jacob's first attempt at each of the long-understood words 'bucket', 'box' and 'bead'. At one time, he had figured out a recipe for saying each of them, with instructions that would have resulted in the production of initial [d]. 'Ball' is still unusual, because he let it go through with the [d] for so long, while he caught the others, but with this model, we at least have a coherent story that predicts how a /b/ → [d] substitution could appear to generalize AFTER Jacob had learned to say [b].

This example is offered as important evidence towards establishing the validity of the familiar construct 'input representation of a word' and 'output representation of a word' similar to those used by Ingram (1974), and also of a new one, 'latent output representation of a word'. We argued that the emergence of 'ball' and 'bang' with dentals can be explained if Jacob had constructed output representations for them at a time when the /b/ → [d] substitution evidenced in 'byebye' was a live rule, but had then refrained from saying them, along with all other words (except 'byebye') whose input representations began with /b/. Since these output representations were never (so far as is known) actualized in speech, I call them 'latent'.

I conclude by noting that this new unobservable construct, 'latent output representation', is very powerful, and should only be used when necessary. Children can fail to say words which they have in their passive vocabulary not only by inhibiting a fully-formed set of articulatory instructions, but, obviously, because they have not yet devised the articulatory instructions, and often the observer will have no evidence as to which is the case in a given instance.

4.4 Probable origin of phonological rules

We shall now examine the rest of the cases in which Jacob made substantial changes in adult model words in producing them. The following are our objectives:

1) To see if the changes have the effect of reducing the inventory of canonical forms, as we have been suggesting they should

2) to see if the changes could have arisen as overgeneralizations of existing word-making recipes, as we have proposed

3) to see if any of these changes have sufficient regularity so that they look like the sorts of rules of child phonology found in the literature

4) to see if we can make any interesting statements about the way that these changes take place and the way that they spread through the lexicon.

4.4.1 Stress-shift rule

The first case we will take up involves stress pattern: Jacob acquired the nursery word 'kaká' (feces, soiled diaper) from a Greek-born babysitter A. D. (whose speech otherwise had no observed effect on Jacob's). This was the only consonant-initial word he acquired which had stress on the second syllable. He extended this exceptional stress pattern to 'cracker', which he had usually said as [káka], and also to 'cookie' [kʌ́ki], [kúki]. (Both these words were used to mean either 'cookie' or 'cracker'; first [káka], then slightly later [kʌ́ki].)

The shift of the stress on 'cracker' from initial to final was reported to me informally, and I do not have the exact date; it was of course very striking since it made 'cracker' a complete homonym with 'kaká'. Jacob, as we said, first learned 'kaká' with final stress and 'cracker/cookie' with initial stress. Then, from 19:10 to 19:24, his spontaneous productions of 'cookie' had final stress, while 'kaka' had initial stress. On 19:27 we find them both vacillating, and both words end up with initial stress.

Certainly, the end result is elimination of the final-stress pattern and reduction of the number of output forms. But there was the intermediate period during which 'cracker'/'cookie', and only 'cookie'/'cracker', went over to the iambic pattern (˘ ´). We must talk about the influence of one single word, 'kaká', on another, 'cookie'; canonical forms, at least as far as we have developed the notion, are too crudely defined to say just why there should be a

Table 4.4 Stress Shift Rule Table

	(prior)	18:27	19:10	19:17	19:24	19:27	20:1	20:18	20:22
'kaka'	kaká	kaká		gak'	káka	kʌká káka			gʌ́ga kʌ́ka
cookie/ cracker	kúki káka		kʌkí		kʌkí	kʌkí (kúki)	(kúki)	kúki	

(entries in parentheses were shadowed, other entries in this table were spontaneous utterances)

special relation between these [kVkV] words that does not extend to other CVCV words: We obviously need to be able to talk systematically about the degree to which words resemble one another, and to derive principles for doing that is beyond the scope of this thesis.

We can only, then, state what is obvious here: 'kaká' and 'cookie/cracker', the only [kVkV] words, influenced each other; their interaction ended in a net reduction of the variety of output forms, but it was preceded by a period of local confusion in which each of them took on the stress pattern of the other. This is our first example of the process called 'consolidation' in chapter 1.

No other words in Jacob's lexicon had their stress pattern disrupted at any time in this study. (His only other two-syllable words whose adult models had final stress were 'away' and 'around', in which he seemed to regard the first syllable as an optional element.)

4.4.2 [ej] → [i] rule

The next set of word-form interactions is more extensive (Table 4.4.2). In some of Jacob's words, he replaces /ej/ in the model by [i]. The small size of the corpus makes it impossible to be certain of the conditioning factor, but the shift seems to take place when the vowel occurs in a closed syllable. This shift, like the stress shift in 'kaka', was preceded by a period of instability. The vowel charts in ch. 3 for Set #5 show that when Jacob was first acquiring 'away', 'key', 'tea' and 'tape', in his 18th month ('away' a little later), he was using no other words with these [+high] vowels. In table 4.4.2, we can see that mid, mid-high, and high front vowels all appeared in the output for each of 'tea', 'tape', and 'key'; 'away' was less richly attested, but seems always to have had a mid-vowel or a diphthong with a non-high nucleus. There are only three

words in which the shift takes place in an open syllable: 'baby', in which vowel harmony alone could have produced it, a shadow production of 'A', which may have been influenced by other letter names being shadowed on the same occasion ('B', 'C', 'D'), but which remains a bad point, as does [^kij 'okay'.

I see the mutual influence of [ej] and [i], ending in the adoption of [ti] for both 'tea' and 'tape', as basically another example of rule formation by consolidation, but since a stable form in [ej] for 'tape' did not precede the period of mutual influence, and since 'tea' and 'key' stabilized with [i] while 'tape' was still fluctuating, there are elements of carryover in this case, too. The extension of the rule, once formed, to new words with [ej] in closed syllables (e.g. 'gate', 'cake') is carryover in its most regular form, that of regular rule application to new words meeting the rule's structural description.

Table 4.5 [ej] to [i] Rule Table

	16:16	17:2	17:11	17:16	17:18	17:23	17:25	17:27	18:2
79. tea	ti				*dj* *dʱi*			*ti*	
97. tape		da		*ej* tʲj	tɛj d	*tɛ*	*txi*	*ti* *di*	*gej*
10. key					k^hi	xɛ k^hi	*xɛ*		

98. away (nuclear vowel always low)

7. Jacob (nuclear vowel always low after 14:0)

41. okay ki (cf. cookie)

(entries *underlined* were spontaneous, others were shadowed in this table)

Table 4.5 [ej] to [i] Rule Table, continued

		18:4	18:9	18:18	18:27	18:30	19:22	19:24	19:29	20:1
79.	tea	(vowel always [i])								
97.	tape	*tej*			(vowel always [i] after 18:27)					
10.	key	(vowel always [i])								
157.	gate			gi						
168.	egg								ik	ik ɛk'
98.	away	(nuclear vowel always low or mid)								
60.	lady	(rare; nuclear vowel always low or mid)								
7.	Jacob	(rare; nuclear vowel always low or mid)								
206.	'A'					ɛj		i		
212.	play					pɛj				

		20:8	20:12	20:15	20:18	20:20	20:22	summer report
(tea, tape, key, away: vowel stable as given above)								
163.	cake					*kek*	gicɛk k'ejk	
304.	table				ti			ti
168.	egg			ek		ɛ		ik
272.	rain					wejn	wej^{n}	
305.	'E'					i ɛj		

(entries *underlined* were spontaneous, others were shadowed, in this table)

4.4.3 "Bice" rule

Now we turn to the most intricate case of mutual influence of word-forms in Jacob's lexicon; the relevant data are displayed in table 4.6. Here, one shift, roughly [V$_{-high}$ j → [aj], seems to have been implemented in two distinct contexts, before sibilants and after labials.

Table 4.6 "Bice" Shift Rule Table

		20:8	20:13	20:15	20:16	20:19	20:20	20:21	20:22	summer
257.	bike	*bʌj* bajk bek		*abaɪ^h* bajk	*bɛjɬ* *bakʰ*				*bajk*	
259.	ice	*ɐx* *ajç*			*ɐjç*					
289.	nice		*nʌjs*							
119.	bus		*bʌ* *bæ^s*		*bʌs*		*baɨs*			bajs
126.	box	bak^h	bakh	bakh	*bʌjtç* *bɔkts*		*bak^h* *bak*		ba^k *ʌbak*	
172.	bang	bajŋ bæ̃				*bajŋ* baŋ	*bæ* *bajŋ*	bajn- bæŋ	*baŋ* *bajŋ*	
131.	boy						baj	baj		
314.	beg						bajg			
316.	umbrella						baj ʌbʌ:			
237.	horsie, horse		*hʌs* *as*			*hɔjs* *hɔ̀si*	*hajçi* ɔçi	*hʌ̀si* *haš*	*hà̀si* *hʌjsi*	
269.	toys					t^{h}ʌis t^{h}ɔis				
38.	book		bʌp^h							
252.	bucket	bak^h	bʌk dʌtɨ	bʌk					ʌbʌkɨ mp^{w}ʌkɨt	
29.	block		*bwɑ*				*ak*			
308.	(your)back					*ʌbɨk*				
216.	broke(n)				*bʷɔk*		*bɛk^h* *bwok*		*bʌ* bw$_ʌ$k	boki bokn̩
101.	ball	*bɔ* *ʌɯ*	*bɔ* *bɐ*	*bɐ* *bɔ*	*bɔ*		*bɔ*		*bɔ*	
227.	bark			bʌi						

(Note: summer, 'grass',[rajs]; 'mess',[majs])

In this table, all Jacob's utterances of the relevant words are entered, and the spontaneous utterances are italicized. The circled tokens are the ones in which the stressed vowel has undergone this shift, and the tokens in boxes are those in which the reverse change seems to have taken place. The best example -- the paradigm case of the shift -- is the word 'bus', which has a labial before the vowel and sibilant after it, satisfying both environmental conditions. It regularly became [bajs], and so for convenience we shall refer to this shift as the 'bice' shift.

The 'bice' shift, like the /ej/ → [i] shift of the previous section, was context-dependent, but it acted on a wider range of input vowels, namely all the low and low-mid vowels. What happened was the following:

At 20:8, Jacob was given a plastic indoor-outdoor tricycle. He immediately learned to call it a 'bike'. His control of the diphthong was not perfect (see boxed tokens in table 4.6), but the off-glide was usually present. At this point, 'eye(s)' and 'ice' were words used frequently (they seemed to be homonyms). There was a toy frog whose eye frequently came out and had to be replaced; Jacob was very fond of cadging ice from adults' drinks. And at that time in general [aj] or [ʌj] was well-established in his output even if the glide was not always produced, in 'fly', 'bye', 'light'. 'Bang' had already been shadowed with some diphthongization as [dæjŋ]; probably reflecting its quite audible off-glide in my speech.

After Jacob learned 'bike', the patterns [bajX] and [Xaj$\begin{Bmatrix} s \\ z \end{Bmatrix}$] seemed to generalize to words which contained low vowels or non-back mid-low vowels: 'bag', 'box', 'bang'; 'horsie', 'toys', 'boy', 'umbrella', and later 'grass', 'mess'. In 'bus', the shift was obligatory, and by Aissen's report it was also obligatory in 'grass' and 'mess'. We can see, on the other hand, that 'ball' was completely unaffected.

If we set up the right canonical forms using hindsight, the 'bice' shift reduced their number, or would have done so if it had been carried to completion, for all sibilant-final words would have been produced with [ajs]/[ʌjs]. Also, the words in [æ:] and [æɨ] would have been eliminated, leaving Jacob with only short [æ] in output. Output [ɔj] would have been eliminated totally with the application of the shift to 'boy' and 'toys'. The remaining cases of the shift, the single occurrences on 'umbrella' and 'box', may have been tentative extension of the rule to more general b-initial contexts, but again, endless adhockery is possible here.

4.4.4 Summary of section 4.4

Returning to the four objectives of this section, it is clear that all three of these shifts result in increasing the generality of some of Jacob's word-making recipes and reducing the inventory of canonical forms. At least /ej/ → [i] and the stress shift are regular enough to be called rules. The shifts that do not involve the mutual influence of the patterns of two words, like the addition of the extraneous initial dentals in 4.1.1, fit in nicely with the notion of shifts as arising from carryover of existing articulatory habits to new words; so does the application of the /ej/ → [i] shift to the new words 'gate' and 'cake', described in section 4.4.2.

However, the shifts in 4.4 which involve mutual influence of two patterns are better handled by a more abstract analysis, in which the difficulty is not ascribed to the child's attempt to establish a new word that goes against an existing articulatory habit. Instead, the problem in these cases seems to be in maintaining two (or more) very similar words without confusing them. Jacob had learned to say 'kaká' correctly before the stress-confusion described in 4.4.1 occurred. What happened after the period of confusion was a *consolidation of forms* rather than a straightforward generalization. Compare the case of 'tea' 'key' and 'tape', as shown in table 4.5. They were learned at about the same time, and Jacob originally had trouble controlling the vowel in all of them. 'Tea' and 'key' stabilized first, before 'tape' joined them. This case could be one of carryover or one of consolidation when the shift makes its first appearance; the subsequent spread of the rule, as we have noted, is a clear case of carryover.

In the case of 'bice', 4.4.3, can we say whether the spread of [aj] was due to carryover from existing patterns of words in /bajX/ and /ajs/, 'bike' and 'ice', or whether it was due to pattern consolidation? The essence of carryover is that a well-established pattern guides the attempt to say a new word. When the 'bice' shift appeared on words acquired later than 'bike' and 'ice', such as 'bag' and 'boy', we have clear cases of carryover. When, however, words like 'bus' and 'box', acquired before 'bike', showed the shift, we have consolidation.

Summarizing: in order to account for these shifts, we have dealt in terms of both articulatory habit (carryover) and phonological reorganization (consolidation). 'Carryover' alone would be an insufficient hypothesis because it presumes that articulatory habits have been established and that the correct model is 'solution of new problems by old methods'. But some of our shifts showed new words influencing older words, so they could not have been cases of carryover.

'Consolidation', the more abstract term of explanation, is the more powerful notion. The idea of patterns interacting without regard to which pattern was acquired first could subsume both of the cases we have distinguished. We could dispense with 'carryover' as a term of explanation and say that all generalization of pattern takes place at an organizational level. Adult 'articulatory habits', after all, are a great deal more than just habits; they are part of an elaborate structure, which must in general be described in abstract terms.

The appeal of the 'carryover' notion is its concreteness and psychological plausibility. I prefer not to dispense with it by the suggested flourish of Occam's razor until more cases of shifts and rule-creation from other children have been studied, because I am not sure that exactly the same mechanisms are involved in 'carryover' and 'consolidation' and I do not think that the question should be defined out of existence. About the spread of rules through Jacob's lexicon, we can unfortunately say very little, because not enough words are involved to address major questions like the validity of a lexical-diffusion model (Ferguson and Farwell 1975, Hsieh 1972) as opposed to a crystal-growth model (Menn, 1973). Nevertheless, there is an evident phonological similarity among the words in which the shifts take place. The vowel shifts did not take place in random environments, but in phonologically limited ones, 'in closed syllables' or 'after /b/ and/or before /s/'.

4.5 Conclusion

We have now presented an approach to a theory of the origin of rules of child phonology: they arise as changes in the shape of adult words to reduce the number of canonical forms, either by over-generalization of existing patterns when the recipe for a new word is being worked out, or as consolidation among similar recipes.

The principal theory in the literature on the origins of rules of child phonology is that of David Stampe. In several respects his approach is opposed to the one I have argued for.

Stampe's theory is mainly concerned with contiguity effects on articulation and with weakening of articulation -- such processes as intervocalic voicing, deletion, flapping of coronals, nasalization of vowels in the vicinity of nasals, and other changes which are characteristic of speech which is poorly controlled. However, not all types of weakening of articulatory control produce the same effects. Lester and Skousen (1974) has shown that drunken speech differs from rapid speech, and child speech differs from both of them even if some of the changes produced are the same.

More important, the interrelationships among the sound patterns of words, to which we have given a central place, do not figure in Stampe's approach at all. Stampe's theory is essentially a modernized 'least effort' theory. Reduction of 'effort' must indeed be recognized as one of the forces acting on language in all changes, but it is an error to overlook the countervailing forces which restore distinctions or create new ones (Slobin 1975, Labov 1972). It is also an error to conceive of 'effort' as being only a low-level articulatory matter: the kind of simplification involved in the stress shift of 'kaká' and the diphthongization of 'bus' to [bajs] is not, as we have emphasized, a simplification of articulation, and neither are many of the rules of child phonology in the literature (Ingram 1975, Menn 1974, Smith 1973).

For these reasons, as well as more formal ones which I have discussed elsewhere (1974), I argue that Stampe's theory, while it calls attention to non-trivial similarities between some rules of adult phonology and some rules of child phonology, is not adequate as a theory of the acquisition of phonology.

CHAPTER V

Acquisition of Intonation Contours

5.1 Introduction

Children acquire early the ability to produce intonation contours which can be reliably classified by adults as declarative, interrogative, emphatic: see Menyuk and Bernholz (1969). Such contours are often present on vocalic or syllabic-string carriers as well as on words.

What next needs to be investigated is whether the children are at first pronouncing these contours parrot-wise, as what might be called an intonation babble, or with communicative intent, and if the latter, whether the child's intent is similar to that ascribed to him/her by the adult listener. If the child does use differences in intonation contour to convey different meanings, we have the task of finding out what the child's meanings are and how they are related to the meanings conveyed by adults in their use of intonation contour.

We shall demonstrate the following major points in this chapter:

1) Jacob, shortly after the beginning of this study, had some semantic control of intonation; he had an active vocabulary of four (proto-) words at that time. (Further study is likely to show such control even earlier.)

2) Jacob first had semantic control of intonation contours on babble 'carriers'; later, contrastive use of some of the same contours appeared on words. In chapter 2 we related this fact to the hypothesis that words are slow to develop a range of functions near the beginning of speech.

In order to begin, we must discuss briefly the use of intonation contour in English. In a non-tone language, the way in which information contours 'have meaning' is different from the way in which most words have meaning. Intonation contours do not refer; basically they seem to carry information about the function of the utterance, but not always in a simple way. The best-studied mode of classifying the function of utterances is according to their speech-act function: e.g. giving new information (declarative), requesting action or information (interrogative), ordering (imperative), plus combinations and more subtle modulations of these categories. These categories are also, of course, marked syntactically in the adult language, but they are discernable in adult single word utterances. We will argue that requests and demands can be separated

by their intonation in babble in Jacob's speech around the time of his first use of words. However, in examining the data, we shall find that the division into interrogative, declarative, and imperative is not well adapted to describing the functional categories of Jacob's speech, and we shall not be able to understand the 'meaning' of Jacob's use of intonation contour without first getting a more felicitous classification of his utterances according to function.

We will establish functional categories for some of Jacob's intonation contours based on what he was doing when he uttered them, how the adults present reacted to his utterance and behavior, and whether Jacob seemed to find the adults' reactions appropriate.

We will then find ourselves able to establish an additional entirely unexpected result, obtained through instrumental analysis of pitch contour: Jacob's short rising-pitch utterances in the first three months of this study fall into two discrete sets, high peak and moderate peak; the high-peak utterances are on babble carriers and directed towards his obtaining an object or service, while the moderate ones are either on words or function to initiate or maintain social interaction. Here, Jacob seems to have invented his own pitch-contrast encoding of a semantic difference, for it does not seem to be parallel to any pitch distinction in the language spoken to or around him. It does, however, have a plausible explanation as a codification or regularization of early tendencies in his own speech. The high-peak utterances use the same pitch range as the whining and squealing object-directed utterances that he used at an earlier stage; the moderate-peak utterances seem to reflect adjustment of the child's pitch range towards the pitch range of the adults around him. The initial semantic division is a functional one, separating vocalization towards adult-as-instrument from vocalization towards adult-as-social-partner. After the system worked this way for a while, it became more complex as Jacob started to use words in his utterances directed towards adults-as-instruments.

The material that is presented here is a limited discussion of the data in the corpus. First, only those contours which attract my ear as 'marked' have been given systematic consideration, and secondly, although appropriate techniques for instrumental analysis of such data are available, only selected utterances have been studied by use of instruments because of the time constraints on this work.

Most of the 'marked' contours in the corpus sound like questions, which for English speakers roughly means that they sound as though they have rising intonation contours. Conversely, to English speakers, those contours which sound as though they are rising usually also sound 'questioning'; those few of Jacob's utterances which sound rising but not questioning have an 'exclamatory' quality. There are very few of them, and we will not consider them here.

Among those contours which the ear picks up as 'rising' and 'questioning' are some which are actually level in fundamental frequency, as revealed by instrumental analysis or repeated careful listening. These level contours will be classed with the rising-questioning contours, for the communicative effect on the adult is apparently the same as that of a mildly rising contour. Naturally, we have no assurance that 'non-falling' is equivalent to 'mildly rising' for Jacob.

Another important mismatch between subjective and objective pitch detection is that a short steady high pitch is not pragmatically distinguished by the English hearer from a rise-to-high (Liberman 1975); the 'questioning' effect persists. Such contours will also be here subsumed by a loose use of the term 'rising'.

A cursory glance at the raw data shows that a division of Jacob's production of intonation contours into a babbling and a word-using stage would be as untenable for his use of intonation contour as it was for his use of segmental phones. Throughout the nine months of the study, Jacob used free babble, with more and more elaborate intonation contours, while during the same time period the regular correlation of intonation with concurrent gestures and action made it clear that sometimes he was using modulation of fundamental frequency to 'mean something'.

5.2 Rising contours on babble carrier: functional categories and 'meaning' of contours

The first marked contour which I noted which was clearly deliberate on Jacob's part was not a rise, but a spontaneous use of a very high pitch on the babbling with which Jacob accompanied hiding his eyes for 'peekaboo'; this corresponded with the high pitch I used in saying 'peekaboo' to him (12:17, fifth session). Shortly thereafter, rising contours were observed associated with several functional categories: first, offering (12:22); then, by (13:6), requesting an object, opening a conversation (attention-getting), and 'curious' noises accompanying peering into rooms, boxes, etc. Earlier, at 12:28 there had been a contour consisting of a (high) rise followed by a fall, clearly accompanying a request for permission to play with an object; greetings at 12:26 were falling rather than rising. (It is possible that a shift towards use of more rising contours occurred between 12:22 and 13:6. Since only one or two examples of rising contour occur per session in most of the sessions before 14 months, such a statement is statistically very weak.)

These functional categories -- offering, greeting, requesting, and peering -- remain frequent and stable as occasions for rising contour throughout the months of this study. Much of our interest in this section will be in Jacob's elaboration of the requesting category.

This limited set of categories handled all the 'questioning' utterances in the corpus until rising contours began to appear on words, at about 15 months. The earliest of these recorded in the corpus was a request to be lifted down from a chair at 15:3. The ability to say words with a rising contour also made possible a new subcategory of requests, the questioning of predication, which appeared at 15:11. In such cases, Jacob used a word appropriate to a situation with a rising tone (e.g. 'round?'); the adult interpretation would be that he was either asking for confirmation that he had the right word for the situation or that he wanted factual information about the situation. In either case, if Jacob was right, the adult would reply something like 'yes, it goes around'; such a response of course satisfied both interpretations of the question, and it seemed to satisfy Jacob as well. The fact that Jacob so quickly developed this new function for the new form of rising-intonation-contour-on-words is very interesting: it suggests that the underlying cognitive capacity to question whether he was using words appropriately was already present before he was able to express such questions.

We now have the following categories for Jacob's use of rising tone: 1) opening conversation 2) offering something to someone 3) requesting that someone do something or give information 4) 'curious noises'.

The first three of the behavioral categories have two important properties in common: Jacob seemed to use them only when he had an audience and they are not *necessarily* associated with rising contour. Since there is no constant association of rising intonation contour with attempts to obtain an object or a service, if we used 'attempting to obtain object or service' as the definition of one function of the child's speech and then look for an intonation contour invariably associated with it, we will find no such contour and have to conclude (correctly) that rising contour does not mean 'wanting something', and also tend to conclude (incorrectly) that the child uses rising intonation contour randomly and meaninglessly.

But let us consider the ways that adults use intonation contour. There is no single contour or small set of contours associated with the function of 'obtaining some goods or service'. We can request, suggest, or demand when we want something; it depends on the social setting and our mood. Similarly, I claim, children 'wanting' have in general a choice that ranges from requesting to demanding; what they do at a given time undoubtedly depends on their personalities, how they feel at the moment, and what sort of responses they anticipate getting from the adults around them. Attracting attention, engaging in object exchange and obtaining services were ends which Jacob tried to attain. The means that he used varied according to how demanding or how supplicating he felt like being at the time.

This is probably true for most children; if it is, we have an explanation of the troubling present situation in which 'everybody knows' that young children can convey meaning by the use of intonation contour, but no published work claims to have demonstrated a child's meaningful use of intonation contour on babble. (See Bloom 1973.)

Now, if there is not an invariant association of function with contour, how is it possible to verify the claim that the contour has meaning for the child as well as for the adult? To some extent it seems to be possible to pick out qualities of the gestures which accompany the child's babbling and also carry the modulations of 'wanting' from begging requests to imperious demands. But interpreting gestures is not easy, and there is really more than one axis of modulation involved here (see next page).

Fortunately, in the present case, the task is simplified as a result of Jacob's agreeable habit of requesting, rather than demanding, the things he wanted. In other words, he used rising contour in almost every instance in which the function of his utterance was the obtaining of some object or service.

Given this fact, we could take the formal characteristic of 'being expressed by a rising intonation contour' as basic, and divide Jacob's utterances primarily into rising (non-falling) versus falling. But we would miss the fact that there is really a range of utterances accompanying reaching for objects, most of which are rising and seem ingratiating, others of which fall and which seem more peremptory, bossier, to the listener. Jacob was polite: he favored rising utterances in the behavioral categories of greeting, offering, and requesting. He used falling contours mainly for noises that accompanied ongoing action on an object or to mark completion of action. However, it is still the *function* of the utterances as evidenced by the concurrent behavior that makes the most coherent basis for classification, since all three of the categories (greeting, offering, requesting) can be modulated along the same spectrum of demandingness from very peremptory to very supplicating (as judged by adults).

I have hypothesized that there are variations in gesture style covarying with the vocal variations, but I have not been able to test this because there are confounding variables, such as the fact that Jacob sometimes appeared to be playing at being bossy, rather than seriously being demanding. (This was called to my attention by Klaus Witz.) This playfulness modified both gesture and vocalization in a way that I have not been able to specify.

As I have just said, demand and request are closely related in the behavior of adults as well as of children, despite the fact that linguistic analysis does not bring this relationship out clearly.

There is a behavioral continuum between 'She told him to' and 'she asked him if he would' which is modulated by considerations of dominance and politeness. In the analysis of the rules of discourse associated with the work of Grice (1957) and Searle (1965), the request for information is the basic question; in English those utterances whose syntactic form is the yes-no question are the basic occasions for rising intonation contour. Both offers and requests for objects are formally derivable from requests for information, but demands are formally very different from requests and have nothing to do with questions.

This analysis is demonstrably of great utility and elegance in describing the syntax of requests and offers, but it is inappropriate for the analysis of Jacob's use of intonation contour. One reason for this is that general information exchange was not a basic category of Jacob's early language. He was concerned only with very specific kinds of information: about what people will and won't do for him or allow him to do, and a little later, about what objects and actions are called.

I think this is a good example of the sort of situation in which modes of linguistic analysis well adapted to account for the use of syntactic devices in adult language are not appropriate for child language. Early child language must be approached primarily in terms of behavioral categories, just as adults in the real world dealing with children's attempts at communication seem to interpret what the child means by what he/she does.

But the dissimilarity in the way adults go about understanding children's use of intonation contour and the way they understand other adults is by no means as great as I have just made it seem. A certain amount of use of intonation contour on non-verbal vocalizations is common among English-speaking adults. When we wish to consider the way in which a child's vocalized contour carries meaning, adult use of a similar mode can be tried as a first approximation, for adults use more than the child's actions to interpret his/her meaning. They also use some type of analogy with adult use of language. Nowhere is this more evident than in the way adults believe that they are able to characterize children's utterances as demanding or requesting depending on the intonation contour alone. We shall see in the next section that there are cases when the analogies by which adults interpret children's utterances may in fact not be correct, but consideration of adult interpretation of intonation contour on vocalizations does give us information about what the child *conveys*, if not what he/she *intends*.

Consider, then, the difference between nudging your friend while you are both reading a movie advertisement and saying 'Mmm?' or saying 'Mmm.' The first is a suggestion, the second a recommendation. The

contour carried the contrast. And this is so in spite of the fact that the verbal paraphrases of the rising contour by no means all have terminal rises. They may, if they are yes-no questions in form: 'Do you want to see this one?' or 'Does this one look good to you?'. They may instead have the terminal fall-from-high of the Wh-question: 'How would you like to see this one?' 'What about this one?' Although an *Nnnn* contoured like a Wh-question cannot function as a question, there is nevertheless one important intonational property that Wh-questions and yes-no questions share: if the preterminal high of e.g. 'How would you like to see this one?' is suppressed, the question changes mood. I would not attempt to characterize this change of mood without experimental study, but I think it is essentially the same as the way that a syntactic yes-no question changes mood if the terminal rise is suppressed. In both cases, the rise is essential to a normal sincere question.

There is a 'natural' character to the map: rising versus falling → $\left\{\begin{matrix}\text{requesting}\\\text{offering}\end{matrix}\right\}$ versus demanding. Although bald claims of naturalness are always to be regarded with suspicion, I will rest this assertion for the present with the reader's intuition, and return to it briefly in the next section.

We can adduce some independent evidence that the demand/request differentiation is not only in the adult's interpretation of Jacob's utterances. It really is the rising contour and/or its high termination that is carrying a message for Jacob. We can also argue that since that same thing seems to be true of whines, the use of a rising-to-high contour when one wants something is probably indeed a primitive and natural use of intonation.

In general, we can take as a working principle this statement: if a signal A is not responded to, and an apparent repetition B of the signal A is sent with certain marked properties of A intensified in B, then those properties are (other things being equal), the essential information-carrying features of A and B from the signal-sender's point of view.

Paula Menyuk's student Mavis Donohue was the first to note such a sequence of signals in one of the Jacob tapes: at 15:3 a first request vocalization (# RH 7 in table 5.6.) rose from 480 Hz to 575 Hz, got little response, and was followed by another vocalization (# RH 8, same table) of about the same sound which rose from 560 Hz to 820 Hz.

If we look at a sequence of whines from a videotape by S. Haselkorn from 13:24, we find a similar intensification of signal. The first of the whines peaked at 600 Hz and then fell; the second rose to over 900 Hz and did not fall. (An amplitude measure was available for those, and the second whine was no louder than the

first.) It would seem, then, that rises to high pitch carried the message in this whine sequence as they did in the request sequence from the later session.

5.3 Marked contours other than rising contours

It will be recalled that Jacob's very early (12:17) high pitch while hiding his eyes, although not carried by any recognizable phonetic shape, was clearly the reflection of an adult pitch pattern associated with this very specific game. In Jacob's general experience, since English is not a tone language, regular association of a pitch pattern with a specific word was rare, so we have no way of knowing whether Jacob's uniform use of the very unmarked falling or rising-falling contours on his early words was because he heard them that way more often or because such contours are (presumed to be) more natural, easier to say. Wherever the truth of this matter lies, the eventual appearance of rising contours on words was very conspicuous. In most cases (in all cases of active use) rising contours on words were only found following instances of those words in his output with falling contours. Words made their initial appearances with rising contour only as shadows or imitations, most frequently in cases where the model word had just been said with a rise, e.g. L. 'Wanna put the beads in my shoe?' J. 'shoe?'. Such rising contours did not show up when Jacob tried the words again, note that he had not made the mistaken conjecture that, for example, the word 'shoe' was always to be uttered with a rising tone.

5.3.1 Marked contours associated with specific words and proto-words

The only marked contour besides the early 'peekaboo' which was firmly associated for a time with one proto-word was what I have termed a 'demonstrative contour' a mid-high-low (— ‾ _) pattern, on the phonetic string ɛ̄-sə̂ which appeared at 16:19. This seemed to be derived from the adult's attention-directing 'What's that?' which was frequently used to point out objects to Jacob, with the hope that perhaps he would respond with the name of the object.

Jacob used 'ɛ̄sə̂' for two distinct purposes. First, as mentioned in ch. 2, it was his response when a police or fire siren sounded (frequent occurrences in Central Square, Cambridge), and was uttered with an alert, 'listening' look on his face but no associated gesture. In this use it was taken to be his word for 'siren'.

Second, 'ɛ̄sə̂' was something he said while pointing to objects. In the first days of its use, this demonstrative word, despite its sounding like 'what's that' to anyone who saw the pointing gesture

that accompanied it, was NOT being used by Jacob to elicit names. The evidence for this is that Jacob did not stop to listen to the adult's response, nor did he repeat 'ɛ̃sə̀' if the adult failed to answer him. However, by about 16:28 Jacob stopped just jabbing his finger at things and saying 'ɛ̃sə̀'; he began to act instead as though he expected adult vocal responses. He would not have had to arrive at this point by first gaining a deeper understanding of what adults are trying to elicit when they say 'what's that', though he may of course have done so. He could have learned to expect adult vocal responses from 'surface' experience, because he almost always got an adult answer to his 'ɛ̃sə̀' + point whether he waited for it or not. He had plenty of opportunity to learn to expect adult vocal response to his behavior, and thus to learn to use 'ɛ̃sə̀' + point when he wanted to get an adult to talk to him.

Later (17:27) 'zɪ̀' (from 'what's this?', possibly) with a high-low contour was also used as a name-elicitor alongside 'ɛ̃sə̀'. An interesting further development which needs study was that Jacob used the demonstrative high-low on some labels, although the adult models for those labels which were sampled did not have this contour.

5.3.2 Use of intonation contour in 'conversational' babble

I have found one other very interesting use of a distinctive intonation contour, which appeared on many occasions after the first attested occurrence at 15:22, about a month before 'ɛ̃sə̀'. He used the adult English hesitation-vocalization 'er..,', uttering it, as adults do, on a sustained mid-tone, with eyes averted down and sideways if he had been facing his addressee, and then launching into a babble-conversation, usually returning his gaze to the addressee. We shall return to a consideration of the lessons to be drawn from this marvelous assimilation of adult conversational patterns later in this chapter.

Finally, taking us away from intonation patterns per se into wholesale imitation of adult speech behavior, there are Jacob's 'telephone conversations', (some of which are video-taped), complete with greeting, pauses, and laughter, which took place at a time when it seemed quite clear that he had no idea that when people talked into telephones, there is someone that they talked to.

5.4 Development of the 'request' category through time

What did Jacob ask for? First, for things; and immediately we see another functional continuum where syntax must treat of discrete categories. Requests whose goal is that Jacob get his hands on some

object may be requests to help Jacob get the object, requests for permission for Jacob to have the object, or both. For the adult listener and for the child, whether it is aid or permission that the child wants depends on physical circumstances and past history. (English, despite grammar teachers, reflects this continuum in the systematic ambiguity of the modal 'can': 'Can I have it?' is ambiguously a request for permission or physical aid, and pragmatically may be both.)

Jacob, at the age of 1 year, certainly understood the distinction permitted-forbidden very well indeed, and there are clear videotaped sequences in which he checked to see if a novel game he invented, e.g. dropping a pencap from a height, would be permissible. It would certainly be overinterpretation, then, to decide that a request directed at an object beyond Jacob's reach was exclusively a request for help. It might have been a request for permission, and it was pragmatically both.

At 13:22 we find Jacob using rising-toned babble to request actions on objects, handing to adults such familiar items as music boxes to be wound or beads to be connected (compare absence of such behavior in novel situations: see supplement); at 14:3 he requested help in climbing onto a chair, and at 14:17, after being told not to do something, he responded with questioning noises that, in context, were both requests to be allowed to do it anyway and what one might consider questioning the prohibition ('Do you really mean NO?'). At 14:21 a rather different type of request was attested: Jacob performed an action, then turned to an adult with a rise interpreted as a request for recognition or ratification of his accomplishment. (He was quite used to having his feats celebrated by an audience.) Related to this use, but also probably a step on the way to the later requests for information, at 15:5 Jacob seemed to be using a rising babble to ask if the object he had picked up was the one he had been asked to find.

Backtracking a little, another type of rise which may be related to the requests and also to the curiosity noises is attested after 14:17. Like the curiosity noises, it differed from requests in not apparently being directed at a hearer. These rising contours were uttered when Jacob was having difficulty getting an object to 'work' -- before he got frustrated with it or handed it to a helpful adult. Watching him, one reacted to these utterances as if Jacob were saying to himself 'What's the matter with this?' Jacob could have developed this pattern, it seems to me, either as an extension of uses of rising contour that he already had, or by watching adults talk to themselves about recalcitrant objects.

For Jacob, the commonest early spontaneous rises on words were not requests for objects, as might be supposed, but the meta-linguistic use, questioning whether a word applied to the ongoing

situation, described above (p. 187). The first clear examples, at 15:11, have Jacob saying 'roll?' while watching an object roll, and later [oioi] in the same circumstance.

Jacob's use of a word with rising contour to ask for permission to turn a knob on the tape recorder was first attested on 15:11 also along with what seemed to be a new use of rise on babble carrier, apparently requesting his hearer to talk to him about an object. This last category, after a while, became very important as name-eliciting behavior, but when it first was attested, it was a small item in Jacob's repertoire.

Between 13:22 and 15:16, then, Jacob developed a rich variety of uses for the rising contour. It is impossible to say how closely the order of attested appearance might reflect an underlying sequence of stages of increasing competence. Presumably time lags of sufficient magnitude are significant indicators that certain uses of intonation contour belong to more advanced stages of development than others, but we do not know what constitutes 'sufficient magnitude'.

Further elaborations seem less like new categories than new applications of old categories, although this remark is probably more a matter of my temperament than the nature of the data. I will conclude this subsection by describing the most prominent of these elaborations.

At and after 16:5, there are long sequences of mostly-rising babble as Jacob led me by the hand to a place where there was something that he wanted, but could not get himself. By 16:14, invitations to share attention to an object were taken by adults as name-eliciting efforts, even though it was not until he was nearly 18 months that Jacob actually made it clear that naming was what he wanted. However, since the rises-which-are-interpreted-as-requests-for-naming are attested from about the same time as the rises on words which seem to be requests for confirmation of predication (15:11), it is quite possible that the intuitive adult reaction is the correct one; at any rate, Jacob obviously knew by 15:11 that things and actions have names which adults sometimes would model for him.

Another rising-tone use can be viewed also as a request for shared attention and/or adult conversation: when Jacob attended to an event such as a noise in the hall and directed rising-contour chatter at an adult. Extended chatter of this sort arose when he kibitzed the setting-up of recording equipment, where perhaps he had also some hopes of being allowed to touch the machinery.

The last elaboration noted of the request category is that the category of request for confirmation of predicate developed a little time-depth. Thus, at 17:27, as noted in ch. 2, Jacob observed his

father getting ready to leave the apartment and said 'Bye-bye?' ([dɛ̄ dā]), to which his father immediately responded, 'Yes, I'm going bye-bye.'

5.5 A problematic use of rising contour

One group of rises is harder to interpret, presumably because they seem less like adult usage like requests, offers, greetings, and curiosity noises. Jacob, at various times after 14:19, occasionally shadowed or imitated a word with rising contour, as we mentioned near the beginning of section 5.2. Why did he do this? When the word had just been modeled for him with a rise, one suspects 'mere' imitation, but sometimes the word had a fall in the model (e.g. L. I found my book. J. uk?). I suspect, but cannot demonstrate, that these were cases in which Jacob was imitating some of the *form* of adult conversation; in section 5.7 we will see a clear and startling example which must be interpreted as imitation of conversational dialogue form.

5.6 Instrumental results from the first three months: subclassifying 'rising' contours by pitch

The number of taped utterances from early sessions whose function is clear is not as large as one would like, though more will eventually be recovered from analysis of videotapes. Nevertheless, preliminary instrumental analysis strongly supports some unexpected findings, and one is of major importance.

A preliminary sampling of early taped rising utterances of good sound quality whose functions were clear seemed to show that there was a functional distinction between those which peaked under 450 Hz and those which peaked over 550 Hz. To see if there was indeed such a contrast, I collected as many additional rising utterances with clear function as I could from the period from 13 to about 15 months; this is not the complete set from that time period because exhaustive transcriptions for all sessions have not been made. Some of the falling utterances from this period were also measured. We shall see that a pitch-peak range contrast does indeed exist, and that it was probably present even earlier in Jacob's speech, say by 13 1/2 months, even though there are only a few measured attestations from that time. By 15:3, we can consider 34 samples, for which we shall set up the following types: Rising-Moderate-Short, Rising-High-Short, and Falling, all under 400 msec and all first attested by 13:6, and two categories of utterances of longer duration, Rising-Moderate-Long and Rising-High-Long, lasting over 650 msec. (The duration distinction is not as clear as the pitch-peak distinction and we will not pursue it in the present account. All the Falling utterances were Moderate in pitch with one exception.)

Let us tabulate these utterances, their pitch maxima, and their functions; all of these were on babble carriers unless noted. (It may be that the babble carriers had some constraints of interest on their articulation, but only very local effects -- persistence of a phonetic shape over immediate repetition -- have so far been discovered.)

Table 5.1 Pitch maxima of utterances of various functions

Utterance No.	Age	Function	Maximum pitch (Hz)	
		Rising Moderate Short Utterances (mostly 400 msec)		
RM 1	12:26	offer	250	
RM 2	13:3	offer ('thankyou')	220	(level)
RM 3	13:3	free conversational babble	340	
RM 4	13:6	query, empty room	380	(450 msec)
RM 5	13:6	"	380	
RM 6	13:6	"	340	
RM 7	13:13	initiate conversation	300	(500 msec)
RM 8	13:20	query, empty room	440	
RM 9	14:28	request adult play game	310	
RM 10	15:3	request adult act on J ('down')	360	(compare RM 9, RM 10)
RM 11	15:3	direct adult attention (first part of sequence of two syllables; second of the syllables was utterance RH 11)	380	
		Rising High Short Utterances		
RH 1	13:6	wants object	900	
RH 2	13:13	"	660	
RH 3	13:20	"	1000	
RH 4	14:24	"	880	
RH 5	15:3	"	600	
RH 6	15:3	" (RH 5 and RH 6 are the first and last syllables of a long sequence uttered while J was straining after an object; some syllables may have been lower, some whiny)	1100	
RH 7	15:3	wants object	575	
RH 8	15:3	" (second request for same object as in RH 7)	815	
RH 9	15:3	request adult act on J	950	
RH 10	15:3	" (second request for same action as in RH 9)	910	
RH 11	15:3	direct adult attention (second part of sequence of two syllables; first of the syllables was utterance RM 11)	840	

Table 5.1 continued: Pitch [illegible] of utterances of various functions

Utterance no.	Age	Function	Maximum pitch (Hz)
		Rising Moderate Long Utterances (650 msec)	
RML 1	13:24	greeting	375
RML 2	13:24	"	340
RML 3	14:29	free conversational babble	400
		Rising High Long Utterances (650 msec)	
RHL 1	13:24	wants object	940
		Falling Short Utterances	
F 1	12:26	greeting	340
F 2			380
F 3	13:3	free conversational babble	300
F 4	13:6	greeting	340
F 5	13:13	echo label of object being played with ('tape')	660
F 6	13:13	narrate action ('down')	300
F 7	13:13	" "	370
F 8	13:13	" ('thankyou')	300

(Note: compare F 8 and RM 2, where the same situation, so far as I can determine, is called 'offer' rather than 'narrative of action' solely because the intonation contour rises in RM 2 and falls in F 8)

Although only a few measurements have been made on falling contours on words beyond 15 months, it seems to be the case at this writing that the moderate-falling-short contour became the norm for all narratives using words.

A pattern emerges clearly from these lists, although there are 'bad' points indicating the need for more detailed study: If an utterance was babble when Jared wanted an object or wanted an adult to act on him, it was high-pitched and rising. The whines that have been studied had the same purpose and pitch range, but tended to be long and of course had the characteristic very nasal 'strained'

voice quality. If an utterance was a word and/or primarily a matter of social interaction, it was moderate in pitch, very little above my usual pitch in speaking to Jacob (which ranged up to 500 Hz peaks). Note that between 13:6 and 13:24, the short-falling greeting was apparently replaced by the long-rising greeting, but the pitch remained moderate.

Grossly, when Jacob wanted an object, the pitch range was like that found in whines, maxima from 550 to 1100 Hz (possibly higher); when he was being sociable, the pitch range approached adult conversational pitch, or at least the pitch of my voice as addressed to him. This dichotomy opens up fascinating speculations about the increasing socialization of the child's communicative repertoire as reflected in his/her choice of pitch range. Jacob had learned, it seems, something about how people talk: what absolute pitch range they use, and, like the rest of us, when his primary motive was being sociable, he used a code more similar to the code of his addressees than he did when he was using people as 'instruments' to obtain his personal ends (see Bates, Camaioni, and Volterra 1975).

This handsome interpretation of the data is wrong in at least two ways. First of all, personal vs. social motivation is not a dichotomy, it is a polarization with a continuum, a 'squish', connecting the poles. Sometimes Jacob not only wanted something, he wanted a particular person to do it/get it for him, and sometimes, as when he wanted an adult to play a game, his 'part' in the game (rolling a ball) required an object as a prop. Secondly it is not at all clear how to treat the two-part demonstrative utterances like the one split up as RM 11 - RH 11, in which Jacob was directing my attention to a scene. Demonstratives are at least as much social as object-oriented. The moderate-followed-by-high sequence could represent a simple compromise of 'personal' and 'social' range, but there are insufficient data to support this conclusion at present, and it would be amazing if things were really that neat.

The personal-social classification began to show signs that it was undergoing reorganization after Jacob reached 16 1/2 months. Of course, we have had to deal with one loophole in it already: since Jacob became able to use words for requests, we have noted that even when those requests were 'personal', Jacob's pitch range was moderate rather than high. I have suggested, contrasting RM 10, on the word 'down', with RH 9 and RH 10 (all three utterances being part of one long conversation in which Jacob wanted to be helped out of a chair at 15:3), that Jacob, in adopting conventional words, also adopted the moderate pitch range that goes with them. This explanation is strengthened by the fact that in the conversational sequence just mentioned, the actual order of Jacob's utterances was RH 9 (peak at 950 Hz), RH 10 (peak at 910 Hz), and then RM 10 (peak at 360). If

Jacob's selection of pitch range was a simple reflection of urgency and tension on his part, it would be unlikely for a third instance of a request to be less urgent than the first two.

After 16 1/2 months, we find evidence of a much more radical departure from the simple early pitch classification. It is interesting to note that the breakdown occurred in the demonstratives, which were always something of a problem to account for. This departure came with the word 'what's that' or 'ẽsa', discussed above in section 5.3.1. It was always uttered with the same mid-high-low intonation contour, which was obviously modeled on the adult English demonstrative. Although it was a word modeled on English, on all the nine cases which I measured the peak was over 450 Hz, and on 16:28 it twice peaked over 900 Hz. All other words had been in the moderate range. The low and mid segments, however, were always below 450 Hz. Now there was no way in which the whole utterance could be classified in function just by looking at its pitch maximum. The high-moderate contrast which encoded utterance function at an earlier stage was not sufficient to describe 'ẽsa'. Jacob had begun to use a marked contour of a highly conventional origin for a very specific purpose, and to realize that contour by going outside the bounds of his earlier classification scheme. We have come to the point where a truly linguistic account of that contour -- an account in terms of linguistic high-low contrasts -- must supersede the purely sociolinguistic account of Jacob's use of intonation contour which served well in the period up to 15 months, and which of course serves in accounting for some aspects of language acquisition and use throughout a speaker's life.

5.7 Learning the meaning of adult intonation contours in the early months

5.7.1 Conversational turn-taking

We have said that Jacob knew, by the beginning of this study, that his utterances and gestures could get adults to do things for him, and during the time he was observed, his ability to specify what he wanted grew steadily. He began to almost always use rising contours for utterances in which he wanted an adult to do more than share a focus of attention, while on the other hand those proto-words and words that accompanied ongoing activity usually showed falling contours and were interpreted as narratives, declarative in mood, by adults. We correlated Jacob's use of marked intonation contours with various functions of utterances, but said that he also used a variety of intonation contours in babbling, just as he had control over some segmental phones which appear both in meaningful utterances and in babble.

Let us now consider how Jacob could have learned the meaning of these contours. To begin with, we must recall that Jacob sometimes learned to produce appropriate-sounding utterances in a very surface, parrot-like way, as in his elaborate telephone conversations (14:3 on). And in some cases, as in the use of the hesitation-vocalization 'er...', we can conclude that Jacob was a careful student of the surface formal properties of adult speech. The startling character of his correct use of certain conversational patterns in which it seems impossible that he had understanding of the 'content' of those patterns suggests that we seriously need to study the form of conversational turn-taking. I do not mean a syntactic study, but a study of the gestural, intonational, and tone-of-voice clues that could be apprehended by an observer who can understand few words but who does understand some of the social functions of speech.

The increasingly finer mastery of conversational form without understanding the meaning of words had its most amazing moment, in my opinion, at 16:12. On that day I was talking to myself although addressing Jacob, and in a rather sad voice made the following negative remark: "Phonemics just doesn't make sense with babies your size." (At this point I kissed him.) To this Jacob responded, "No? [dõ]," and I, without realizing that anything odd had taken place, answered him "no." He was, at this point, able to pick out negatives well buried in statements (e.g. I don't really think you should do that), and he must have learned that a negative statement can be responded to with a negative question (You don't?).

We find continued examples, after this point, supporting the conclusion that Jacob had learned certain patterns of the form 'If A says X, B says Y'. But we also have evidence that Jacob may not have been able to separate out conversational roles in this fashion in the early months of this study. The first evidence that he did possess that ability in any context of activity was at 14:3, when Jacob responded to being given an object by a babbled mid-falling-to-low contour which sounded like a 'thankyou'.

It should be emphasized that there must be a long development after the child's first glimmering that different speakers may be supposed to say different things. Note that in early two-party conversation exchanges, both parties are supposed to say the same thing: 'bye bye', 'hi', etc. Early eliciting by adults expects children to say just what has been said to them, perhaps minus the command 'say'. Conversely, we know how late the mastery of deixis is. A child who has solved the problem of which parties to a giving-transaction say 'please' and which say 'thankyou' is still likely to be asking to be lifted by saying 'carry you' or to be cuddled by saying 'sit on my lap'.

5.7.2 The 'naturalness' problem in studying learning of intonation contour

When it comes to trying to decide what Jacob had learned about the use of intonation contour in conversation, we have an additional source of complexity. Some aspects of the use of intonation contour are certainly 'natural', although others are language-specific and can override natural tendencies. Furthermore, our mammalian heritage (at least) probably gives us an innate predisposition to associate high pitches with small or infantile creatures and low pitches with large powerful creatures. As Mark Liberman has suggested to me (and see Liberman 1975), a rising or high-pitched termination may generally signal, in the ongoing interaction, the speaker's assumption of a subordinate position, waiting for the addressee to take the floor. However, as we remarked in the preceding section, this signal does not surface in most uses of the English Wh-question, which has a terminal fall, and is presumably subject to a host of other classes of exceptions. The expected presence of counterexamples makes assertions of 'naturalness' in language very difficult to test, and much nonsense has been spouted on this topic; I shall be very conservative in my use of the notion, and try to err on the side of assuming that almost everything is conventional rather than natural.

5.7.3 Learning to request: the 'offer-elicitation' hypothesis

Recall, then, that characterization of a child's vocalic signal accompanying a reach as a 'demand' or a 'request' depends largely on whether it falls or rises, although tone-of-voice is also relevant: whiny rises do not evoke the characterization 'request'. We have said that Jacob seldom demanded and rarely whines; he requested things and actions. He could have gotten what he wanted, as far as I can tell, by demanding or whining, and there are other accounts in which children most usually get their way by whining. (Greenfield, Smith, and Laufer, to appear). How did Jacob come to request things? The contour itself may be a natural one to use, but demanding and whining are also natural behaviors.

A particularly illuminating incident observed by Haselkorn (per. comm.) during an interview session in a Hebrew-speaking household suggests an important possibility, although it did not involve intonation contour.

The mother being observed typically accompanied the giving of snack food to the child by saying /kʌx/ 'take'. The child, on the observed occasion, after attempting to get a cookie by naming it (not very distinctly) and failing, said [kʌx]; his mother accepted this as a request/demand, and the child got his cookie.

The child here knew that a certain syllable was characteristically associated by his mother with an action that he wanted her to perform. In the context, he was clearly using that syllable instrumentally to get her to perform that action. [kʌx] was, for him, a handle on the situation -- but from observation, we cannot tell how crude a handle. Did he know that [kʌx] is what the donor is supposed to say, so that he was extending its meaning in using it instrumentally? Or was the syllable, for him, attached to the food-giving interchange as a whole, without regard to whether the donor or the recipient says it? (The problem is reminiscent of the question of object-naming, as in the well-known discussion by Roger Brown (1958)).

We may compare this report with Jacob's use of 'thank you', his first proto-word, which we have already discussed in chapter 2. As we there remarked, it is by no means an idiosyncrasy of Jacob's that he used 'thankyou' to accompany his giving an object to someone, although adults never modeled such a use for him (e.g. in an attempt to get him to say 'thank you' when he was given something). The conservative assumption is that until Jacob stopped saying 'thank you' *while* giving (about 18 months), he had not finished figuring out that ONLY the recipient says it; furthermore, we should also consider it very likely that when Jacob started to say 'thank you' some time before 12:8, he had no idea that there might be a difference between what the donor says and what the recipient says. The only alternative possibility is that he knew that it was properly the recipient's speech, but that he was using it instrumentally to get the addressee to participate in a giving-game with him.

We must likewise consider the possibility that Jacob's use of rising contour when he wanted something, (of requests, in other words) derived not (or not only) from watching adults request things, but also from an adult behavior that involved him more directly: what adults say when they offered him things. Jacob could have used a rise-when-wanting the same way that the Hebrew-speaking child cited above used a word which accompanied giving to elicit giving-behavior from his mother; he could have been using the sound-that-accompanies-offering in order to ELICIT offering. (We might find some support for this 'offer-elicitation' hypothesis from the fact that Jacob's use of rising contour in offers was attested two weeks before use of rising contours on requests, while there was an attested high-with-terminal-fall 'request' about halfway between these occurrences. But presently, as I have said, I have no way to determine whether such time lags are great enough to be taken as symptoms of an underlying change in Jacob's knowledge of the use of contours -- in this case, as indicating competence in using 'offering' contours before competence in using 'requesting' contours.)

Our hypothesis now is that Jacob requested because adults offered: 'Do you want some toast?' 'Wanna get up?' 'Shall I make you a tower?' 'Wanna knock it down?'

Whether this happens, in general, I believe, will be quite specific to the personality of the child and his/her caregivers, the cultural milieu, and the physical setting of the interactions. Jacob was, at least during the taped sessions (and usually, as far as I could tell), attended to by adults who were not trying to accomplish very much while they were looking after him: he was either the only child present or one of two. He was an easygoing child who could take 'no' for an answer rather well unless he was tired, and was willing to cooperate in being dressed and changed (rather more likely to harass his mother than his sitters). Adults became accustomed to his good will, and spoke to him in modes that presupposed that he was willing to cooperate unless he demonstrated that he was not. If he had been more rambunctious or more passive, or if the caregivers were busier or had had a different cultural set about how to address children, there might have been a significant shift in the intonation contours typically addressed to him -- in particular, many of the offers to entertain him ('Shall I wind it for you?') might not have been made at all, and the offers of service ('More egg?') might have been imperatives ('Eat some more egg!'). This is not to imply that Jacob heard no imperatives; on the contrary, there were a good many, but they were mostly cease-and-desist orders, not attempts to get him to do something.

Cross-child and cross-cultural study could test the general hypothesis that has been developed here: the form of the young child's early *asking* behavior is principally determined by the form of offering behavior of his/her caregivers.

5.7.4 Rising contours on 'adult babble' and on Jacob's free babble

There is one other group of rising contours for which an adult model of some theoretical interest may be hypothesized for Jacob's output. As the reader will already have noted, Jacob heard rhetorical remarks whose purpose was usually obscure to the utterers themselves. Many of these were questions: 'Where are your socks?' 'Do you think it's gonna rain while we're out?' 'What's your mama's phone number?'. Some of these, heard on tape, clearly function as word-teaching: 'where's your socks?' may be followed by further chatter in which the word 'socks' is repeated in several frames. But the more complex ones are very much a sort of babble from adult to child, phatic utterances whose communicated content is something like 'you are here and I am here and I know that you're here'. What also is evident is the friendly affective tone of all this. I suggest that the great amount of rising-contour on Jacob's free babble may derive from all the rising contour on the chatter that he heard.

5.7.5 Rising contours on adult elicitation of performance

Let us conclude this chapter by looking at another use of rising contour addressed to Jacob which undoubtedly played some part in his early learning of the function of these contours, even though I have no specific suggestions as to where that knowledge may have showed up in his output. This is a use of rising contour that I had never thought of until I heard myself using it on tape. Menyuk (pers. comm.) however informs me that related types of verbal behavior are used by other caregivers.

It seems that when I demonstrated a verbal pattern that accompanied a motor ritual action to Jacob, I gave it as it would normally be 'performed': 'Bye-bye', 'Clap hands', 'Peekaboo', 'Nice kitty'. However, once Jacob picked up the motor set associated with such an utterance, I began in some cases to use the verbal part with a rising contour as a way of eliciting a performance of the motor act from him: 'Clap hands?' 'Wanna play peekaboo?'. A sample interaction from 13:6 runs:

L. Nice monkey?

L. Nice monkey?

(J. pats toy monkey in his lap)

L. (approving, providing vocal accompaniment to J's act):

Nice monkey. Nice monkey.

5.8 Apology and conclusion

This chapter represents only a beginning of the study of the data on intonation contour in the corpus, both for Jacob's speech and the speech of his caregivers. I have studied and presented those topics which have become salient to me, and have left for future work topics which should prove to be of equal importance. In particular, as the reader has seen, I have concentrated on the early months, trying to push back as far as I could toward the time of emergence of meaningful contrast in intonation contour.

I want to pause in concluding this chapter and point out some of the major topics which have NOT been pursued. One is the general evolution of intonation contour on 'free' babble. My subjective impression is that free purely phatic babble was much richer in

variety and length of intonation contour than babble directed instrumentally towards an end. Study of free babble would reward us with a much better picture of what Jacob knew about the outer form of sociable conversation.

Then, as words became increasingly important in Jacob's production, the free babble seemed to undergo great changes, presumably because Jacob was beginning to realize, in various ways, that adults were not babbling to him. The nature of these changes has not been studied at all.

The evolution of Jacob's use of intonation contour on words has barely been touched except for the onset of the mid-high-low demonstrative contour which turned out to be such an important example in establishing that there was an increase over time in the organizational complexity of Jacob's intonation system. We can expect that complexity to continue to increase, although we cannot tell in what way.

Even without instrumental analysis, it was possible to catalogue rising versus falling utterances and to discuss the way in which the functions of obtaining objects, greeting, and offering could be expressed by either. But with the instrumental analysis in the early months, we were able to make finer distinctions; it is possible that similar new contrasts will be discovered with the help of instrumental analysis of the period from 15 months on.

Instrumental analysis of caregivers' speech to and around Jacob should also reveal details of several different speech registers, from soothing nonsense through deliberate word modeling and imperatives that the child is expected to understand, and on through monologue-formally-directed-at-the-child, conversation between two adults jocularly directed at the child and finally real adult conversation that ignores the child.

Summarizing this chapter on the description and explanation of Jacob's uses of intonation contour: I have argued that while function should be the primary category for classification of the child's babbled utterances and early speech, there is no reason for there to be an invariant association of one intonation contour with one function. This may occur for given functions in a given child, but in general the use of intonation contour is correlated with the varying of behavior along a submissive-to-dominant continuum which can vary independently of the function of an utterance. Since this is the case, use of intonation contour by small children cannot be studied in any depth without the use of visual records, for about all that can be done from audio records alone is to classify the babbled utterances as interrogative, declarative, or emphatic, and that classification is inadequate for the study of what the child means by the use of intonation contour.

We saw that in Jacob's particular case, he habitually did use a rising contour to obtain material ends and social responses from adults, so that his semantic control of intonation contour on babble was easy to establish.

(We also established, in passing, that for Jacob there was a long period of overlap -- at least the eight and one-half months of this study -- when Jacob had started to talk but had not ceased to babble. This is contrary to assertions found in the literature; I think we really have no idea as to how much of an overlap is normal and what the range of variation is.)

Through instrumental analysis, a finer division of Jacob's use of rising intonation contour was discovered. This split was of totally unsuspected nature: he distinguished rising contours with high peaks (over 550 Hz, often up to 900 Hz) from rising contours with moderate peaks (under 450 Hz). The high-peak utterances were used on babbled utterances when this utterance was aimed at the adult-as-instrument; in other words, when he wanted the adult to give him something or put him somewhere. The moderate-peak rising utterances were words or else were sociable in purpose: greetings, offers, invitations to games, kibitzing noises.

This categorization did not work quite smoothly for Jacob's demonstratives, and after a while he began to use an entirely new contour directly modeled on the English mid-high-low demonstrative pattern. Even though this pattern was on a (proto-) word, the 'high' syllable of Jacob's demonstrative was in the 'high' pitch range, while the low and mid syllables were in his 'moderate' range. The older psychological-social basis for classifying the pitch contour of his utterances was inapplicable to the new contour; at this point he was beginning to change over into a truly linguistic system of pitch contrast.

We then discussed the problem of how children learn the meaning of intonation contours. We acknowledged that there was probably some innate component of the association of high pitch with weakness and low pitch with power, but beyond that there is a great deal for the child to learn. For one thing, the child might have to learn the fact that conversations are in general not 'symmetrical' -- usually the two parties are supposed to say different things. We saw evidence that Jacob might not have known this at 12 months, when he said 'thank-you' in giving objects -- at any rate, whether he knew it or not, it didn't seem to affect his actions. This observation opened the way for the following hypothesis concerning Jacob's use of requests instead of demands: he may have picked up on the rising contour used by adults when they offered things and services to him, and used it to them in turn in an attempt to ELICIT the behavior from them. It is

also possible that he learned to use requests from listening to adults request, however, and the hypotheses are not mutually exclusive.

Jacob did continue to learn more about the form of conversation, and by 16:12 demonstrated that he had indeed learned about conversational asymmetry, for at that time he responded to a negative statement (of which he could have understood only the fact that it was negative) by the correct sociable response, the negative question 'No?'.

We have a very rich set of behaviors here. There are intonation contours which are invariably associated with one word and, on the other hand, contours which can be used on both words and babble. We have narrowly-defined functions like 'greeting', vague ones like 'curious noises', and broad, subdividable functions like 'obtaining goods and services'. We have mastery of form without content (sociable negative question response to negative statement) and of function where the child's apprehension of the form is at least suspect (request contour; 'what's that' taken as demonstrative, which it functionally is, instead of interrogative, which it formally is). There is meaningless, purely phatic use of intonation contour on babble alongside of semantically controlled use of both contour and absolute pitch. In general, intonation contours develop uses on babble first and then appear on words, but the demonstrative contour appeared only on words from the time of its first use. We also have here an area of investigation that is at once highly accessible, because of the existence of computer methods of intonation contour analysis (F_o extraction) and the ease of obtaining fundamental frequency and duration information from narrow-band spectrograms, and highly problematic because our understanding of adult use of intonation contour is rudimentary.

One aspect of the acquisition of intonation helps it to illuminate the central problem of developmental psycholinguistics, the interrelation of the development of form and of function. Because the child seems to find accurate imitation of intonation contour rather easy, we get an especially good opportunity to concentrate on the deeper questions of language acquisition, those concerning the child's understanding of how to use language. We are able to observe clearly the fascinating interplay between the child's mastery of forms whose functions he/she does not fully understand and the attempts at using speech for functions for which he/she does not have a form readily available.

CHAPTER VI

Overview: Pattern, Control, and Contrast

How did Jacob learn to talk? What did he learn about speech communication in the months from 12:8 to 20:22?

He learned a great deal about both the form and the function of speech between humans. He learned that words have other-oriented and self-oriented instrumental functions -- that he could use them to get people to do things with him and for him. He developed vocalizations, both word and babble, as a means of initiating and continuing social interaction: greetings, conversational place-holders and responses, invitations to joint action. He also developed requests for help, permission, and information. He learned to use words for most of these functions, although at the beginning of the study his only 'word' had the sole function of accompanying his own action.

Control of intonation contour can be determined when some uses for some contours can be correlated with utterance meaning or function. Jacob's control of intonation contour on babble carrier and his ability to use it contrastively can be pushed back to about the age of 13 months, when he had only three or four protowords, and it may well have existed before then.

Jacob's striking ability and willingness to imitate -- or better, to emulate -- the exterior form of conversational interchange, suggests that the process of matching intonational form to function may involve the mastery of form as a first step, and then a gradual deepening of understanding of the function it serves in the ambient language.

While control of production did not seem to be a problem with respect to Jacob's learning the uses of intonation contour, the development of articulation was pervaded by the difficulties of accurately matching adult models. Jacob had to discover what articulatory gestures make what noises, and then he had to get this information under automatic control so that he could say words when he meant them without attending to the details of production. We might compare this task to learning to write in a new alphabet; at the beginning one draws the strange shapes carefully; later one can write the characters while not paying conscious attention to anything but their identity; after that one comes to be able to write a whole word without thinking of how to spell it.

I have deliberately used this analogy because I wish to draw attention to its peril, which reviews an important point of this thesis: words in the speech stream are Gestalten which the child must learn to analyze; they are not presented in segments analogous to the letters of an alphabet. The syllable seems to function as a unit of analysis for some children, but if Jacob used this mode of analysis, it was not as prominent as, on the one hand, his extraction of patterns that extended over two syllables, and on the other, analysis into segments. The front-vowel -- back-vowel pattern and the G_G_ pattern (see chapter 3) were patterns that extended over two syllables; the immediate use of initial [d] with several different vowels showed that the syllable was analyzed into segments.

For Jacob, vowels caused difficulty in the following cases: sequences of unlike vocalic elements in a word (either diphthongs or XVCVX sequences), and the learning of [ɔ]. ([u] also posed a problem, but there is too little evidence in that case to argue from.)

We have interpreted the difficulties with vocalic sequences as not lying in the vowels themselves, but in the difficulty of carrying out a sequence of unlike-vowel articulatory instructions. The problem with [ɔ] was partly in articulating it and partly in maintaining previously-established [o] as distinct from it.

The actual discovery of how to say consonants was delayed in a way that suggests they presented inherent difficulties to Jacob which were then compounded by the difficulties of producing sequences of unlike consonants. Furthermore, for consonants, the position in the syllable had an effect: at the end of the study, Jacob was still restricted to producing [b] only in syllable-initial position and [p] only syllable-finally.

In certain cases in this study, control (accurate production of a sound) developed before there was any evidence that there was output contrast: for example, the initial [d] in the first dV(N) words was recognizable as a dental although there were no velars or labials in contrast with it.

On the other hand, there are cases where Jacob seemed to be attempting to maintain contrast even when his control of a sound was very poor, as in the case of his learning [ɔ] and [b].

The analysis of the Jacob corpus that I have presented here I regard as a step towards what is called in Kiparsky and Menn a 'discovery theory' of the acquisition of phonology. This theory, unlike earlier ones, describes the acquisition of motor control of articulation and the appearance of rules of child phonology as

separate but potentially interacting developments. In the present work, this theory has been further elaborated on the basis of the evidence from Jacob. We have here found evidence for claiming that the acquisition of articulatory control is separate from the organization of sounds into phones and phonemes, although these developments interact.

In parallel with this dichotomy is its temporal 'horizontal' extension: we find the mastery of certain prosodic patterns and the organization of these patterns into small sets of canonical forms to be separate but interlinked developments. Organization can be manifested in the first attempts at a word, in the carryover of a segment or pattern already mastered to a new use. It can also be shown in the maintenance of paradigmatic gaps produced by avoidance of certain phones, and in the occurrence of paradigmatic disturbances in the existing phonemic system when a new phoneme is being learned. Finally, it is clearly visible in the consolidation of existing prosodic patterns.

Rules of child phonology are the systematic sound shifts characteristic of children's output as a result of carryover or consolidation.

The existing theories of the acquisition of phonology explicitly involve a high level of innate determination of the order and mode of acquisition, and the discovery theory ranges itself in opposition to this deterministic view. However, innateness is a most difficult concept (see Užgiris and Hunt 1975). There is a sense in which the structures of adult language are indeed innate: much of what we account for in linguistics must be a consequence of human biological parameters interacting with the a priori requirements of a communications system, just as human biology exerts profound constraints on baseball games and the design of furniture.

With regard to language acquisition, the innateness question is, in Slobin's words, a red herring. There are too many obstacles to deducing interesting consequences about language or its ontogenesis from consideration of what we presently know about humans and communication. For one thing, language might be very far short of a potential optimum human communication system. Another, more relevant to the enterprise at hand, is that the end state could be much more highly determined than the route by which speakers arrive at that end state.

A child must observe language in use and devise ways to understand it and employ it. Some biological facts, like the fast-fading auditory short-term memory, will restrict the child's options, and some, like the ability to discriminate fine details of sounds in the speech-sound range, will facilitate the task. Probably some modes of attack on language learning are more efficient than others.

Perhaps children avoid some of the conceivable bad ways of going about learning language because they are neurologically constructed to avoid them, but we have no assurance that they do avoid them. Perhaps some of them make some very bad initial attempts at figuring out what adults are doing when they talk, and the unproductive attempts are so fruitless that all we can see is variation in the age at which children start to talk. Or perhaps, if we look closely, we will see an ever greater variety of children's approaches to the task of learning language.

In synopsis, I think that the data and arguments of this thesis can be reduced to the following statements:

1) The functional development of Jacob's word was from ritual accompaniment of his own action towards flexible instrumental use of language for varied ends.

2) Formal development of phonology proceeded by the interaction of a) the establishment of certain articulatory patterns, segments and prosodies and b) the paradigmatic organization of those patterns into phones, phonemes, and sets of canonical forms. The 'unfolding' theories of acquisition of phonology of Jakobson and Stampe and the 'extraction' model of Olmsted are unable to account for the data; an interaction theory is required.

3) When there is meaningful use of intonation contour on babble, the primary information given by the intonation contour concerns the 'mood' of the utterance along a gradient from 'demanding' to 'requesting'; the function of the utterance is primarily communicated by gesture and physical setting.

4) At the age studied here, mastery of aspects of the exterior form and phatic function of conversational exchanges proceeds while comprehension of the information content of conversation is still very rudimentary.

SUPPLEMENT

Cognitive Development Testing

1. Discussion of interpretation of Užgiris and Hunt tests

2. Results of Užgiris and Hunt Tests administered by S. Haselkorn

1. Discussion of interpretation of Užgiris and Hunt tests

The ever-present danger in psycholinguistic studies by the psychologist is that he or she will underestimate the complexity of language acquisition in looking for an accepted doctrine of language development to work from; conversely, the danger faced by a linguist like me is the temptation to take a digested version of a leading and attractive psychological theory as True. Fortunately, my discussions with Haselkorn and the detailed data-based critique of Piaget in Užgiris and Hunt have prevented me at least from falling into the grossest variety of oversimplification, although I am sure that many subtler oversimplifications of psychological theory are present. The major oversimplification which Užgiris and Hunt warn against is the reduction of the description of a child's level of development to a single parameter, the parameter of belonging to one of a linearly ordered set of developmental stages. They repeatedly caution that progress in the separate areas or branches of development tapped by their several scales of tasks seems to proceed at different rates, "suggest[ing] that there may be more independence in development than a stage theory encompassing all of early psychological development would require" (p. 134).

It goes without saying that this warning should be taken especially seriously by psycholinguists attempting to correlate linguistic and psychological development. Furthermore, the present study, in which we have naturalistic diary observations and the test results, brings out another complication in the assessment of ability: spontaneous behavior which seemed to fit the description of an advanced stage sometimes appeared at a time when Jacob's performance on tests belonged to a less advanced stage. For example, Jacob had some games of pretending which a naive observer would certainly call symbolic play as early as 13:24, when his performances on the U & H scales were interpreted as appropriate to Piagetian sensori-motor Stage IV and V. Haselkorn and I presently have two lines of explanation for this discrepancy (both of which could be true simultaneously), and there may be others as well.

The first line of explanation is concerned with the intrinsic properties of development. The important point is that symbolic thought surely does not suddenly emerge from the child's head like Athene in full armor, and it would be a burlesque of Piagetian theory to ascribe such a claim to it. Compare: In chapter 2 we followed something of the evolution of Jacob's use of words and symbols. It was a long, slow process. Words did not make the transition from signal to symbol in a flock; for a while there seemed to be only one word, 'down', which had several possible functions. Later, the action words as a class could be used flexibly, but names of objects were still almost always found as pure labels.

I see the emergence of symbolic play and symbolic thought as likely to be similar, although there is simply not the breadth of behavioral observation in this study that would be required to defend such a claim. I mention it because it is suggested to me by the following sequence of informal observations: At 13:3 Jacob pretended to feed a toy giraffe some toast; at 13:15 Jacob pretended to feed both real people and toys with an empty plastic spoon; and by the end of the study he used a toy shovel for a spoon, an upside-down hollow toy duck for a dish, and not only 'fed' his toy animals with great care and precision but also handed me the shovel and gave me a pantomime sequence of instructions to put the shovel in the 'dish' and then feed several of his toys.

Surely one does not want to be forced into the position of saying that play-feeding became truly symbolic in such-and-such a week, nor can one make general statements about Jacob's ability to symbolize in general based only on his performance in the very familiar routine of play-feeding, which could have been far in advance of his general level, just as his first instrumental use of 'down' was ahead of his general linguistic level.

The other possible line of explanation for spontaneous behavior sometimes seeming so far in advance of test behavior is the depressing possibility that in spite of the care taken by U & H to devise reliable, replicable test tasks, and in spite of Haselkorn's generally successful attempts to establish comfortable relations with Jacob (who learned to greet her and her bag of toys very enthusiastically after a few visits), the novelty and stress of the test situation still caused systematic underestimation of Jacob's abilities. While this can never be discounted completely, I doubt that the tests are so seriously defective. Stress creates artefact, but novelty tests for general competence. There are diary observations which are completely in agreement with the test results. Those observations concern Jacob's reaction to novel situations that came up in our daily routine. For example, Jacob was able to indicate by a pantomime gesture that he wanted me to do something that I usually did

for him many times in the course of a day -- put together two pop-beads, yet when I introduced a new game of running a toy motorcycle up his leg and then stopped, all he did was lob the motorcycle at me and wait. He was apparently unable to give pantomime instructions in the novel situation.

I include these observations, unsystematic as they are, as examples of the difficulty one may encounter in trying to characterize a child's general level of cognitive ability in order to formulate and test hypotheses about the relation of cognitive to linguistic development. Hoping that I have now warned the reader sufficiently against the search for a magic number which fully describes the child's level of cognitive development, I also include, for the reader's convenience, figures derived from Zachry's (1972) analysis of the U & H scales with respect to the Piagetian sensorimotor stages. Jacob's performance across the four scales tested by Haselkorn usually straddled adjacent stages. This absence of a simple translation from U & H scale steps to a single sensorimotor stage is not likely to be due to any fault in Zachry's analysis, for Užgiris and Hunt observed the same phenomenon in a much more direct fashion when they were devising their test scales (p. 51): "...infants responded to most of the eliciting situations prepared by the examiner with one of the critical actions that Piaget had described. This permitted classifying their actions as indicative of one of his stages of functioning. The examiner used the narrative records to determine the sensorimotor stage which seemed to be most characteristic of each infant.....This initial classification, made by the same examiner who had observed the infants, depended heavily upon behaviors indicative of the general development of object construction and representation. It was noted that in other branches of development such as imitation or operational causality, the actions of a substantial proportion of the infants seemed typical of a stage either preceding or following that which characterized their general level of functioning defined chiefly by object construction. This observation suggested that perhaps development does not proceed at an even pace in all branches as implied by Piaget's stages."

2. Test results

There were seven testing occasions, at 13:23, 14:7, 14:28, 15:26, 17:2, 18:11, and 20:13. The test is divided into six groups of tasks, of which Haselkorn administered four: Scale I, The Development of Visual Pursuit and the Permanence of Objects; Scale II, The Development of Means for Obtaining Desired Environmental Events, Scale IV, The Development of Operational Causality; and Scale V, The Construction of Object Relations in Space. Scale III and Scale VI were omitted. There are a few cases in these tests where the issue

is the child's ability to perform some task without being shown how first. In these cases, the test items were presented to Jacob in such an order that no earlier task provided a clue as to how to do the task in question. In general, however, these tests are designed to be insensitive to order of presentation of tasks. Užgiris and Hunt approach the notion of the child's level of development in terms of whether the child can get hold of an idea and use it, and not whether it happens to have occurred to him/her prior to the testing occasion. They say (p. 53): "Since the aim was to obtain evidence in the form of clear implications from the infant's actions in the eliciting situations of specific capabilities and of specific construction of reality rather than to score the presence or absence of particular responses to standardized test items, there were no injunctions against repeating the presentation of an eliciting situation, against postponing it, or against modifying its non-critical aspects."

2.1 First test session, 13:24

Scale I, Visual Pursuit and Object Permanence

Jacob was able to find an object which he had seen S.H. hide under a cloth (performance 4b and 4d on Scale I Examination Record Form), to find an object which he had seen S. H. hide under one of two cloths without being confused by the presence of the second cloth (performance 5c), and on several (but not all) attempts he was able to find an object which he had seen S. H. hide under one of two cloths even when the hiding place of the object was repeatedly switched from one cloth to the other (6c, 6b). This is performance at scale-step #6 of the U & H object-permanence scale, and is considered by Zachry (1976) to be behavior belonging to Piaget's sensori-motor stage V.

Scale II, Development of Means for Obtaining Desired Environmental Results

Jacob, when he had an object in each hand, reached for a third object without letting go of either of the others and was thus unable to grasp it (performance 4a on Scale II); when he was confronted by an out-of-reach object resting on a 'support' (e.g. flat pillow) which he was able to reach, he persisted in trying to reach the goal object without using the support as a means of pulling the goal object closer (performance 6c); when an object was placed at a distance from him on the floor, he crawled after it to get it (performance 5c). When he was in a high chair and an object he seemed to be interested in was dangled out of reach by a string near his hand, he merely played with the string. Here, Jacob was at U & H scale step #4 on Scale II, which is at Piaget's sensori-motor stage IV according to Zachry.

Scale IV, Development of Operational Causality

Here, Jacob also performed at Piaget's sensorimotor stage IV, according to Zachry's analysis of the U & H scales; he was at scale step #2 of Scale IV. Specifically, he behaved as follows: When S. H. 'created a spectacle' -- that is, did something which aroused Jacob's interest, he did nothing which could be interpreted as encouraging her to repeat the action during her pauses (5b); when the 'spectacle' involved action on an object (blowing up a balloon), he tried to imitate her behavior (without succeeding in blowing it up) (behavior 6e, Scale IV), and when the action was winding up a mechanical toy vehicle, he only moved it across the floor manually when it ran down (performance 7b, Scale IV).

Scale V, Construction of Object Relations in Space

On scale V, Jacob's performance was a U & H scale step #3, interpreted by Zachry as also being at Piaget's sensorimotor stage IV. Jacob was able to recognize the reverse side of objects (5c, Scale V), removed small blocks one-by-one from a deep cup rather than pouring them out (6c); in imitating the building of a two-block tower, he did not leave the second object on the first (7b), and did not seem able to learn to use an inclined plane as a 'hill' for objects to roll down (8b). He sometimes looked to see where dropped objects landed (9b, c); he did not try to make detours around a barrier (a chair) to retrieve an object which was rolled beneath the barrier and to a point beyond it (10b).

Comparison with Use of Language

From the beginning of the study at 12:8 until the first test session at 13:23, Jacob was recorded as having used six (proto-) words: 'thankyou' in the 'giving' game, 'Jacob' in playing 'peeka-boo', 'no' and 'don't' while contemplating or engaging in forbidden behavior, 'there' when putting objects down, and 'toast' on one occasion, apparently a request.

13:23 Summary of First Test Session

	Scale I	Scale II	Scale IV	Scale V
step #	6	4	2	3
sensorimotor stage	V	IV	IV	IV

2.2 Second Test Session, 14:7

Scale I, Visual Pursuit and Object Permanence

Jacob's performance on this session was at U & H scale step /3, Piaget's sensorimotor stage V according to Zachry. He could now efficiently find an object hidden under a cloth in more complex circumstances: when he had watched it being hidden under one of three clothes lying next to one another (Scale I, performance 7c) or when he had seen it hidden under a pile of three cloths (Scale I, 9c). If he first saw an object hidden under one cloth and then saw it moved to a place under another cloth (successive visible displacement), he searched at random under the cloths until he found it (8d).

Scale II, Development of Means for obtaining Desired Environmental Results

Jacob at this second session performed at step #7 on Scale II, which Zachry places at Piaget's sensorimotor stage V. This time, when Jacob had an object in each hand, he put one down before reaching for a third object (performance 4c, Scale II); when he was presented with a desirable object beyond his reach which rested on a support within his reach, he first just reached after the object, but after he was shown how to get it by pulling on the support, he was able to do it for himself (6a and 6d, Scale II). When he was seated in a high chair and a desired object was dangled out of reach from a string near his hand, he seemed unable to recognize any way that the string could be used to aid him to get the object (9a and 9b).

Scale IV, Development of Operational Causality

Jacob's performance here did not come out neatly with respect to the scale steps, but seemed to be partly at step #4 and partly at step #5 of Scale IV, which comes out partly at sensorimotor stage IV and partly at sensorimotor stage V in Zachry's interpretation. When S. H. blew up a balloon, sometimes he just touched her or the balloon and waited, (6c, Scale IV), sometimes gave it back to her (6d), and sometimes tried to imitate her action on the object (6e); when she wound up a mechanical vehicle, he only tried to put it through its paces manually instead of giving it to her to wind up again (7b).

Scale V, Construction of Object Relations in Space

Here Jacob performed at scale step 10, which Zachry places in Piaget's sensorimotor stage V. When several blocks were placed in a cup, he did not remove them singly, as he had two weeks before, but neither did he pour them out; instead, he discovered that he

could keep the cup right side up and bounce the blocks out by shaking the cup up and down. At this session he built a tower of two objects (7c, Scale V), and allowed toys to roll down an inclined plane (8c), but he acted baffled by the problem of detouring around a chair to get a ball that had rolled under and beyond it (10 other).

Comparison with Use of Language

In the two weeks from the first session at 13:23 to the second at 14:7, Jacob had added two more (proto-)words, 'down' and 'round', both used to accompany his own actions of knocking down block towers and rotating objects.

14:7 Summary of Second Test Session

	Scale I	Scale II	Scale IV	Scale V
step #	8	7	4 - 5	10
sensorimotor stage	V	V	IV - V	V

2.3 Third Test Session, 14:28

Scale I, Visual Pursuit and Object Permanence

On this session, Jacob performed at step #10 on Scale I. In addition to being able to repeat his earlier performances in finding objects hidden beneath cloths, he could now find an object after 'successive visible displacements' by searching efficiently under the last cloth in the path (8f, Scale I). He could also find an object after an invisible displacement: that is an object which he saw S. H. put into a small box, and which she then poured from the box into a hiding place under a cloth without allowing him to see the actual transfer (10d, 10e). Furthermore, he could find the object after two invisible displacements -- that is, when S. H. put the object into a box, moved it under one cloth, pretended to pour it out under there, then moved the box under a second cloth without allowing Jacob a glimpse inside, and finally poured the object out under the second cloth (11c). In this task, Jacob immediately looked under the second cloth for the object. According to Zachry, this is performance at Piaget's sensorimotor Stage IV; Jacob had a capacity for 'representation' of objects which were out of sight.

Scale II, Development of Means for Obtaining Desired Environmental Events

On this scale, Jacob seemed to have made little progress. He still performed at scale step #7, (sensorimotor stage V according to Zachry). He became bored or frustrated at the tasks higher on this scale. When confronted with the task of devising a way to get a long necklace in a container which was too wobbly to stand by itself, he was unable to do so (IIa, b); another standard task was also beyond him: he was given a set of standard plastic blocks, identically shaped squat cylinders each with a hole through the middle, of different bright colors, with a dowel which fitted through the holes. There was also one 'joker', a cylinder exactly like the others in shape but without a hole. In this task the subject is first shown how to string the blocks on the dowel; when he/she has gotten used to this way to play with the blocks, the 'joker' is mixed with them and the child's reaction to it is observed. On this occasion, Jacob did not seem to understand that anything was the matter with the 'joker', but just kept trying to shove it onto the dowel with the other blocks (12b).

On U & H scale IV, development of operational causality, Jacob was now clearly at step 5, Piaget's stage V according to Zachry. Now after S. H. wound up a mechanical toy and it ran down, Jacob returned it to her instead of pushing it around (7d). Furthermore, he communicated by gesture that he wanted it to be wound for him. This is entirely consistent with his behavior in the non-test situation in which he was trying to get adults to turn him around in a revolving chair (ch. 2).

On U & H scale V, construction of object relations in space, Jacob had progressed to a boundary between scale step 10, placed by Zachry at Piaget's stage V, and step 11, which Zachry places at Piaget's Stage VI. He made a detour to retrieve objects which had rolled under barriers (10c), usually 'showed appreciation of the force of gravity' in allowing toys to roll down an incline (8c, b), but did not respond to questions about the whereabouts of an absent familiar person (11a).

Comparison with Use of Language

In the three weeks between testing sessions two and three, Jacob acquired three new action-accompanying proto-words [ioio] 'up', and 'tap-tap', and the label 'doll'. He had also been reported to use 'down' as imperative, comment on action of other, report of object falling, and on 14:24, as a commentary as he peered out of an eighth-storey window: this one word showed autonomy (see ch. 2). This testing session was also the occasion of the videotaped event

discussed in chapter 2 in which Jacob seemed able to use his protoword [ioio] only to narrate action, not to request it; he conveyed his requests by gesture and using intonation contour on babble carrier.

14:28 Summary of Third Test Session

	Scale I	Scale II	Scale IV	Scale V
step #	10	7	5	10 - 11
sensorimotor stage	VI	V	V	V - VI

2.4 Fourth Test Session, 15:26

Scale I, Visual Pursuit and Object Permanence

Jacob's ability to handle 'invisible displacements' had increased to U & H scale step 14: S. H. placed a desired object in a box, pretended to pour object out under two of three cloths placed in front of Jacob, and actually poured it out under a third cloth. (The actual hiding place varied as to which cloth it was and whether it was the first, second, or third cloth in the action sequence.) Jacob had not been able to see the object since the time when it was placed in the box, but as soon as he was shown that the box was empty, he began a systematic search for the object under the cloths, and if it was not under the last one, he immediately checked another until he found it.

S. H. argues that the U & H scoring system, in requiring the child to search under the screens 'from the last screen back to the first' is irrelevantly strict here; that criterial behavior to show that the child has 'representation' of the object should simply be that the search for the object is systematic, with a single check under each cloth, until the object is found, indicating that the child knows that it is under one of them and can remember which cloth(s) he/she has already looked under.) With respect to object permanence, Jacob was thus further advanced into Piaget's stage VI according to Zachry.

On U & H Scale II, development of means for creating desired environmental effects, Jacob had progressed considerably, performing at U & H scale step 12, which Zachry places at Piaget's level VI. This time he could use a string attached to a dangling object to haul it up within reach (9f), and was able to quickly figure a way to hold the wobbly container up with one hand while getting the long floppy necklace into it with the other (11e). However, he was apparently unaware that there was anything the matter with the 'joker' in the set of cylindrical blocks, and kept trying to thread it onto the dowel like the others (12b).

On U & H scale IV, development of operational causality, Jacob was now performing at scale step 6 or 7, both of which lie within Piaget's stage VI according to Zachry. Now after S. H. had wound up a toy and it had run down, he sometimes gave it back, but he also tried to wind it himself after being shown how, or sometimes without even being shown. (6d, 6e; 7d, 7e, 8)

On the tasks of U & H scale V, construction of object relations, which Jacob had mastered at the third session except for the verbal-response item, no results were obtained; he was uncooperative and probably bored.

Comparison with Use of Language

The fourth test session was four weeks after the third, at 15:26. Jacob had added only three words to his active vocabulary in those four weeks, 'hello', 'here' as an accompaniment to giving an object, and the predicate 'hot'. But in terms of function, these four weeks had seen a good deal of progress. Jacob had begun to regularly use his action words with rising contour to request action and permission to act, and to ask for confirmation of his predications. (ch. 5). Words, or at least action words, had fully joined gestures and intonation contour as means to get adults to do things for him.

15:26 Summary of Fourth Test Session

	Scale I	Scale II	Scale IV	Scale V
step #	14	12	6 - 7	No results
sensorimotor stage	VI	VI	VI	

The fifth session was five weeks after the fourth, at the age of 17:2. Eight words, seven of them object names and one the demonstrative 'what's that' had been acquired in the interim; the object names were used only as labels, but the action words continued to be used in a variety of ways. Jacob continued to perform at the top of scale I, object permanence, although he was a little bit erratic in some of his searches for objects under cloths (13b, c, 14c, d, 15 systematic but not in special order), maintaining a Piaget stage VI performance. With respect to scale II, development of means for obtaining desired environmental events, which he had mastered at the fourth session except for the rings with the 'joker', he was uncooperative and no results were gotten except for that last task. Here he showed some improvement; after one bout in which he tried to force the solid 'joker' onto the dowel, he was presented with the set of blocks a second time, and on the second occasion he

tried the 'joker' once and then set it aside (12b, c). Presumably he would have also maintained a Piaget stage VI performance on this scale too, if he had been cooperative. On scale IV, development of operational causality, there was no visible change or even a slight regression (6d, 7d, e): Jacob handed back wind-up toys to S. H. or tried to wind them himself after being shown how, but did not simply go right for the key himself as he had at the previous test session. On scale V, construction of object relations in space, he maintained his top-of-scale performance, so that one can consider him to be in Piaget's stage VI there too, according to Zachry.

It is evident that Jacob had little more progress to make on these scales after 17:2, since they top out essentially with the overall attainment of Piaget's stage VI. However, he was tested on some of the tasks at two more sessions, at 18:11, and 20:13, for the sake of completeness. On the last session, he succeeded in avoiding the 'joker' ring after trying it once (12c, scale II). On the sixth and seventh sessions he almost always tried to wind up the mechanical toys himself before handing them back to S. H. (7e, scale IV, on session six; 7f, d on session seven). S. H. did not check out the remaining task in scale V on those sessions, response to name of absent familiar person (task 11), for her own work as indicating to her that this task was unsatisfactory as a test of the concept of absent object. However, Jacob had spontaneously illustrated mastery of this concept long before this time. A clear example occurred at 16:5 (before S. H.'s fifth test session), when Jacob took me by the hand in the living room and led me into the bedroom, and then indicated that he wanted an object stuck out of sight between the crib and wall. This proved to be his bottle which he could not have seen for over an hour.

Table 6 Supplement Summary Table Part 1, test results, language use

		1st test session 13:23	2nd test session 14:7	3rd test session 14:28	4th test session 15:26	5th test session 17:2	6th test session 18:11	7th test session 20:13
Scale I visual pursuit, object permanence	U&H	6	8	10	14	14		(loss of interest)
	s-m	V	V	VI	VI	VI		
Scale II means to desired events	U&H	4 (7)	6(7)	7	12			
	s-m	IV	V	V	VI			
Scale IV opera-tional causa-lity	U&H	2	4-5	5	6-7			
	s-m	IV	IV-V	V	VI			
Scale V construc-tion of object relations	U&H	7	10	11	no result			
	s-m	IV	V	VI				
use of language		proto-words accompany his own action		'down' used as impera-tive; others still 'signals'	wide range for action words	object words used as pure labels		

Table 6 Supplement Summary Table Part 2, selected spontaneous behavior

12:15	shows object to person
13:3	pretending to feed person; babble greeting
13:13	pantomime action in order to check for permission
13:15	pretends to feed doll and person with empty spoon
13:20	does not understand how to orient two nesting blocks in order to make a tower
13:22	holds out pop-beads to L.M. in order to have them put together (very familiar toy and adult action on toy)
13:27	fails to elicit adult cooperation in newly-introduced game
13:29	gives object to adult to have action on it repeated
14:3	babble call for food
14:10	points to desired object
14:21	pretends to 'drink' object from can
15:5	hunts for absent objects on purely verbal cue
15:26	pretends to sleep, pretends doll is sleeping
15:29	puts L.M.'s hand on object to be manipulated
16:5	leads L.M. to hidden bottle (see text)

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APPENDIX

1. Jacob's Output Vocabulary

2. Užgiris and Hunt Test Forms

KEY TO APPENDIX

Alphabetical Listing of Gross Output

206 'A'
294 all
80 all gone
223 alphabet book
140 apple
231 apple juice
233 apple sauce
27 (a)round
235 ash tray
98 (a)way

207 'B'
181 baby
327 back
279 backwards
314 bag
101 ball
112 banana
172 bang
227 bark
166 basket
325 battery
139 beads
182 bell
263 belt/buckle
275 bib
257 bike
329 block
315 boat
38 book
55 boot
111 bookie
106 bottle
232 bottom
23 bounce
310 bowl
126 box
131 boy
216 break/broke
169 brush
118 bubble
252 bucket
184 bump
309 burp

119 bus
144 button
13 byebye

219 'C'
163 cake
90 car
134 cat
84 catch
109 cereal
103 chair
120 cheese
84 chest
143 chocolate
221 click
130 clock
34 close
303 comb
52 cookie
72 cork
192 cottage cheese
174 crack
37 cracker
225 crumb
285 cougar
36 cow
105 cup

186 daddy
102 dance
312 deer
28 diaper
214 dirt
16 doggie
20 doll
245 domino
135 Donald
174 donut
95 door
210 doorbell
22 dot
8 down
42 duck
158 dump
159 dump truck

305 'E'
168 egg
45 ear
39 earring
142 eat
138 eye

306 'F'
300 feet
255 fence
150 fish
87 fish block
317 fit
190 flag
241 flower
99 fly
162 frog

307 'G'
157 gate
76 gently
75 get
88 giraffe
93 give
11 glasses
201 grandma
167 gobble
54 gone
244 goose

276 'H'
180 hair
152 handle
62 hat
53 hello
51 here
281 hi
146 hiccups
9 hm
188 hammer
58 hole
324 home
273 horn
237 horsie
49 hot

256 hot dog
17 hug

259 ice
15 in
196 iron

222 'J'
117 jacket
7 Jacob
149 jam
116 jar
114 jingle
176 juice

295 'K'
177 kaka
10 key(s)
73 kick(ing)
155 knob
200 knife

60 lady
183 lamb
298 lap
164 latch
92 leaf
151 leak
194 lemon
195 lentils
236 letters
322 lid
69 light
132 lime
136 lion
287 Lise
50 look

230 magnet
291 mailbox
197 mama
181 man
249 matzo
187 me
108 meow
127 Mickey
260 milk
326 mirror

228 mitten
234 mommy
33 monkey
35 moo
149 mop
193 more
262 my/mine

289 nice
4 no
290 nope
66 nose
185 no way!
25 nut

295 'O'
71 off
301 oink
41 okay
326 olive
24 on
204 open
137 out
267 outside
224 owl

311 'P'
318 pedal
173 peep-peep
19 peekaboo
203 peg
18 pen-cap
323 penny
156 pepper
327 piece
284 piggy
274 pillow
253 plane
212 play
258 pocket
215 pocket book
100 pot
59 pull
293 puppy

68 quack

293 rabbit
272 rain
296 raisin
283 Randa
213 rattle
218 read
160 record [red]
114 reel
209 ride
21 ring
122 roar
320 Robin
78 rock
40 roll
239 rug

129 salami
155 salt
211 Scholl
292 seal
205 see
148 sew
153 shaker
321 sharp
302 shell
270 shirt
56 shoe
64 siren
264 sit
121 slate
118 slide
129 slingshot
264 snake
70 snap
83 snow
57 sock
266 spoon
165 spout
154 squish
288 step
48 stick
282 sticky
242 stopped
115 stroller
246 sugar
89 swing

220 'T'
304 table
110 tail
94 tangerine
32 tap
97 tape
319 tapedeck
79 tea
125 teapot
46 teether
1 thankyou
123 that
243 that'sa
3 there
107 this
85 thumb
113 tile
2 toast
[tomato]
82 toe
297 top
250 tower
26 toys
96 tractor
238 train
12 tree
91 truck
247 turkey
31 turtle

261 uh-huh
61 uh-oh
169 uh-uh
316 umbrella
179 under
30 up

224 'V'

145 walk
175 wall
147 watch
271 way up
202 wet
278 what's that
44 whee!
77 wheel
65 whistle
178 wind
81 window
47 woof
280 workshop

74 ya
313 yak
[yeah]
308 your back
171 yum

208 'Z'
128 zebra
43 zip

26 [ioio]
67 [esa] [za]
5 [deka] babble
63 retroflex babble
104 er...
25 [oɣi] babble
107 [zɨ] (this)
6 'razzberry'
noise of whistling top
133 imitation of pump
161 coronal click
268 [ɛsjɛ] (interrogative)

1. Words in square brackets [ ] were only reported; they were not taped or written down on the spot.

2. Capital letters, e.g. 'B', denote names of letters of the alphabet.

3. Double entries such as belt/buckle or kick(ing) indicate that it was not possible to decide which of the indicated adult forms was Jacob's intended target.

Session	1	2	3	4	5	6	7	8	9
Age	12:8	12:10	12:12	12:15	12:17	12:19	12:22	12:24	12:26
1. thankyou	dɨdʌ̃	dazá	dɨdɔj	dʌdɛ		bɛ	dɔdɛ		gædu
	dɨ̃dɛjdɨ̃	di	dædæʷ	daj-dà		dɜt			dædu
	ɬɛjʌ	dadʌ́	dɛtæ			dɔidʌ			dʌzdæ
2. toast			dö̈ʌ						
3. there				dɑ	dɑ	dʌm	dʌh		
4. no						(no)	nʌʌʌʌʌ...		
5. [dɨgʌ]						✓	✓		✓
6. 'razzberry'						(✓)		(✓)	(✓)
7. Jacob									
8. down									

Notes: Shadowed or imitated utterances are parenthesized. Reported utterances are in double parentheses. A check mark indicates the occurrence of a particular babble-pattern or imitation of an adult nonsense form.

Vertical digraphs such as $\overset{d}{g}$ in a single token indicate transcriber's uncertainty about the sound heard. An asterisk placed near a token of a word indicates that other tokens of that word were recorded in the same session which differed from the tokens displayed in the chart.

Session	10	11	12	13	14	15	16	17	18
Age	12:28	13:1	13:3	13:6	13:8	13:10	13:13	13:15	13:17
1. thankyou		dædæ	dɛɣɜdæ	d ⁿks		dejtɑ	deitɑ		
		dɑjdɑ́	de$_{d}^{g}$ɑ́	dɛdʌ			dædæw		
				gɑjdʌ					
				dɑitɑ					
2. toast									
3. there		dɛ	dɛ	dæ					
4. no		ŋɛʌ					ɛno	dõ	
							dõ	no*	
5. [dɬgʌ]		✓	✓	✓		✓			
6. 'razzberry'	(✓)					(✓)			
7. Jacob				dikʌ		(dɛit^{h}æ)	dɛikʌ		
				(?)æku*		(gɛikʌ)	gɛikʌ		
8. down									
9. hm			(hm)						
10. key				(ki)					
11. glasses				(ŋæhn̥)					
12. tree					(t^{w}i)				
13. byebye								(dɜdɜ)	(dædæ)
14. jingle									

Session	19	20	21	22	23	24	25	26	27
Age	13:20	13:22	13:24	13:27	13:29	14:0	14:3	14:5	14:7
1. thankyou								gǣgī	
					dæ̃tɨ			gɛ̄jõ	
2. toast									
3. there							dʌx	dɛ	
4. no			((no))						
5. [dɨgʌ]						✓			✓
6. 'razzberry'									
7. Jacob	(gɛkʌ)		(gɛiku)				dɨɛ:ga		geka
8. down		(dæ)	dæn	dæ	ba	dæn:	dædm̥	do:	dʌ:
			(dʌn)			don:	(dæn)	dja	do:
9. hm		(hm)					(hm)	(hm)	
10. key									
11. glasses									
12. tree									
13. byebye	(b̥ b̥ædæ)	(dædæ)							
14. jingle	(ǰiŋu)		(ædʌ́ŋ)						

Session	28	29	30	31	32	33	34	35	36
Age	14:10	14:12	14:17	14:19	14:21	14:24	14:26	14:28	15:1
1. thankyou				dɛdʌ^{m}		dætʌ	ɣita	dɛ:do:	dɨdu
						dajt^{ʔ}ʌ	ḍdeitu		dædʌw
							gɛgo...		daitə
							dɛ:tʌ*		djætʌ*
2. toast									
3. there									
4. no						dʌn			dõn
						n:			
5. [dɨgʌ]	✓	✓		✓(velar)		✓	✓		
6. 'razzberry'									
7. Jacob									
8. down	dæʌ:	dæ^{w}	dæ^{w}ʌ		dãəo	dæ	dɛ	dʌm	dæn
	dæo	dãæ	dæ^{w}n		dm̥	dæm	d^{h}æown	dæw	dɛ:dæn
					dum:		dʌm:		
9. hm									
10. key						(kh)			
11. glasses									
12. tree									
13. byebye									
14. jingle								ʔgɛgu	

Session	37	38	39	40	41	42	43	44	45
Age	15:3	15:5	15:11	15:16	15:22	15:24	15:26	15:29	16:0
1. thankyou	gaita	dɛdum	de:tum	dædæ	daita		gegu	dajdʌ	gi:go
	gaka	ge:t^{h}a	dæ'		((velar))		gajgo	gego	d̥.d̥ g̊go
	daj:ta		dum				gɛjgu	dijugego	
			dæw						
2. toast									
3. there						dɛ			
4. no					do		dõdõ	d^{h}õ	
					də^{ʔ}do^{ʔ}				
5. [dɬgʌ]							✓		
6. 'razzberry'									
7. Jacob									
8. down	do:n	dæum		dun	do	dom	dæw	dõ	dʌm
	dæw	dæw		dowdow	dom	dɛu	dum	du:m	dæwn^{m}
					dæw	dæwm		dæm	
9. hm									
10. key									
11. glasses									
12. tree									
13. byebye					^{ʔ}(dental)	dædæ			
14. jingle									

Session	46	47	48	49	50	51	52	53	54
Age	16:2	16:5	16:7	16:12	16:14	16:16	16:19	16:21	16:23
1. thankyou	daɣ^{m}ũ	gigo^{w}	dajda	dɛgʌ^{ʔ}	ɜdɨdɨ	digo*	dajdʌ	dɛdaa.	
	gegu	gog^{h}ɛ	gĩ:do	dedo	dɛdo	dejo	gigʌ..	..gegu	
	dĩdo	dɛgʌ	dĩdo			(ekʌ)		gego	
								dajdo	
2. toast		do							
		do:							
3. there							dà		djæ̀
4. no	dÃ		dõ		dõ	dõ	do		
	((dõn))				do	dõ			
5. [dɨgʌ]									
6. 'razzberry'									
7. Jacob						dɛdʌ			
8. down	dæm	dæwm	dʌm	dæwnɛʌ			dʌm	dʌm	
9. hm									
10. key									
11. glasses									
12. tree									
13. byebye	dɑdɑ								dãdæ̂
	dɑdæ								
14. jingle									

Session	55	56	57	58	59	60	61	62	63
Age	16:26	16:28	16:30	17:2	17:4	17:6	17:9	17:11	17:13
1. thankyou			dɛ̈ta gigu d̈id̈	dɛ̈dɛ̈	djɛ̈kn̩ gækʌ dɛ̈dʌ				dVdV (offer)
2. toast									
3. there				dɛ̈					dʌ
4. no						dɐ̃			
5. d̈ig									
6. 'razzberry'									
7. Jacob									
8. down			do	dæw	dow	dn̩			dæo
9. hm									
10. key									
11. key									
12. glasses									
13. tree									
14. jingle									

Session	64	65	66	67	68	69	70	71	72
Age	17:16	17:18	17:23	17:25	17:27	18:2	18:4	18:9	18:11
1. thankyou		ɛkʌ							
2. toast									
3. there		da	da		da				
4. no		do							
5. [dɨgʌ]									
6. 'razzberry'									
7. Jacob						((dǰɛjko))			
8. down		dæo	do:		dæu		do	dɛn	
		da	dɔ:ʌ				dm	dʌm	
		dɔn							
9. hm				(hm)					
10. key		k^hi	xiɛ	xɛ			ki	ki	
			k^hi				(k^hi)		
11. glasses									
12. tree									
13. byebye		d^hada		dada		dɛda (questioning)	dɛdʌ		
				dædæ					
14. jingle									

Session	73	74	75	76	77	78	79A/B		80
Age	18:13	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10
1. thankyou		dɛjd^ (receipt)			gekm̩				
2. toast					dia				
3. there		da	?da						
		dæ		dm					
4. no									no
5. [dɨg^]									
6. 'razzberry'									
7. Jacob			(ɛk^)						
8. down		dæw*	d^w		dowm*	dæw	do		dæ̃w̃
		d^m:			d^m				d̥ɐwm
									d̥ɐw
9. hm									
10. key		ki	ki			ki	[[ki]]		ki
		xi							
11. glasses									
12. tree		d^hi							
		ti							
13. byebye			dad^			dedo			
14. jingle									

Session	81	82	83	84	85	86	87	88	89
Age	19:13	19:15	19:17	19:20	19:22	19:24	19:27	19:29	20:1
1. thankyou									
2. toast								dj^ [ɬɔ]	
3. there									
4. no	do' no*	no	do no	næ no	n^w	no no	nɛo no	no	no
5. [dɨg^]									
6. 'razzberry'									
7. Jacob									
8. down	dæwm dæw		dæw	dæw dæwm	dæw	dæw dæ		dæn:	mdæ don
9. hm									
10. key			ki					k^hi	
11. glasses							[dæ:tɨ]		
12. tree									
13. byebye			bajbɛj						
14. jingle									

Session	89A	90	91	92	93	94	95A	95B	95C
Age	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19
1. thankyou									
2. toast									
3. there									
4. no		no	no	nʌ	no	no	njʷ	ʌ̄nō	
			ʌæo	no *	næw			no	
5. [dɨgʌ]									
6. 'razzberry'									
7. Jacob									
8. down	dæw	[dæ]	do	dæ̃wᵐ		dæw			
		dɛw				doⁿ			
		dæwm							
9. ɦm									
10. key					ki	kʰiç*			
					kiç*	kʰi			
11. glasses									
12. tree									
13. byebye					[b:aj]				
					ʌba				
14. jingle									

Session	95D	95	96A	96
Age	20:20	20:20	20:21	20:22
1. thankyou				
2. toast				
3. there				dæ
4. no		no	no	no
				(ʌ)nə
5. [dɨgʌ]				
6. 'razzberry'				
7. Jacob				
8. down		dæw		
9. hm				
10. key		ti xi		(obscured)
		ki		
11. glasses				
12. tree				
13. byebye		baj		baj *
				mʌj
14. jingle				

Session	20	21	22	23	24	25	26	27	28
Age	13:22	13:24	13:27	13:29	14:0	14:3	14:5	14:7	14:10
15. in			((in))						
16. dog(gie)			((?))						
17. hug									
18. pencap				aŋgæ					
19. peekaboo				(ikabu)		(p)ik^{h}ʌBʌ			
20. doll				(da)					
21. ring	(gʌŋ)								
22. dot	(da)								
23. bounce						bæw^{n}			
24. on									
25. [oɣi]									
26. ioio									
27. (a)round					wæmbwæ	(d͡ǽndǽn)	(d̄ad͡æ)		
					wæwæ				
28. diaper					(d̄ɛ̄:t̄ɛ̄)				
29. block					(β:a)				
30. up					(ʌ^{h})				

Session	29	30	31	32	33	34	35	36	37
Age	14:12	14:17	14:19	14:21	14:24	14:26	14:28	15:1	15:3
15. in									
16. dog(gie)									
17. hug									
18. pencap									
19. peekaboo									
20. doll						da			
21. ring									
22. dot									
23. bounce									
24. on		ɔ̃ɪ̃							
25. [oɣi]		ˊ							
26. [ioio]					ioio	ioioio wiuwio	ioio	ioio	ioio oioio
27. (a)round					(wæwæw)		(wæn)		
28. diaper									
29. block									
30. up					up (whispered)				

Session	38	39	40	41	42	43	44	45	46
Age	15:5	15:11	15:16	15:22	15:24	15:26	15:29	16:0	16:2
15. in									
16. dog(gie)									
17. hug					(hʌ$^{?}$)				
18. pencap									
19. peekaboo									
20. doll				(?)dæ		dæw (dɔ)			dʌw
21. ring									
22. dot									
23. bounce									
24. on						(ɔ)			
25. [oɣi]	ogɛ$^{)}$								
26. [ioio]	ioio	oioi* wejaweja	ioio	wiʌwiʌ oioio	ʌ́iʌ́iʌ́i	iʌwiʌ ɔijo...	ioio... wijuwiju	wiʌiʌ ioio	iʌiʌ ʌ́wʌ́ió:ʌ́
27. (a)round			(wæwæ) wʌwi						(RæRæ)
28. diaper									
29. block									
30. up		ʌ$^{)}$							

Session	47	48	49	50	51	52	53	54	55
Age	16:5	16:7	16:12	16:14	16:16	16:19	16:21	16:23	16:26
15. in									
16. dog(gie)					ʔdʌ				
17. hug									
18. pencap									
19. peekaboo									
20. doll	daw								
21. ring									
22. dot								(da)	
								(daˀ)	
23. bounce									
24. on									
25. [oɣi]									
26. [ioio]	ʌ́iʌiʌi		wɛ́iʌiʌ	ʌ́iʌiʌi	wiʌwiʌ		ɨ:iaɛ	jajajaj	ɨiajɛ
	iʌiʌ		ʌiʌj		ɛio				
27. (a)round					(wænwæn)				
					wæwæw*				
28. diaper									
29. block									
30. up									

Session	56	57	58	59	60	61	62	63	64
Age	16:28	16:30	17:2	17:4	17:6	17:9	17:11	17:13	17:16
15. in									
16. dog(gie)									
17. hug									
18. pencap									
19. pencap									
19. peekaboo									
20. doli								((da))	
21. ring									
22. dot									
23. bounce									
24. on									
25. [oɣi]									
26. [ioio]	ɛijɛiɔ	ɛʌɛʌɛ	ioio	ʌiʌi			oioio		oioio iɛjʌ
27. (a)round		wæ				æwʌ		ʌwœ	
28. diaper							(dajdʌ)		
29. block									
30. up									

Session	65	66	67	68	69	70	71	72	73
Age	17:18	17:23	17:25	17:27	18:2	18:4	18:9	18:11	18:13
15. in									
16. dog(gie)									
17. hug									
18. pencap									
19. peekaboo									
20. doll	ɓ dɔ::								
21. ring									
22. dot									
23. bounce									
24. on									
25. [oɣi]									
26. [ioio]	ɛjʌɛjʌ			ɛʌ ʌi	oioi				
27. (ɐ)round						[wæwæ]			
28. diaper									
29. block									
30. up									

Session	74	75	76	77	78	79	79A/B	80	81
Age	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10	19:13
15. in									
16. dog(gie)	da								
17. hug									
18. pencap									
19. peekaboo									
20. doll									
21. ring									
22. dot									
23. bounce									
24. on		ʌh a	a	a					
25. [oɣi]									
26. [ioio]	ajai	ioio	ajajaj	ajajaj					
27. (a)round			ʌwæ̂		iaia æ̂wʌæ̂wʌ	[æwæw] æwm	æw wæw - wæn		wæ
28. diaper									
29. block									
30. up	[ap] [ap]	[æp] [ʌˀ]			ʌh			[ʌpˀ] [ap]	

Session	82	83	84	85	86	87	88	89	89A
Age	19:15	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5
15. in									
16. dog(gie)					ʌdʌdi				
17. hug			hʌ						
18. pencap									
19. peekaboo									
20. doll				? bwʌ			d^ha		
21. ring		ʌ̟j							
22. dot									
23. bounce									
24. on									
25. [oɣi]									
26. [ioio]		ajajaj	oioio		ajʌajʌ	ɛjaja			
27. (a)round		ʌwæwn ɱwæ	næw			wæ͡wæ͡w			wæ͡ʌwæ͡n
28. diaper		[bapi] [bʌjbɛj]							
29. block						b^wa		bʌk (b)ʌk	
30. up		ʌp ʌpt	ʌ æˀ				ʌp [ʌp]	ap	ap ʌbʌ*

Session	90	91	92	93	94	95A	95B	95C	95D
Age	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20
15. in									
16. dog(gie)									
17. hug									
18. pencap									
19. peekaboo	[βika]								
20. doll									
21. ring									
22. dot									
23. bounce									
24. on					ɔ̃		ɔn	ʌn	
					ɔn			ɔmɔ:	
25. [oɣi]									
26. [iolo]									
27. (a)round	ʌwæ̂		wæ̂wwæ̃w	æmæw *	ʌmwama				
28. diaper									
29. block			bwæ						
30. up			[ap^{h}]		[ʌp]				

Session	95	96A	96
Age	20:20	20:21	20:22
15. in			
16. dog(gie)			
17. hug			
18. pencap			
19. peekaboo			
20. doll			[da]
			[itʌ̄](this doll)
21. ring			
22. ring			
22. dot			
23. bounce			
24. on		ɔn	[ʌ:n]
		ʌn	
25. [oɣi]			
26. [ioio]	ajaʌjʌ		
27. (a)round	wæ͡wwæ͡n	wæw	wæwn
	ʌ̃w:		
28. diaper			
29. block			
30. up			[ʌp]

Session	27	28	29	30	31	32	33	34	35
Age	14:7	14:10	14:12	14:17	14:19	14:21	14:24	14:26	15:1
31. turtle	(d3dʌ)								
32. tap-tap			(dætæ)					(wædə)	dædə
33. monkey			ɐ̃ki:						
34. close				(kʌ)					
35. moo			(m::)						
36. cow			(k-k)						
37. cracker				(k)					
38. book			(ʌk)						
39. earring						[iʌ]			
40. roll						[wo-wo]	[wo:w]		
41. okay									
42. duck						dʌ			
43. zip						[z]			
44. whee						?[ui]			
45. ear							ʌi		
46. teether									[titi]
									[ti:tʌ]

Session	36	37	38	39	40	41	42	43	44
Age	15:1	15:3	15:5	15:11	15:16	15:22	15:24	15:26	15:29
31. turtle									
32. tap-tap						(tata)		tata	tætæ
									tjætjæ
33. monkey									
34. close			(ʔko)						
35. moo									
36. cow									
37. cracker									
38. book									
39. earring						[æi]			
						[ʌi]			
40. roll	wo:			[wʌ:]		[wow]		[wo:]	
41. okay									
42. duck									djʌʔ
43. zip									
44. whee									
45. ear									
46. teether									

Session	45	46	47	48	49	50	51	52	53
Age	16:0	16:2	16:5	16:7	16:12	16:14	16:16	16:19	16:21
31. turtle									
32. tap-tap		(dæ̃p$^{(?)}$)	tætætæ...			(tæ)			
33. monkey									
34. close									
35. moo									
36. cow									
37. cracker									
38. book									
39. earring						ija	iʌi	iʌ	
40. roll									
41. okay									
42. duck									
43. zip									
44. whee									
45. ear									
46. teether									

Session	54	55	56	57	58	59	60	61	62
Age	16:23	16:26	16:28	16:30	17:2	17:4	17:6	17:9	17:11
31. turtle									
32. tap-tap			(tætæ)						
33. monkey									
34. close									
35. moo									
36. cow									
37. cracker				(kækæ) (kikæ)					kaka
38. book									
39. earring									
40. roll									
41. okay									[ʌkĩ]
42. duck									
43. zip									
44. whee								[ɪ]	[ɪ:]
45. ear									
46. teether									

Session	63	64	65	66	67	68	69	70	71
Age	17:13	17:16	17:18	17:23	17:25	17:27	18:2	18:4	18:9
31. turtle									
32. tap-tap									
33. monkey									
34. close		do	dʌ						
35. cow									
37. cracker	kaka		kʌkæ				gega		
38. book									
39. earring						ɛ			
						[ʌɛ]			
40. roll				uw					
				[o]					
41. okay									
42. duck									
43. zip			[zi]						
44. whee			[i:]	[i]					
45. ear									
46. teether									

Session	72	73	74	75	76	77	78	79	79A/B
Age	18:11	18:13	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9
31. turtle		tɜdʌ							
32. tap-tap									
33. monkey									
34. close				do					
35. moo							mu		
36. cow							dæw		
37. cracker							æw		
38. book									
39. earring									
40. roll								ow	
41. okay									
42. duck					ʔ[gʌˀ]				
43. zip									
44. whee					[ʌi]				
45. ear									
46. teether									

Session	80	81	82	83	84	85	86	87	88
Age	19:10	19:13	19:15	19:17	19:20	19:22	19:24	19:27	19:29
31. turtle									
32. tap-tap					$t^{\prime}æ$				
33. monkey									
34. close									
35. moo									
36. cow									
37. cracker	kʌki								
38. book									
39. earring			aj						
40. roll									
41. okay									
42. duck		dʌ							dɛ
43. zip									[dʌk]
44. whee									
45. ear									
46. teether									

Session	89	89A	90	91	92	93	94	95A	95B
Age	20:1	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19
31. turtle									
32. tap-tap							tata		
							tatɑ		
33. monkey									
34. close									
35. moo						[mo]			
36. cow									
37. cracker							[kʌkm̩m̩]		
							[kʌkw̩]		
38. book					[bʌp^{h}]				
39. earring									
40. roll			wow						
41. okay									
42. duck	[duk$^{\text{'}}$]				[dʌk]				
	duk^{h}								
43. zip			[zip]						
			[z$\dot{\text{t}}^{?}$]*						
44. whee									
45. ear									
46. teether									

Session	95C	95D	95	96A	96
Age	20:19	20:20	20:20	20:21	20:22
31. turtle					
32. tap-tap					
33. monkey					
34. close					
35. moo			mwu:u		$m^{w}o$
			mo:		mæ
36. cow			[k$^{\text{ʔ}}$æw]		[ʌko]
			kjæw *		kæow
37. cracker				(kʌki))	
38. book					
39. earring					
40. roll					
41. okay					
42. duck					
43. zip					
44. whee					
45. ear			[i]		
46. teether					

Session	35	36	37	38	39	40	41	42	43
Age	14:28	15:1	15:3	15:5	15:11	15:16	15:22	15:24	15:26
47. woof	(?)								
48. stick	(dɨ)								
49. hot							hæ (whisp)		
							h		
50. look							[[?]]		
51. here							hi		
52. cookie									
53. hello							aglɔgla.. ʌʌʌʌʌ		
							aulʌˈulo		
54. gone									
55. boot		(ˈuˈ)							
56. shoe(s)				[suːsaˈ]					
57. sock									
58. hole						(ho)			
59. pull							[puw]		
60. lady								[lei]	
61. uh-oh									
62. hat									

Session	44	45	46	47	48	49	50	51	52
Age	15:29	16:0	16:2	16:5	16:7	16:12	16:14	16:16	16:19
47. woof	[wufwuf]							[ufiʌf] [wufwuf]	wʌ
48. stick									
49. hot			h hɛ						
50. look									
51. here			hjæ						
52. cookie									[ugɛ]
53. hello									
54. gone	[gnŋ]								
55. boot									
56. shoe(s)									
57. sock									
58. hole									
59. pull									
60. lady									
61. uh-oh	oˀo Dʌˀo								
62. hat	[hæ] [ha]								

Session	53	54	55	56	57	58	59	60	61
Age	16:21	16:23	16:26	16:28	16:30	17:2	17:4	17:6	17:9
47. woof									wʌfwʌ:f
48. stick									
49. hot		(hot tea, ɛti)							
50. look									
51. here									
52. cookie				-	?				
53. hello									
54. gone									
55. boot									
56. shoe(s)									
57. sock									
58. hole									
59. pull									
60. lady		[deji]							
61. uh-oh									
62. hat				hæ					

Session	62	63	64	65	66	67	68	69	70
Age	17:11	17:13	17:16	17:18	17:23	17:25	17:27	18:2	18:4
47. woof				? (barking)		(barking)	(barking)		
48. stick									
49. hot	h (whisper)		(hʌ)	ha (whisper					
50. look									
51. here									
52. cookie		kaka							
53. hello									
54. gone									
55. boot									
56. shoe(s)	(?sibilant)								(s̆ũ)
57. sock				(sa)					
58. hole		o							
59. pull									
60. lady		(j̆ɛhi)							
61. uh-oh						(ʌo)		ʌˀohˀ	
62. hat				(kæ)					

Session	71	72	73	74	75	76	77	78	79
Age	18:9	18:11	18:13	18:18	18:20	18:23	18:25	18:27	18:30
47. woof						(barking)		af-af af	
48. stick									
49. hot									
50. look									
51. here									
52. cookie				kikʌ					
				(kuki)					
53. hello									
54. gone									
55. boot									
56. shoe(s)								(du)	
57. sock									(gakˌ / ˀakˀ)
58. hole			(hɛʌw)	(ho)					
59. pull									
60. lady						(ʌuɛji)			
61. uh-oh									
62. hat									

Session	79A/B	80	81	82	83	84	85	86	87
Age	19:8/9	19:10	19:13	19:15	19:17	19:20	19:22	19:24	19:27
47. woof					æfæf		(barking)	wa waw	
48. stick									
49. hot		ha' (whisper)			ha' (whisper)	ha'			ha'
50. look									
51. here									
52. cookie		k^ki (kuki)						k^kí	k^kí (kuki)
53. hello									
54. gone									
55. boot									
56. shoe(s)		(du)	du (or = boot?)						
57. sock					(sa)			(sa)	
58. hole								hu (ho)	(hu)
59. pull									
60. lady					(laj)				
61. uh-oh									
62. hat						(hæ'un) (haton)			

Session	88	89	89A	90	91	92	93	94	95A
Age	19:29	20:1	20:5	20:8	20:12	20:13	20:15	20:18	20:18
47. woof		wuf				(barking)	(barking)		
48. stick									
49. hot	(much play with word 'hot')		hat^{s}			hɔt^{h} hat^{h}			
50. look									
51. here									
52. cookie	(kuki)							pʌgɨh kukji	
53. hello									
54. gone									
55. boot									
56. shoe(s)		(š̆s) (šuž̆)		(ɨš̆) š̆ɨs*		sɨs sws*	sɨz išu	isis*	
57. sock						s̀ək sʌ *			
58. hole		hɔ							
59. pull									
60. lady									
61. uh-oh									
62. hat	(hʌɨt)	ha^{ɔ} hɛtɛ*		hat^{h}		hɛt^{h}		(hæt^{h})	ha^{ɔ} hat

Session	95B	95C	95D	95	96A	96
Age	20:19	20:19	20:20	20:20	20:21	20:22
47. woof				ɑ̀ɑ̀ʌf		æfæf
48. stick						
49. hot	hɑt		hɑt			hɑt
	hʌt		hats			
50. look						
51. here						
52. cookie			kʌki	ˈuki		kʌki
			kuki*			kuki*
53. hello						
54. gone						
55. boot						
56. shoe(s)				ˋs̈w		siw
				s̈i		ˇ̈si, su
57. sock	sʌ					
	sjæ					
58. hole						
59. pull						
60. lady						(wʌj)
61. uh-oh						
62. hat				hat		hɑt
						hætʰ

Session	47	48	49	50	51	52	53	54	55
Age	16:5	16:7	16:12	16:14	16:16	16:19	16:21	16:23	16:26
63. (retroflex babble)									
64. siren						ẽsə̃			
65. whistle						a wʌ̃wwʌ̃w			
66. nose						(dõ')	do		
						(do)			
67. esa							ẽsə̃	ẽsə̃	sə̃
68. quack									
69. light									
70. snap	(æ')					(dæ)			
71. off	ʌʌ̀								
72. cork			(kʌk)						
			(kɛk)						
73. kick(ing)			(gigi)						
74. ya			(ɑ)						
75. get				gɛ?					
76. gently					(ɛi)				
77. wheel						(wi͡iwwi͡iw)			
78. rock(s)					(ʌwʌ)		(ʌkʌ)		
					(æwiæwi)				

Session	56	57	58	59	60	61	62	63	64
Age	16:28	16:30	17:2	17:4	17:6	17:9	17:11	17:13	17:16
63. (retro-flex babble)									
64. siren			ẽsɑ̃		((s)ʌ)	ssæ	sɑ		
65. whistle						(wɔ)			
66. nose									
67. esa	ɛ̄sæ̂		ɛ̄sæ̂						sæ̂
68. quack	kʌk		isæ kʌk	g kæ					
	kʌkʉ								
69. light	(Ljɑ)		Lɪ		(Læ)	(Lɑj)	ʌLæ		
70. snap	aj'								
71. off						ox			
						(ʌx)			
72. cork									
73. kick(ing)									
74. ya									
75. get									
76. gently									
77. wheel									
78. rock(a)									

Session	65	66	67	68	69	70	71	72	73
Age	17:18	17:23	17:25	17:27	18:2	18:4	18:9	18:11	18:13
63. (retroflex babble)									
64. siren									
65. whistle									
66. nose									
67. esa	s͡ɑ								zɑ
68. quack							(kɑ-kɑ)		
							(kakɑ...)		
69. light	(ʌɪ)	(Lɑj)							Lʌɪˇzʌɪ
	(zɑj)*								
70. snap				(h$^{?}$næ)					
				(hnɑ)					
71. off									
72. cork				kʌ$^{?}$					
73. kick(ing)									
74. ya									
75. get									
76. gently									
77. wheel									
78. rock(a)									

Session	74	75	76	77	78	79	79A/B	80	81
Age	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10	19:13
63. (retroflex babble)									
64. siren									
65. whistle									
66. nose				h_{nu}					
67. esa									
68. quack				gʌkʌk	kækæk				
69. light		Lɛ	LʌJ	Laj			Laj		
		aj		aj	waj				
70. snap									
71. off			ɑ	ɑ	ʊx	ɑx			ɔ
						ɔ, ɑ			
72. cork									
73. kick(ing)								(kɨk)	
74. ya									
75. get									
76. gently									
77. wheel		(?)				(ʌw͡iʌ)			
78. rock(a)	(ɑk)								

Session	82	83	84	85	86	87	88	89	89A
Age	19:15	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5
63. (retroflex babble)									
64. siren									
65. whistle					wɨ				
66. nose									
67. esa		ʔæ				(ʌzæ)			
68. quack									
69. light		laj	Laj	wʌj	(lajt^{h})	wajc	LʌjdɪI	lʌj	
					laj*	laj	(l:ajt^{h})*	wɛt^{h}	
70. snap			(n̥æ)						
			(næ)*						
71. off	ɔ	ah	ɔ̃		(ɔ)	ɔ	ɔ,af	a,ɔ	
			(æ)				ɔx	ʌ	
72. cork					(k^{h}ɔ)				
					(kɔ^{t})				
73. kick(ing)									
74. ya									
75. get									
76. gently									
77. wheel									
78. rock(a)									

Session	90	91	92	93	94	95A	95B	95C	95D
Age	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20
63. (retroflex babble)									
64. siren									
65. whistle									
66. nose									
67. esa			sæ	ʌzæ	sæ				
68. quack									
69. light					lə	lɛt			
					l:ʌt^{h*}	læt			
70. snap									
71. off	ʌ		ʌ	ʌ	ɔf				ɔ
	ɑ		ɔx	(ʌf)					ɑ
72. cork					(kʌk)				
					((ʌ)kʌ)				
73. kick(ing)									
74. ya									
75. get									
76. gently									
77. wheel									
78. rock(a)									

Session	95	96A	96
Age	20:20	20:21	20:22
63. (retroflex babble)			
64. siren			
65. whistle			
66. nose			
67. esa	zæ		
68. quack			
69. light	lɛjt^{h}	Lɑjt	LʌʔtLʌ^{ʔ}t
	(lʌjt)	lɑt*	
70. snap			
71. off		ɑ	ʌf
		ʌf	
72. cork			
73. kick(ing)			
74. ya			
75. get			
76. gently			
77. wheel			
78. rock(a)			

Session	47	48	49	50	51	52	53	54	55
Age	16:5	16:7	16:12	16:14	16:16	16:19	16:21	16:23	16:26
79. tea					(tɪ)				
80. all gone						(gego)			
81. window						(winuw)			
82. toe						(to)			
83. snow							(?)(dɑ)		
							(nɑ)		
84. chest									
85. thumb							(ʌm)		
86. catch									
87. fish block							(f̄ʌ̄)		
88. giraffe								(æ)	
89. swing									(s...)
90. car									(k...)
91. truck	(?)tʌ						tčʌ		(tč...)
92. leaf									(ɪ)
93. give									
94. tangerine									

Session	56	57	58	59	60	61	62	63	64
Age	16:28	16:30	17:2	17:4	17:6	17:9	17:11	17:13	17:16
79. tea									
80. all gone									
81. window									
82. toe			do						
83. snow									
84. chest									
85. thumb									
86. catch									
87. fish block									
88. giraffe								(dæ)	
89. swing									
90. car			ʔ	kɑ	gɛɑ ʌkæ	gæ	kɑ		(gʌx) gʌgʌ
91. truck				čʌ t!ʌx	kʌ kɑ	(ʌtʌk) kʌ*	ɛtʌ gæ*	gʌ	
92. leaf									
93. give	(g3)								
94. tangerine		(gɪ) (ɨ)							

Session	65	66	67	68	69	70	71	72	73
Age	17:18	17:23	17:25	17:27	18:2	18:4	18:9	18:11	18:13
79. tea	di			ti		($t^{w}i$)	(uti)		
	dɛi								
80. all gone									
81. window									
82. toe		(tʌ)							
83. snow									
84. chest									
85. thumb									
86. catch									
87. fish block									
88. giraffe		(iwæ)		(wæ)					
89. swing									
90. car	kæ	kæ	kɑ	kɑ	kɑ	gɑ	kɑ		kː
	kʌ					($k^{h}ɑ$)			k^{h}ː
91. truck	kʌ		twi						(kʌ)
	kæ		gæ*						
92. leaf									
93. give									
94. tangerine									

Session	74	75	76	77	78	79	79A/B	80	81
Age	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10	19:13
79. tea		ti di							
80. all gone									
81. window									
82. toe									
83. snow		(sʌ)							
84. chest									
85. thumb									
86. catch									
87. fish block									
88. giraffe									
89. swing									
90. car	g^hɑ kɑ	ʌk^hɑ ɣɑ	kɑ	kɑ gɑ	kɑ		k^hɑ	(ˀ)k͡ɑ	
91. truck	kɑ	kʌ	t^hʌ (gɑ)						gʌ
92. leaf									
93. give									
94. tangerine									

Session	82	83	84	85	86	87	88	89	89A
Age	19:15	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5
79. tea							ti		
80. all gone									
81. window					(ʔ)(dɔ̂dɔ̂)				
82. toe									
83. snow									
84. chest					tzɛ				
85. thumb									
86. catch									
87. fish block									
88. giraffe								wɑ (wæ)	
89. swing							((jɛ)wɨ)		
90. car		$k^h ɑ_{\dot{}}$	kɑ	((kʰɑ))		((ɛ)gɑ)	(kɑr)	$k^h ɑ$	
91. truck		ʌtʌk ɛtsɑ					kɑ		
92. leaf									
93. give									
94. tangerine									

Session	90	91	92	93	94	95A	95B	95C	95D
Age	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20
79. tea									
80. all gone	(ɑjgʌ)								
81. window									
82. toe	(t$^{?}$o)			(?)(tʌ) (?)ko					
83. snow									
84. chest									
85. thumb									
86. catch									
87. fish block									
88. giraffe									
89. swing									
90. car			kɜ (kʰɑ)	kʰɑ kʌ	kɑ				kʰɑ kɔʌ*
91. truck									
92. leaf									
93. give									
94. tangerine									

Session	95	96A	96
Age	20:20	20:21	20:22
79. tea			ti
80. all gone			
81. window			
82. toe			
83. snow			
84. chest			
85. thumb			
86. catch			
87. fish block			
88. giraffe	wɑ		
89. swing			
90. car			
91. truck			
92. leaf			
93. give			
94. tangerine			

Session	57	58	59	60	61	62	63	64	65
Age	16:28	16:30	17:2	17:4	17:6	17:11	17:13	17:16	17:18
95. door	? du		dɔ						do: dɔ
96. tractor	(gæ$^{?}$kæ)								(gæki) (kækʌ)*
97. tape		$^{?}$tæ						ɛj (t$^{?}$ɛj)	(t$^{?}$ɛj) (dɛ)
98. (a)way		$^{?}$							(ʌyɛ)
99. fly		(ɑj)							
100. pot						bʌ			
101. ball							bo		
102. dance-dance							(dʒ-dɛ)		
103. chair									djɛ
104. er-									ʌ: ɛ:
105. cup									kʌ
106. bottle									bɛ
107. zɨ									
108. meow									
109. cereal									
110. tail		(diʌ)							

Session	66	67	68	69	70	71	72	73	74
Age	17:23	17:25	17:27	18:2	18:4	18:9	18:11	18:13	18:18
95. door	du								
96. tractor			di$^{?}$t^{h}i		gɔ				
					gɔu:gɑ			ɣægi	k^{h}ɹ
97. tape	te	$^{?}$txi	tɨjʌ	gɛj	tej				ti
			di,ti						ɟɛ*
98. (a)way								(wɛ)	(ɑwe)
99. fly			(mwe)					(wɛ$^{?}$)	
100. pot									
101. ball									
102. dance									
103. chair									
104. er-									
105. cup									
106. bottle				(gigʌ)					
				kVkV g g					
107. zɨ			zɨ						
			dɨ						
108. meow			hmwæw*						
			(imitation of cat)						
109. cereal			tsɨ						
110. tail			sɨ						

Session	75	76	77	78	79	79A/B	80	81	82
Age	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10	19:13	19:15
95. door	do			du	dɔ	ʌdu	do (du)		
96. tractor		kʌ	(gʌk)*	(gʌ)	ɪ̄tʌ̄		gogi		
97. tape	tɑj (dɛj)	kʌ	dɑj	ti	di				
98. (a)way	we				ow$^{?}$ɛj	(wʌj) (wɛj)			
99. fly									
100. pot									
101. ball								dɔ	
102. dance-dance									
103. chair									
104. er-							ʌm...		
105. cup									
106. bottle									
107. zɨ									
108. meow									
109. cereal									
110. tail									

Session	83	84	85	86	87	88	89	89A	90
Age	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5	20:8
95. door	do	ðu		(du)		du	do		du
	dɔ	dɔ					du		
96. tractor		ˀsætæ							
97. tape	(t^hi)					ti			(ti)
	(di)								
98. (a)way	wɑj	(ɛ)wɑj		ʌ̄:w͡ɛj		wej	wɛj		wʌj
	(or = plane?)						wɑj		wɛ
99. fly	(wʌj)					ŋwɑj			
						w̃ɛj			
100. pot									
101. ball	dʌ	dɔ		dɔ	dɑ	do	dɔ,do		ʌw
	dɔ	djɑ			(bˑ)		(bɔ)		bo,bɔ
102. dance									
103. chair									
104. er-									
105. cup									
106. bottle		bʌpˀm							
107. zɨ									
108. meow	mæow	mːɛu				æw	mæw		mæw
						mwæw	mwæw		
109. cereal									
110. tail				(dɛ)		(tew)			
				(de)		(dɛ)			

Session	91	92	93	94	95A	95B	95C	95D	95
Age	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20	20:20
95. door				du du:r					
96. tractor									
97. tape									
98. (a)way		(ɑ)wɛ wɛjh	$w_{\tilde{A}}^{\varepsilon}j$	wɛj	wʌj wɛj	bɑj			wɔj
99. fly									
100. pot									
101. ball	dwu ?βɑ	bɔ bɑ	bɔ bɑ	bɑ bɔ			bɔ		bɔ
102. dance									
103. chair									
104. er-									
105. cup				?(bʌp) (bɑp)					
106. bottle									
107. zi									
108. meow		?	mæw	?					mæw
109. cereal			çʌ						
110. tail									dæ

Session	96A	96
Age	20:21	20:22
95. door		
96. tractor		
97. tape		
98. (a)way	wʌj	(wɛj)
99. fly		
100. pot		
101. ball		bɔ
102. dance		
103. chair		
104. er-		
105. cup		
106. bottle		
107. zɨ		
108. meow		
109. cereal		çiw
110. tail		

Session	60	61	62	63	64	65	66	67	68
Age	17:4	17:6	17:11	17:13	17:16	17:18	17:23	17:25	17:27
111. bootie	?((dutI))								
112. banana	?((dæʌʌ))								
113. tile	(?)								
114. reel	(i)			?	ɨʌ				
					(RiʌʌR)				
115. stroller	?	ɔˀɛ					(doLʌ)		
116. jar		(dž ɑ)							
117. jacket			(ækʌ)						
118. slide			(Iɑj)						
119. bus			(bʌ)						
120. cheese				?23					
121. slate						(S-)			
122. roar						(ɑrɑ)			
123. that						ðæ			
124. slingshot						(sɨ)			
125. teapot						(dɛjɑ)			
126. box						(bɑ)			

Session	69	70	71	72	73	74	75	76	77
Age	18:2	18:4	18:9	18:11	18:13	18:18	18:20	18:23	18:25
111. bootie									
112. banana									
113. tile									
114. reel									
115. stroller									
116. jar									
117. jacket									
118. slide									
119. bus									
120. cheese				ǰi					(zi)
121. slate									
122. roar									
123. that									
124. slingshot									
125. teapot			(tita)				(tsetɑ)	((titɔ))	
			(twitɑ)				(tibɑ)		
126. box		(tɛ́i kɛ̀) (tapebox)							

Session	78	79	79A/B	80	81	82	83	84	85
Age	18:27	18:30	19:8/9	19:10	19:13	19:15	19:17	19:20	19:22
111. bootie									
112. banana									
113. tile									
114. reel									
115. stroller									
116. jar									
117. jacket									
118. slide									
119. bus	(bʌ)				((bʌ))			bɑ?	
120. cheese									
121. slate									
122. roar									
123. that									
124. slingshot									
125. teapot									
126. box			(ba)					pɑ	bɑ
			dɑ,bɑ					(bɑ)	

Session	86	87	88	89	89A	90	91	92	93
Age	19:24	19:27	19:29	20:1	20:5	20:8	20:12	20:13	20:15
111. bootie									
112. banana									
113. tile									
114. reel									
115. stroller									
116. jar									
117. jacket									
118. slide									
119. bus	bʌ		bʌkʰ	bɑ				bʌ	
	bɑ		bɐkʰ					bæˢ	
120. cheese	(čˇi)	tɕiɕ	ʂ̀i:ʂ̀ɕ*						
	s:i̟								
121. slate									
122. roar									
123. that		(dæ)	dækʰ						
124. slingshot									
125. teapot									
126. box		bɑ-kh	bækʰ	bwɑ		bɑkʰ		bʌ	bɑkh
			bɑk					bɐ̃kh	

Session	94	95A	95B	95C	95D	95	96A	96
Age	20:18	20:18	20:19	20:19	20:20	20:20	20:21	20:22
111. bootie								
112. banana								
113. tile								
114. reel								
115. stroller								
116. jar								
117. jacket								
118. slide								
119. bus	bɑs					(bɑɪs:)		
120. cheese								
121. slate								
122. roar								
123. that	da					ðæ	dæ	dæ
124. slingshot								
125. teapot								
126. box	bɑjtc					bɑk^{h}		(bɑ^{k})
	bɑkts*					bɑk		(ʌ)bɑk

Session	66	67	68	69	70	71	72	73	74
Age	17:23	17:25	17:27	18:2	18:4	18:9	18:11	18:13	18:18
127. Mickey	(¯-)								
128. zebra	(ɾβʌ)								
129. salami		(Mɛ)							
130. clock		(gɑ)							
		(??ki)							
131. boy			(ɔj)						
132. lime			(lɑj)						
133. (air noise)*			(fx̌:)						
(air escaping from pump)			(khɛ)						
134. cat			gɨtɨ						
135. Donald									
136. lion									
137. out									
138. eye									
139. beads									
140. apple									
141. leak									
142. eat									

Session	75	76	77	78	79	79A/B	80	81	82
Age	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10	19:13	19:15
127. Mickey									
128. zebra									
129. salami									
130. clock									
131. boy									
132. lime									
133. (air noise)*									
134. cat									
135. Donald	(dɑdʊ)								
	$dɛd^{ʊ}ɛ$								
136. lion	ɑj	waj (Laj)							
137. out	(o^)					(æwt)		(?)	
138. eye			ɑj						
139. beads	di								
140. apple				(æpu)			æp̩m		
				(æp)					
141. leak				((li))					
142. eat				((i))					

Session	83	84	85	86	87	88	89	89A	90
Age	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5	20:8
127. Mickey									
128. zebra	(bid^{w}ʌ)								
129. salami									
130. clock									
131. boy									
132. lime									
133. (air noise)*									
134. cat						dæ$^{?}$	(gæt) (dæk)		
135. Donald									
136. lion		ʌɑj (wʌ)		(ɑj)					
137.out									
138. eye	ɑj	(ɑj) (ʌj)				(ɑjç) ɑj	ɑj		ɑj
139. beads		(bjj)							
140. apple					(æpɑ) (æpw*)				
141. leak									
142. eat		i$^{?}$							

Session	91	92	93	94	95A	95B	95C	95D	95
Age	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20	20:20
127. Mickey									
128. zebra									
129. salami									
130. clock									
131. boy									(bɔj)
132. lime									
133. (air noise)*									
134. cat				kæ$^{?}$					(K$^{?}$æ$^{?}$) gæ(?)
135. Donald									
136. lion									
137. out									
138. eye		ɑjç ɑj	aj						ɑj wɔj*
139. beads									
140. apple			(æp-ʌm) (æp:m)						(æpmæ) æpw
141. leak									
142. eat	(it^{h})	(it^{h})	it		((itɑ)) (eat that)			i	it

Session	96A	96
Age	20:21	20:22
127. Mickey		
128. zebra		
129. salami		
130. clock		
131. boy		
132. lime		
133. (air noise)*		
134. cat		
135. Donald		
136. lion		
137. out		
138. eye		
139. beads		((ʌ)bi)
		(bi)
140. apple		
141. leak		
142. eat		i

Session	69	70	71	72	73	74	75	76	77
Age	18:2	18:4	18:9	18:11	18:13	18:18	18:20	18:23	18:25
143. chocolate									
144. button	(ʌ$^{?}$ʌn)								
	(gʌkn̥)								
145. walk									
146. hiccups		(hɛ̄t̄k)							
147. watch		(wɑ)			(ʌwæ)				
148. sew			(do)						
149. jam					(næ)				
					(dzæ)				
150. fish					(xɨ:)				
151. knob					(nɑ)		nɑ		
152. handle					(hɑhɑ)				
					(dʌtʌ)				
153. shaker					(tɛtæ)				
154. squish					(gʌx)				
					(ki:x)				
155. salt					(sɛ)				
					(sɔ)				
156. pepper						(pɛø̃ʌ̃)			
157. gate						(gi)			
158. dump						(dm̥^{p})			
						(dʌp)			

Session	78	79	79A/B	80	81	82	83	84	85
Age	18:27	18:30	19:8/9	19:10	19:13	19:15	19:17	19:20	19:22
143. chocolate	tit^ kik^								
144. button									
145. walk		o?							
146. hiccups									
147. watch								wɔsç	
148. sew									
149. jam									
150. fish									
151. knob									
152. handle									
153. shaker									
154. squish									
155. salt				(sɑ)					
156. pepper						((mɛ̃mɛ̃))		pæp	
						((bɛʔɛ))		p bæ:bm	
157. gate									
158. dump	(dɛm)								
	(d^p)								

Session	86	87	88	89	89A	90	91	92	93
Age	19:24	19:27	19:29	20:1	20:5	20:8	20:12	20:13	20:15
143. chocolate									
144. button								(bɔ̃pm̥)	
								(bɑ:mˢ)	
145. walk							(wʌk)	ɔkʰ	
146. hiccups									
147. watch									mwɑ
148. sew									
149. jam									
150. fish									
151. knob									
152. handle									
153. shaker									
154. squish									
155. salt									
156. pepper				(pʰe)					
157. gate									
158. dump									

Session	94	95A	95B	95C	95D	95	96A	96
Age	20:18	20:18	20:19	20:19	20:20	20:20	20:21	20:22
143. chocolate								
144. button								(bʌ$^{?}$m)
145. walk						wɔk wʌk		wæk
146. hiccups								
147. watch								
148. sew								
149. jam								
150. fish								
151. knob								
152. handle								hænŋə
153. shaker								
154. squish								
155. salt							(sjɔ)	ɔ$^{?}$
156. pepper								jowk
157. gate								
158. dump								

Session	73	74	75	76	77	78	79	79A/B	80
Age	18:13	18:18	18:20	18:23	18:25	18:27	18:30	19:8/9	19:10
159. dumptruck		(dɐ̃gʌ̃)					(lɑ̃tʌ̃)		
160. record		(lɑjɛ)							
		(ɐgʌ)							
161. (click)	(imitation of a click)								
162. frog		ɑ							
163. cake			(ki)						
			(ke)*						
164. latch			(læ)						
165. spout			(dæw)*						
			(væj)*						
166. basket			(dæs-hʌ)						
			(dɪtʌ)						
167. gobble					((gɑ^{ʔ}(ʔ)))				
168. egg					(ej^{h})				
169. brush					(bʌ)				
170. donut						(dʌn)			
171. yum						ʌm			
172. bang						(djæŋ)			dæŋ
									dæjŋ:
173. peep							((pi))		
							(pɛ)		
174. crack							(kɑ)		(k^{h}ɑ)
							(kwæ)*		

Session	81	82	83	84	85	86	87	88	89
Age	19:13	19:15	19:17	19:20	19:22	19:24	19:27	19:29	20:1
159. dumptruck								dɛ? dʌ	
160. record									
161. (click)									
162. frog									
163. cake					(ʌk)				
164. latch									
165. spout							(?)		
166. basket									
167. gobble									
168. egg								ik	ik ɛk?
169. brush									
170. donut									
171. yum									
172. bang									
173. peep									
174. crack									

Session	89A	90	91	92	93	94	95A	95B	95C
Age	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19
159. dumptruck									
160. record									
161. (click)									
162. frog			(wah)						
163. cake								kek	
164. latch									
165. spout									
166. basket									
167. gobble									
168. egg					(e$^{?}$k)				
169. brush		bɔ							
		bʌ							
170. donut									
171. yum									
172. bang				(bæŋ^{kh})		bæŋ		bajŋ	
				bæ̰ŋk^{h}*		bɑjŋ			
173. peep									
174. crack									

Session	95D	95	96A	96
Age	20:20	20:20	20:21	20:22
159. dumptruck				
160. record				
161. (click)				
162. frog				
163. cake				(kʔejkʰ) (gi:k)
164. latch				
165. spout				
166. basket				
167. gobble				
168. egg		ɛ		
169. brush				
170. donut				
171. yum				
172. bang		bæ̃ bəjŋ	bəjn- nəjŋ	bəjŋ bəŋ:
173. peep				
174. crack				

Session	78	79	79A/B	80	81	82	83	84	85
Age	18:27	18:30	19:8/9	19:10	19:13	19:15	19:17	19:20	19:22
175. wall	((wɔ))							wɛ̃	
								w:ʔw	
176. juice	(ʌǰu)						(du)		
177. kaká	(kɑkɑ́)						gʌk^{ʔ}		
178. wind (v.t.)			(wɑ̃j)						
179. under		(ʌhʌ̃)							
		(ʌhʌ)							
180. hair		(?)							
181. baby				(b^{h}ɑbɛj)	bæbæj		bʌjp^{ʔ}i		(:)bɑ̃jbɪ̃
					bɑbɑ*				
182. bell									
183. lamb								Jæ	
184. bump								bʌ	
185. no way!								nowʌj	
186. Daddy									dædi
187. me									
188. hammer									
189. uh-uh									
190. flag									

Session	86	87	88	89	89A	90	91	92	93
Age	19:24	19:27	19:29	20:1	20:5	20:8	20:12	20:13	20:15
175. wall	(wɔ)			(wɔ)					($b^{w}ɹ$)
176. juice					ǰiç ǰus:				
177. kaká	káka	kaká káka							
178. wind (v.t.)								((m)wɑj) wɛ̃ɳ	
179. under									
180. hair									
181. baby			b:ɛjbi $b^{h}ɛ$bi				bɑbi	bʌbi bɛbi	
182. bell									
183. lamb				(Læ)					
184. bump									
185. no way!									
186. Daddy									dædi
187. me	mɛ $m^{w}ɛ$		(mej)						
188. hammer	hæhm	(ɑm̩)	(hæ̃hm̩)		hæhmæ (hæhm̩)	hæhm			(hɑhʌm)
189. uh-uh	ʌ ʔ ʌ								
190. flag		vɑǰ							

Session	94	95A	95B	95C	95D	95	96A	96
Age	20:18	20:18	20:19	20:19	20:20	20:20	20:21	20:22
175. wall								
176. juice							(duts)	
							(djüs)	
177. kaka								gʌ́gɑ
								kɑ́kɑ
178. wind								
179. under								
180. hair								
181. baby								bɛjbi
								bibi
182. bell								
183. lamb								
184. bump								
185. no way!		no wɛj						
186. Daddy								
187. me								
188. hammer								
189. uh-uh								
190. flag								

Session	79A/B	80	81	82	83	84	85	86	87
Age	19:8/9	19:10	19:13	19:15	19:17	19:20	19:22	19:24	19:27
191. man								(mæ̃)	
192. cottage cheese								(kɑʔv)	dɑtix: gɑčiˑ
193. more									mo
194. lemon	(LɑlʌˑLʌ)								
	(ɣlʌˑLʌ)								
195. lentils	(LjʌLʌˑLʌ)								
196. iron		(?)							
197. mama		((?))							
198. bubble		(bʌbʌˑLʌ)							
		(bɛΦʌˑLʌ)							
199. mop		(mːɑ)							
200. knife		(nːɑj)							
201. grandma									
202. wet			((wɛ))						
203. peg			((mej))						
204. open					(om)				
					(o)				
205. see						(t^hi)			ti
						di^h			
206. 'A'						(ej)			(i)

Session	88	89	89A	90	91	92	93	94	95A
Age	19:29	20:1	20:5	20:8	20:12	20:13	20:15	20:18	20:18
191. man									
192. cottage cheese	dɑtsi dɑtčiç			(jɑtš -či)			dɑits čiz*		
193. more									
194. lemon									
195. lentils									
196. iron									
197. mama	(^mɑmɑ́)					mɑmɑ	mɑm^		
198. bubble									
199. mop									
200. knife							(ɲɑj:) (hɑj)	(n:ɑj) (nʲjɑ)*	
201. grandma									
202. wet		(we?) w^							
203. peg									
204. open								ʊ ?^hm	
205. see									
206. 'A'									

Session	95B	95C	95D	95	96A	96
Age	20:19	20:19	20:20	20:20	20:21	20:22
191. man						
192. cottage cheese						
193. more				mwɔj		mo
194. lemon						
195. lentils						
196. iron						
197. mama					m^ m^m	
198. bubble						
199. mop						
200. knife						
201. grandma						
202. wet						
203. peg						
204. open						
205. see						
206. 'A'						

Session	83	84	85	86	87	88	89	89A	90
Age	19:17	19:20	19:22	19:24	19:27	19:29	20:1	20:5	20:8
207. 'B'	(bij)	bij		(ɣi)		di (bi)			
208. 'Z'	(dzij) (t^hi)								
209. ride	(la)		(Baj) (?)						waj
210. doorbell	(d̄od̄ʌ)								
211. Scholl	(šo)								
212. play	(pɛj)								(pɛj)
213. rattle	(Ræ)			(wæDw)					
214. dirt	(dɛ)								
215. pocketbook			(bʌbw)		(pɑ(kɛ)bu)				
216. break			(bek)				($bɛk^h$)		
218. read			(wit^h)						
219. 'C'		si				(testi)= 'that's a ( )'			
220. 'T'		$t^?$i							
221. chick		($d^{(?)}$ɨk) ki,ik							
222. 'J'					((ʌ)dzɛj)		(ǰɛ)		
223. alphabet book		(æpubʌ) (æpʌbʌbʌ)							

Sesssion	91	92	93	94	95A	95B	95C	95D	95
Age	20:12	20:13	20:15	20:18	20:18	20:19	20:19	20:20	20:20
207. 'B'			(bɛ)						
208. 'Z'									
209. ride		wɑ:j							ɑj
		(ɛ)wɑ							
210. doorbell									
211 Scholl									
212. play									
213. rattle									$m_{wæ}$
214. dirt				dɨrt^{h}					
215. pocketbook									
216. break/broke				(b^{w}ɔk)					bek^{h}
									bwok
218. read									
219. 'C'					((ʌ)s̃i)				(si)
220. 'T'									
221. chick									
222. 'J'									
223. alphabet book									

Session	96A	96
Age	20:21	20:22
207. 'B'		
208. 'Z'		
209. ride		
210. doorbell		
211. Scholl		
212. play		
213. rattle		
214. dirt		
215. pocketbook		
216. break/broke		bʌ (bᵂʌk)
218. read		
219. 'C'		
220. 'T'		
221. chick		
222. 'J'		
223. alphabet book		

Session	84	85	86	87	88	89	89A	90	91
Age	19:20	19:22	19:24	19:27	19:29	20:1	20:5	20:8	20:12
224. owl	ʌwʌ				(æw)				
225. crumb		(xʌ)							
226. mirror		(m̃æ̂)							
227. bark				?(bæ)					
228. mitten				(mĩ)					
229. 'V'				(gi)					
230. magnet				?(m)					
231. apple juice				(Lædʌ́dʌ)					
				(Lædʌdu)					
232. bottom				(bɑ̀m)					
233. apple sauce				æpʌXɔ			?		
234. mommy				(mʌm...)					
235. ashtray					(gu̇ækɛj)				
236. letter					(ɛdu)				
					(?ɛjʌ)				
237. horsie					(hʌs̀i)	hʌsi			hʌsi
									ɔ̀si*
238. train									
239. rug						(wʌ)		(wʌj)	
								(wʌk^{h})	

Session	92	93	94	95A	95B	95C	95D	95	96A
Age	20:13	20:15	20:18	20:18	20:19	20:19	20:20	20:20	20:21
224. owl									
225. crumb									
226. mirror									
227. bark		(bʌk)							
228. mitten									
229. 'V'									
230. magnet	mæ̃								
231. apple juice									
232. bottom									
233. apple sauce									
234. mommy									
235. ashtray									
236. letter									
237. horsie		(hʌs)			hɔ́si			hɑjsi	hʌ̀si
		ɑs			hɔjsjɬ				hɑ̀s
238. train									
239. rug	wækʰ	wʌ			ʌwʌ			(wʌɣ)	
	(wʌk)*				wʌ			(wʌ)*	

Session 96

Age 20:22

224. owl

225. crumb

226. mirror

227. bark

228. mitten

229. 'V'

230. magnet

231. apple juice

232. bottom

233. apple sauce

234. mommy

235. ashtray

236. letter

237. horsie hɑ̀si
hʌjsi

238. train

239. rug

Session	89	89A	90	91	92	93	94	95A	95B
Age	20:1	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19
241. flower									
242. stopped									
243. that'sa									
244. goose									
245. 'O'									
246. sugar									
247. turkey									
248. domino									
249. matzo									
250. tower					(tæ:)		(dæwɨ)*		
251. nut									
252. bucket			(bʌk)	(bʌkʰ)					
			(dʌtɨ)*						
253. plane				maj					
254. plug									
255. fence	(we)								
256. hot dog		(haku)							haːku
		haku							

Session	95C	95D	95	96A	96
Age	20:19	20:20	20:20	20:21	20:22
241. flower					
242. stopped					(dɐp)
243. that'sa			(æts)		
			(æðʌ)		
244. goose					
245. 'O'					
246. sugar					
247. turkey					
248. domino					
249. matzo					
250. tower					tɑ:
251. nut					
252. bucket					((ʌ)bʌkɨ)
					(mp^{w}ʌkɨt^{h})
253. plane				mẽ	
254. plug					
255. fence					
256. hot dog				xɑku	
				hɑk^{w}e*	

Session	89A	90	91	92	93	94	95A	95B	95C
Age	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19	20:19
257. bike		bʌj			ɑbɑkʰ	bɛjk			
		(bɑjk)*			(bɑjk)	bɑkʰ			
258. pocket		ΦʌpʌΦ							
259. ice		æx				ɑjç			
		ɑjç							
260. milk				mʌk	(ʌ)mʌ	muk	muk	m̥:ok	
				mwk	(ʌ)mʌk*	ʌmʌ:k*	mʌk	mʌk	
261. uh-huh				ɑhhuh					
262. my/mine				mɑj					
				mɑ					
263. belt/buckle					bʌk				
					(bək)				
264. sit						sɨtʰ			
265. snake									
266. spoon						pm			
						pom*			
267. outside		(æw)				æwčæ			
						ʌšʌ			
268. (ɛsjɛ)								ɛsjɛ́	
269. toys							tˈojs		
							tʰʌìs̀		
270. shirt					(sæt)		(s̀i)		
271. way up							(s̀it)		
272. rain									

Session	95D	95	96A	96
Age	20:20	20:20	20:21	20:22
257. bike				bɑjk
258. pocket				
259. ice				
260. milk		muk	mʌk	
		mʌk	$m^{w}ʌk$	
261. uh-huh				
262. my/mine				
263. belt/buckle		bwk		
		(bɛlˀ)		
264. sit				
265. snake		(?)$_{sjɛ}$		
266. spoon				
267. outside				
268. [ɛsjɛ]				
269. toys		(?)		
270. shirt		xit^{h}		
		sit^{h}		
271. way up		(wejɑ)		
		(βejɑ)		
272. rain		(wejn)	(wej(n))	

Session	89	89A	90	91	92	93	94	95A	95B
Age	20:1	20:5	20:8	20:12	20:13	20:15	20:18	20:18	20:19
273. horn									
274. pillow									
275. bib						bip	(bɨˀ)		
276. 'H'	(ɛjčʌ)								
277. kitty cat	(ɛtʊ...)								
278. what	(wɑ)								
279. backward			(bæ:k)						
280. workshop			(wugʊ)						
281. hi			(hɑj)						
282. sticky			(sje)						
283. Randa			(ŋǣn̄ʌ)						
			(ɲ:ɑndʌ)						
284. piggy				(pɨkʰ)					
285. cougar				(kʉ̈)					
286. it go					(ɛko)				
287. Lise					(s̀is̀ʌ)		(mˇixʌ)	(šjʌ)	
							(siʌ)		
288. stop					(se)				

Session	95C	95D	95	96A	96
Age	20:19	20:20	20:20	20:21	20:22
273. horn					(hʌn)
					(hʌən)*
274. pillow					bæ
					bʌj^{ð}pɛ
275. bib					bip
276. 'H'					
277. kitty cat					
278. what					
279. backward					
280. workshop					
281. hi					
282. sticky					
283. Randa					
284. piggy					
285. cougar					
286. it go					
287. Lise			(siə)	(s̀ij)	
				(s̀isjɛ)	
288. stop					

Session	92	93	94	95A	95B	95C	95D	95	96A
Age	20:13	20:15	20:18	20:18	20:19	20:19	20:20	20:20	20:21
289. nice	(nʌjs)								
290. nope	nʌp								
291. mailbox		((ʔ)-bɑk)							
292. seal		(siə)							
		(sjʌ)							
293. rabbit		(wɑ)							
		(wæ)							
294. all									
295. 'K'		(kˀæi)							
		(k^hɛj)							
296. raisin		(wɛʌ)							
297. top		(dɑ)							
298. lap		(wa)							
299. puppy		(pʌpi)							
		(bɑbi)							
300. feet		(fit^h)							
301. oink			?					(oiŋk)	
302. shell			(šzɛwʌ)						
303. comb			(kum)						
			(kˀjɛm)						
304. table			(ti)		(Note: none of these words had tokens appearing on session 95)				

Session	95A	95B	95C	95D	95	96A	96
Age	20:18	20:19	20:19	20:20	20:20	20:21	20:22
305. 'E'	(i)						
	(ej)						
306. 'F'	(ɛ)						
307. 'G'	(ʌǰi)						
308. your back		(ʌbɛkʰ)					
309. burp		(bʌp)					
310. bowl		(bu)					
		(bow)					
311. 'P'					(pʾi)		
312. deer					(diəw)		
					(diw)*		
313. yak					(?) (gæ:kʰ)		
314. bag					(bɑjg)		
315. boat					(bʷotʰ)		
					(boʾ)*		
316. umbrella					(ʌbwʌ::)		
					(bɑj)		
317. fit						(fɨt)	
318. pedal							(bʌʾm)
319. tape deck							(t̄d̄ʌ̄)
320. Robin							(wʌbʾ)

Session	95	96A	96
Age	20:20	20:21	20:22
321. sharp			(ž^p)
322. lid			(z:ɬd)
323. penny			(bæ)
324. home			(hom)
325. battery			(bæj)
			(bæ)
326. olive			(a'iv)
327. piece			(?) (pis)
328. back			(bæk)

SCALE I Appendix 2 Užgiris and Hunt Tests

SITUATION	PRESENTATION 1	2	3	4	5
3. Finding an Object Which is Partially Covered (3)					
a. Loses interest	.....				
b. Reacts to the loss, but does not obtain object	.....				
*c. Obtains the object	.....				
Other:	.....				
4. Finding an Object Which is Completely Covered (3)					
a. Loses interest	.....				
b. Reacts to loss, but does not obtain object	.....				
c. Pulls screen, but not enough to obtain object	.....				
*d. Pulls screen off and obtains object	.....				
Other:	.....				
5. Finding an Object Completely Covered in Two Places (2)					
a. Loses interest	.....				
b. Searches for object where it was previously found	.....				
c. Searches for object where it is last hidden	.....				
Other:	.....				
6. Finding an Object Completely Covered in Two Places Alternately (3 - 5)					
a. Becomes perplexed and loses interest	.....				
b. Searches haphazardly under one or both screens	.....				
*c. Searches correctly under each of the screens	.....				
Other:	.....				
7. Finding an Object Completely Covered in Three Places (5 - 7)					
a. Loses interest	.....				
b. Searches haphazardly under some or all screens	.....				
*c. Searches directly under correct screen	.....				
Other:	.....				

SCALE I

SITUATION	PRESENTATION				
	1	2	3	4	5
8. Finding an Object After Successive Visible Displacements (3 - 5)					
a. Does not follow successive hidings	.....				
b. Searches only under the first screen	.....				
c. Searches under screen where object was previously found	.....				
d. Searches haphazardly under all screens	.....				
e. Searches in order of hiding	.....				
f. Searches directly under the last screen in path	.....				
Other:	.....				
9. Finding an Object Under Three Superimposed Screens (2 - 3)					
a. Loses interest	.....				
b. Lifts one or two screens, but fails to find object	.....				
*c. Removes all screens and obtains object	.....				
Other:	.....				
10. Finding an Object Following One Invisible Displacement (3)					
a. Loses interest	.....				
b. Reacts to loss, does not search	.....				
c. Searches only in the box	.....				
*d. Checks the box and searches under the screen	.....				
*e. Searches under screen directly	.....				
Other:	.....				
11. Finding an Object Following One Invisible Displacement with Two Screens (2)					
a. Searches only in box	.....				
b. Searches under screen where object was previously found	.....				
*c. Searches directly under correct screen	.....				
Other:	.....				

SCALE I

SITUATION	PRESENTATION				
	1	2	3	4	5
12. Finding an Object Following One Invisible Displacement with Two Screens Alternated (3)					
a. Loses interest	.....				
b. Searches haphazardly under screens	.....				
*c. Searches directly under correct screen	.....				
Other:	.....				
13. Finding an Object Following One Invisible Displacement with Three Screens (5-7)					
a. Loses interest	.....				
b. Searches haphazardly under all screens	.....				
*c. Searches directly under correct screen	.....				
Other:	.....				
14. Finding Object Following a Series of Invisible Displacements (4-6)					
a. Searches only in E's hand	.....				
b. Searches only under first one or two screens in the path	.....				
*c. Searches under all screens in the path in the order of hiding	.....				
d. Searches directly under the last screen in the path	.....				
Other:	.....				
15. Finding Object Following a Series of Invisible Displacements with Evidence of Representation (2)					
a. Searches only under last screen	.....				
b. Searches haphazardly under all screens	.....				
*c. Searches systematically from the last screen back to the first	.....				
Other:	.....				

SCALE II

SITUATION	PRESENTATION 1	2	3	4
4. Letting Go of an Object in Order to Reach for Another (3)				
a. Reaches for third object while holding the others	.....			
b. Reaches for third object with filled hands and drops one in the process of reaching	.....			
*c. Drops one of the objects prior to reaching for third	.....			
Other:	.....			
5. Use of Locomotion as Means (2)				
a. No attempt to retrieve object, continues play	.....			
b. Indicates desire for object, but does not try to retrieve it	.....			
*c. Moves to regain the object and resumes play using it	.....			
Other:	.....			
6. Use of the Relationship of Support (2)				
a. Reaches for object on the support (2)	.....			
b. Tries to get object by climbing	.....			
c. Appeals to another person to get the object	.....			
*d. Pulls the support after demonstration	.....			
*e. Pulls support without demonstration	.....			
Other:	.....			
7. Understanding of the Relationship of Support (1-2)				
a. Pulls support expecting to obtain object	.....			
b. Pulls support, but reaches for object at same time	.....			
*c. Does not pull the support without the object on it	.....			
Other:	.....			

SCALE II

SITUATION	PRESENTATION 1	2	3	4
8. Use of String Horizontally (2)				
a. Reaches for the object, ignoring string	.....			
b. Manipulates the string, but does not pull it enough to get object	.....			
*c. Pulls string and gets object after demonstration	.....			
*d. Pulls string and gets object without demonstration	.....			
Other:	.....			
9. Use of String Vertically (2-3)				
a. Indicates desire for object, ignoring the string	.....			
b. Drops string to floor and becomes unhappy	.....			
c. Plays with the string itself	.....			
d. Pulls the string, but not sufficiently to get the object	.....			
*e. Pulls string and obtains object after demonstration	.....			
*f. Pulls string and obtains object without demonstration	.....			
Other:	.....			
10. Use of Stick as Means (2)				
a. Plays only with stick	.....			
b. Reaches for object, disregarding stick	.....			
c. Plays with stick, and object, does not get object closer	.....			
*d. Uses stick to get object after demonstration	.....			
*e. Uses stick to get object without demonstration	.....			
Other:	.....			

SCALE II

SITUATION	PRESENTATION 1	2	3	4
11. Foresight in the Problem of the Necklace and the Container (2-3)				
a. Does not try to put necklace into container	.....			
b. Attempts to put necklace in, but fails repeatedly	.....			
c. Succeeds in putting necklace in after several unsuccessful attempts	.....			
d. Invents a method which is successful after a failure	.....			
*e. Adopts a method which is successful from the first	.....			
Other:	.....			
12. Foresight in the Problem of the Solid Ring (2-3)				
a. Does not stack rings	.....			
b. Uses force in trying to stack solid ring repeatedly	.....			
c. Attempts to stack solid ring once and avoids it subsequently	.....			
*d. Sets aside the solid ring without attempting to stack it	.....			
Other:	.....			

SCALE IV

SITUATION	PRESENTATION 1	2	3
4. Behavior in a Familiar Game Situation (2-3)			
a. Shows no interest	.....		
b. Remains passive during pauses	.....		
c. A dominant act during pauses suggests a "procedure"	.....		
d. Performs part of the act during pauses	.....		
e. Touches E and waits during pauses	.....		
Other:	.....		
5. Behavior to a Spectacle Created by an Agent (1-2)			
a. Shows interest only during spectacle	.....		
b. Shows excitement, but no dominant act during pauses	.....		
*c. A dominant act during pauses suggests a "procedure"	.....		
*d. Touches E and waits during pauses	.....		
e. Attempts to imitate E	.....		
Other:	.....		
6. Behavior to a Spectacle Created by an Agent Acting on an Object (2-3)			
a. Shows interest only during spectacle	.....		
b. A dominant act during pauses suggests a "procedure"	.....		
*c. Touches E or the object and waits	.....		
*d. Gives object back to E	.....		
e. Attempts to activate object	.....		
Other:	.....		
7. Behavior to a Spectacle Created by a Mechanical Agent (1-2)			
a. Plays with object only	.....		
b. Makes object perform its activity manually	.....		
c. Touches E or object and waits	.....		
*d. Gives object back to E	.....		
*e. Attempts to activate object mechanically after demonstration	.....		
*f. Attempts to discover a way to activate object mechanically before demonstration	.....		
Other:	.....		

SCALE V

SITUATION	PRESENTATION				
	1	2	3	4	5
4. Following the Trajectory of a Rapidly Moving Object (3-4)					
a. Does not follow object, continues to look at E's hand					
b. Follows some, but does not locate object					
*c. Follows object and locates it visually only when it lands in view					
d. Searches with the eyes for object when it lands out of view, but does not lean					
*e. Leans to search for object in the direction where it must have landed					
Other:					
5. Recognizing the Reverse Side of Objects (2-3)					
a. Grasps object with no sign of appreciation of reversal					
b. Withdraws hands and appears surprised at reversal					
*c. Grasps object, but turns it around immediately or by comparing both sides indicates appreciation of reversal					
Other:					
6. Using the Relationship of the Container and the Contained (2-3)					
a. Does not put objects in; only touches those inside					
b. Takes objects out, does not put any in					
c. Puts objects in and takes them out one by one					
*d. Puts or drops objects in, reverses container to get them out					
Other:					

SCALE V

SITUATION	PRESENTATION				
	1	2	3	4	5
7. Placing Objects in Equilibrium One Upon Another (2-3)					
a. Does not try to build tower	.....				
b. Approximates two objects, but does not leave the second on the first	.....				
*c. Builds a tower of at least two objects	.....				
Other:	.....				
8. Appreciating Gravity in Play with Objects (2-3)					
a. Does not attempt action	.....				
b. Acts without showing appreciation of gravity	.....				
*c. Acts with appreciation of the force of gravity	.....				
Other:	.....				
9. Exploring Fall of Dropped Objects (1-2)					
a. Does not systematically drop objects	.....				
b. Drops several objects repeatedly, does not look at where they land	.....				
c. Drops several objects repeatedly and looks to see where they land	.....				
Other:	.....				
10. Making Detours (2-3)					
a. Loses interest in objects	.....				
b. Attempts to reach for the object using the same path as object	.....				
c. Goes directly around the barrier, thus making a detour	.....				
Other:	.....				
11. Indicating Absence of Familiar Persons (1)					
a. Does not comprehend question	.....				
b. Goes to the usual location of the person	.....				
*c. Indicates knowledge of absence by gesture or word	.....				
Other:	.....				

Sample Summary Record Forms

SCALE I:

THE DEVELOPMENT OF VISUAL PURSUIT AND THE PERMANENCE OF OBJECTS

Infant Code Number:

Age:

SCALE STEP	RELEVANT SITUATION NUMBER	CRITICAL INFANT ACTION	INFANT ACTIONS OBSERVED
1	1	d	
2	2	c	
3	3	c	
4	2	d	
5	4	d	
6	6 (and 5)	6-c (and 5-c)*	
7	7	c	
8	9	c	
9	10	d or e	
10	11	c	
11	12	c	
12	13	c	
13	14	c	
14	14 and 15	14-d plus 15-c	

*Infant actions in situations 5 and 8 were not included in the scaling analysis. The scale step for which actions in situation 5 may be relevant is indicated in parentheses.

SCALE II:

THE DEVELOPMENT OF MEANS FOR OBTAINING DESIRED ENVIRONMENTAL EVENTS

Infant Code Number:

Age:

SCALE STEP	RELEVANT SITUATION NUMBER	CRITICAL INFANT ACTION	INFANT ACTIONS OBSERVED
1	1	b	
2	3	c	
3	2	b	
4	2	c or d	
5	4	c	
6	6	d or e	
7	5	c	
8	7	c	
9	8	c or d	
10	9	e or f	
11	10	d or e	
12	11	e	
13	12	d	

SCALE IV:

THE DEVELOPMENT OF OPERATIONAL CAUSALITY

Infant Code Number:

Age:

SCALE STEP	RELEVANT SITUATION NUMBER	CRITICAL INFANT ACTION	INFANT ACTIONS OBSERVED
1	1	b	
2	2	c	
3	3, 5, 6 (and 4)	3-c or 5-c (and 6-b, 4-c)*	
4	5, 6, 7	5-d or 6-c (and 7-c)	
5	6,7	6-d or 7-d	
6	7	e	
7	7	f	

*Situation 4 was not included in the scaling analysis; the infant action which may be appropriate for one of the scale steps is indicated in parentheses.

SCALE V:

THE CONSTRUCTION OF OBJECT RELATIONS IN SPACE

Infant Code Number:

Age:

SCALE STEP	RELEVANT SITUATION NUMBER	CRITICAL INFANT ACTION	INFANT ACTIONS OBSERVED
1	1	b	
2	1	c	
3	2	d	
4	3	d	
5	4	c	
6	4	e	
7	5	c	
8	6	d	
9	7	c	
10	8 (and 9)	8-c (and 9-c)*	
11	11 (and 10)	11-c (and 10-c)	

*Situations 9 and 10 were not included in the scaling analysis; the infant actions in these situations which may be appropriate for particular scale steps are indicated in parentheses.