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ON THE DEVELOPMENT OF LANGUAGE
PRODUCTION MECHANISMS

FRANK WIJNEN

ON THE DEVELOPMENT OF LANGUAGE PRODUCTION MECHANISMS

Een wetenschappelijke proeve op het gebied van de sociale wetenschappen.

PROEFSCHRIFT

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Frank Wijnen

1.1 THE AIM OF THIS STUDY

There is a somewhat peculiar difference between the approaches to language behavior of psycholinguists who deal with adults and psycholinguists who deal with children. The generally accepted definition of the domains of inquiry of psycholinguistics is 'language perception, language production and language acquisition'. Evidently, this mapping of the field is equally applicable to the study of adults and children. Indeed, within 'adult psycholinguistics', we encounter each of the three topics. There is a vast and ever-expanding body of research in language perception and language comprehension. Language production, although it still does not get the research attention it deserves, has become a respectable and lively field, and language learning in adults, both tutored and untutored, receives a good deal of attention, although perhaps from researchers who do not tend to call themselves psycholinguists.

In contrast to this, developmental psycholinguists are primarily engaged in studying the acquisition of linguistic knowledge, leaving the perception and production of language by children relatively untouched. This may not come as a surprise, for the main characteristic which discriminates adult language users from children, is that the latter know less than the former. Children acquire knowledge of their mother tongue continuously. Their knowledge increases from day to day, even from hour to hour. Consequently, the acquisition problem is central in the psycholinguistic study of children.

In the study of language acquisition, most attention has been paid to the 'what-question': How should the knowledge that children possess during the first four or five years of their lives be characterized? Consequently, it could be said that to a large extent, developmental psycholinguistics fulfills a role with respect to child language that is analogous to that of linguistics in the study of adult language behavior. Many developmental psycholinguists behave somewhat like anthropological linguists, meticulously observing and analyzing child language in order to gain an understanding of the grammar that underlies it. In spite of the fact that developmental psycholinguistics is one of the fastest growing members of the family of cognitive sciences, its state of the art with respect to the 'what' question is, briefly and somewhat cynically stated, that there are no answers at all. This is not to imply that all efforts have been useless, on the contrary. It is a matter of fact that we now know all sorts of

things about children's language development that we did not even imagine 20 years ago. However, regarding the specific question of *what* it is that children acquire, it should be stated that there is, at best, a multitude of conflicting opinions.

Maybe the answers are not yet available because thirty years of reasonably programmatic, institutionalized developmental psycholinguistic research has not been enough.¹ Perhaps it is too difficult (or even impossible) to induce models of knowledge from natural speech data (Wexler 1982). Perhaps the basic premise in this quest, viz. that there is something like 'child language', just like there are English, Dutch, Warlpiri, Tamil, and so forth, is false. Child language may be a language which does not exist, according to the late Willem Kaper in his last book (Kaper 1985), and he may be right. Perhaps the conceptual apparatus that has been applied in the field is insufficient, or even plainly wrong. For instance, many studies of the development of syntax have attempted to describe developing grammars in terms of phrase structure rules and transformations. In the meantime, however, it has become clear that these notions may not be the best option in an explanatorily adequate grammar (Chomsky 1986).

The 'how-question' in developmental psycholinguistics, i.e., what process underlies the purportedly rapid and smooth acquisition of the mother tongue, is also still far from being answered. In part, this may be due to the continuing indeterminacy regarding the answer to the 'what-question', i.e., a description of the knowledge that children possess at different stages of language development, for this is a necessary condition. However, the problem is more profound, since there even appears to be a lack of consensus concerning the general characterization of the process of first language learning (cf., for instance, the diversity of contributions in a recent volume on this matter, edited by MacWhinney [1987]). Some say children learn language in an essentially passive way: they just gradually accumulate knowledge by listening to adults. Others argue that the child is actively engaged in a process of constructing or reconstructing the units and rules of the target language (Karmiloff-Smith 1979, Elbers 1989a). And there are those who think that language is not something that is learned, but something which *matures*, rather like a physical organ (Chomsky 1988, Borer & Wexler 1987).

As stated before, the acquisition problem is undoubtedly central to developmental psycholinguistics. However, acquiring knowledge of language is not the only thing a child does. A child is also a language *user*: although his knowledge may be incomplete, he applies it in speaking and listening. The child, like the adult language user, possesses cognitive mechanisms that enable him to comprehend and produce language. Consequently, the questions should be asked as to what these processes look like in children; whether they differ from those in adults and, if so, how they change during development. In other words, developmental psycholinguistics should also care about the ontogenesis of the mechanisms of speaking and understanding.

¹ I do not intend to disregard the often significant and insightful work that was done before 1960. However, I tend to think that this research was neither "programmatic" nor "institutionalized".

Investigating the development of language processing mechanisms is not only inherently interesting and valuable, it may also prove to be relevant for the study of (knowledge) acquisition. Students of child language development often (if not always) start from the premise that the cognitive mechanisms (involved in the production and perception of language) in adults and children are identical. This was called the 'null-hypothesis of developmental psychology' by John MacNamara (1982). Pinker (1984) argues that it is necessary to presuppose this hypothesis in order to be able to provide an *explanatory* account of language acquisition:

The most explanatory theory will posit the fewest developmental changes in the mechanism of the virtual machine [i.e., the cognitive apparatus, F.W.], attributing developmental change, when necessary, to increases in the child's knowledge base, increasing access of computational procedures to the knowledge base, and quantitative changes in parameters like the size of working memory (Pinker 1984.6-7)

The null-hypothesis may be fruitful or even necessary in the quest for an explanation of language acquisition, but it may be empirically invalid. In spite of the scant attention that has been paid to language mechanisms in children, there are some indications that speaking and understanding may proceed differently in children than in adults. A note of warning is order here: of course children do understand and speak 'differently' as compared to adults in the sense that they do not understand certain words or constructions, overregularize morphology, et cetera. Such differences are trivial, however, from the perspective of the development of speaking and understanding mechanisms, as far as they reflect a reduced amount of knowledge. What is at stake here are differences in the representations and processes which underlie speaking and understanding (the relation between what is known and how it is represented and processed, is of course somewhat more complex, see Chapters 3, 6). For instance, in the domain of comprehension. Cole and Perfetti (1980) claim that the interplay between bottom-up and top-down processes in spoken word recognition is different for children and adults. As regards production: recent developments in child phonology indicate that the nature of word form representations in young speakers and, consequently, the process of encoding words for production are clearly different from those in adults

Findings from the study of the development of speaking and understanding mechanisms could, or perhaps should, have an impact on the types of solutions that are proposed in the study of the acquisition of knowledge. For instance: if behavioral studies indicate that in young children word forms are represented as unanalyzed routines (see Chapters 2, 3, Wijnen, Veenhof-Haan & Elbers 1989), then it seems senseless to model these children's phonological knowledge in terms of phonological segments and segment-oriented rules. This point of view is controversial, of course, for it suggests a much closer connection between so-called 'competence', i.e., knowledge of language, and performance, i.e., the processes involved in speaking and understanding, than is customary.

This dissertation is intended as a contribution to the study of the ontogenesis of language mechanisms. Specifically, it investigates the development of the cognitive mechanism underlying language production. The central issue of the research reported in this dissertation is: Does the language production mechanism alter during the period in which

language is acquired. Thus, the studies of which this dissertation consists are tests of the 'null-hypothesis' in developmental psychology, applied to the domain of language production.

Clearly, this enterprise presupposes a picture of the goal state of development, i.e., the mature language production mechanism. There is such a picture, albeit incomplete. It has grown out of the contributions of several distinguished scholars such as Fromkin (1971), Garrett (1975, 1980, etc.), Kempen & Hoenkamp (1987), and Levelt (1989). It may be called the *information processing model* of language production, and it forms the backbone of this dissertation. A brief introductory overview of this model will be provided in section 1.2. Recently, information processing models of cognition were challenged by a new approach, usually called 'connectionism'. Examples of connectionist models of language production are provided in Stemberger (1985) and Dell (1986) and MacKay (1987). It might be that the results of my research can be accounted for by connectionist notions. This should not come as a surprise in view of the suggestion that connectionist models can account for any kind of behavior, as they are virtually unconstrained (cf., Massaro 1988). For the domain of language development this would imply that connectionist models can learn anything, whereas children are, as a matter of fact, constrained, presumably in a way that is represented in theories of universal grammar. The attractive side of connectionist models, on the other hand, is the fact *that* they learn; in fact processing and learning are indiscriminable. This, in its turn, presupposes the identity of knowledge (competence) and processing (performance), a perspective to which I am fundamentally sympathetic. Thus, connectionist models may have a great potential for providing an integrated account of language acquisition and language processing, provided that they can be adequately constrained. However, this potential is not systematically scrutinized in this book.

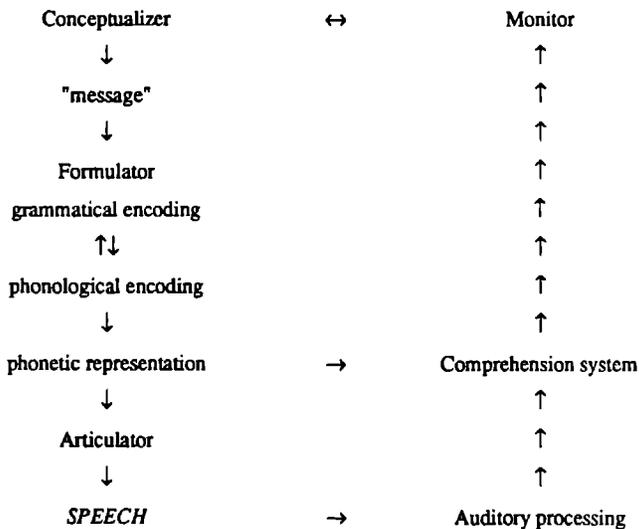
1.2 AN OUTLINE OF THE MATURE SPEAKER

Although the debate with regard to the precise mechanics of the system still continues, recent research on the human speech production ability has converged in a three-partite division of the cognitive apparatus. A recent representation of this model can be found in Levelt (1989). Although Levelt's model has certain idiosyncratic characteristics, it reflects many characteristics of related proposals (see references above). Thus, it can be considered as an adequate starting point for the formation of hypotheses concerning the development of the speaker.

The three main parts of the speech production mechanism, as portrayed in Figure 1.1 are labelled *Conceptualizer*, *Formulator*, and *Articulator*. The *Conceptualizer* creates pre-verbal messages in what is presumed to be some sort of propositional format. The messages are input into the *Formulator*, which consists of two sub-processors, the *grammatical encoder* and the *phonological encoder*. The *formulator* is a lexically driven device. Message fragments, generated by the *Conceptualizer*, are employed to access lexical representations of appropriate words via a 'semantic' route. These lexical representations or 'lemmata'

incorporate information concerning the lexical items' syntactic properties, i.e., syntactic category, and syntactic arguments. This information is used to build syntactic structures, which are input to the phonological encoder. This processor associates the end nodes (lemmata) of the syntactic structures with the appropriate phonological forms (lexemes) and computes the overall phonetic plan for the utterance (or utterance segment), which is transmitted to the final component of the system, the Articulator. This processor employs the phonetic plans provided by the phonological encoder to construct motor programs for the articulatory apparatus. The output of the system, i.e., overt speech, as well as the phonetic plan underlying it (inner speech), can be monitored for errors in syntax, lexical choice and articulation, as well as for pragmatic and communicative appropriateness of the messages communicated. Levelt (1989) argues that the monitoring function is performed by the speech comprehension system, in a manner comparable to that which enables the analysis and understanding of speech by others.

Figure 1. A rough blueprint for the speaker (after Levelt 1989)



I will not attempt to provide a detailed exposition of the mature language production system, including discussions of the precise nature of the representations and the time course of processes involved. For this information the reader is referred to Levelt's outstanding work (1989). Some of these issues will come up in the discussions of the developing system in the ensuing chapters. Each of these is introduced by a short review of the research into the component of adult language production to which it relates. For the moment, it will suffice to consider the global defining characteristics of the speech production system as proposed

by Levelt. Later on it will be argued that these characteristics are not yet incorporated in the system's 'initial state', but are attained in the course of development.

The defining attributes of the mature speech production system are threefold: *modularity*, *hierarchy*, and *incremental function*. The term 'modularity' refers to the assumption that the Formulator's two components and the Articulator are what Levelt calls 'relatively autonomous specialists'. This implies that a particular processing component is the only processor that is capable of a certain task, and that furthermore, this task is the only one that the processor is capable of. Thus, for instance, the Grammatical Encoder is the only processor that is capable of building surface structures, and it cannot do anything else. Furthermore, processors can perform their tasks all by themselves, that is, without dependence upon the products of other processors inside or outside the speech production system, except, of course, for the superordinate processor that provides the necessary input. This input is the proximal cause of the processor's functioning and needs to be of a particular format. Hence, the Formulator only reacts to message representations generated by the Conceptualizer, and the Articulator is only triggered by phonetic plan representations, produced by the phonological encoder.

The production system is *hierarchical*, which means that a lower-order processor can only begin to operate when the superordinate component has produced a sufficient amount of output, and that lower-order processors do not influence the functioning of higher-order processors. Thus, the Articulator cannot influence the computations at the level of the Formulator, and the functioning of the Formulator, in its turn, is of no consequence whatsoever for the procedures in the Conceptualizer. The only exception to this rule concerns the two subcomponents of the Formulator. Experimental as well as naturalistic evidence has suggested that the processes involved in phonological encoding may affect the computation of syntactic structures at the level of grammatical encoding (Levelt & Maassen 1982, Bock 1987).

Finally, the speech production system is characterized by what is called *incremental operation*. This refers to the assumption that during speaking all processing components are simultaneously active in processing different fragments of the utterance to be produced. For instance, if the speaker's intention has been to declare '*Yesterday all my troubles seemed so far away*', it is conceivable that at a certain point in time the first phrase '*yesterday*' is being articulated, while at the same time the second phrase '*all my troubles*' is phonologically encoded (a subprocess of the Formulator), and the third phrase '*seemed so far away*' is in propositional format entered into the grammatical encoding component of the Formulator. The simultaneous functioning of the separate processors within the production system may be compared to an assembly line in an automobile factory. It is clear that all workers in such a factory are working 'in parallel', but they do not work simultaneously on the same automobile.

1.3 THE TOPICS.

The empirical body of this dissertation consists of four chapters, each of which can be read as an autonomous research report. In fact, these chapters were written as journal articles, one has already been published, the others have been, or will be, submitted for publication in various periodicals. There are two ways to introduce these chapters. The first is to approach them from the bottom up, as it were, by describing what sort of phenomena they discuss and how they proceed in reaching conclusions. This is, in a way, the most straightforward approach, since the research reported is typically 'data-driven'. However, in spite of this data-drivenness, each of the four studies was designed to address a specific problem within the theoretical framework of language production in children. Highlighting these four topics and relating them to the model outlined above would be the second, 'top-down' way to introduce the studies of which this dissertation consists. I will do both.

First of all, however, it should be stressed that all four empirical chapters describe naturalistic, observational studies of language behavior. The behavior studied does not, in general, refer to the 'substance' of children's utterances, but rather to their form. In particular, the phenomena that are studied are instances where 'form' breaks down: hesitations, speech errors, self-corrections. Each study is based on a longitudinally collected set of natural speech data of two 2-3- year old boys. Consequently, the numbers of subjects are small: one or (mostly) two. The traditional objection from experimental psychology against small sample sizes is that it precludes generalization. Admittedly, there may be a chance that some of the observations reported here will not be replicated in other children. On the other hand, the fine-grained analyses which can be performed on small numbers of subjects may lead to strong hypotheses concerning the development of the processing structures *underlying* the observed behavior.

Seen 'from the bottom-up', Chapter 2 reports on an analysis of spontaneous word fragmentations, i.e., instances of speech disfluency in which units of speech that are recognized as words are broken up into parts. The analyses focus on the places in words, defined in terms of the sequence of speech sounds, where interruptions occur, and where speaking is resumed. Chapter 3 deals with so-called 'incidental errors' in the speech of the two subjects. Incidental errors are defined as errors that are ostensibly not accountable for in terms of lack of knowledge. The focus is on errors at the level of words and sounds. Among the issues addressed are the relations, both conceptual and formal, between words involved in substitution errors. Furthermore, special attention is given to the question whether sound errors are articulatory or phonological (i.e., involving misselections or misorderings of phonological segments). Chapter 4 provides an analysis of non-fluencies, in particular repetitions of sounds, syllables, words and phrases. Conclusions are drawn with respect to the form and distribution of these phenomena, and with respect to the relation with indices of linguistic growth such as vocabulary size and sentence length. Finally, Chapter 5 contains an analysis of speech revisions, i.e., alterations of previous utterances. Three types of revisions are studied: self-corrections (spontaneous revisions involving non-fluency), replacements (spontaneous, non-interruptive alterations) and clarifications (revisions upon requests from a

listener). The analyses focus on the formal differences between these three categories with respect to what aspects of utterances are revised and how.

Looking 'from the top down', Chapter 2 deals with articulatory processing. It is argued that syllable-sized chunks of speech correspond to units of processing at the level of articulatory program assembly and execution. Ontogenetically, syllable routines are the motoric foundation for the subsequent development of phonological processing. Chapter 3 launches some ideas on the development of lexical processing, i.e., the retrieval and outputting of words in speech. It is suggested that the mental lexicon is initially non-modular. Chapter 4 addresses the development of formulation, i.e., the processes involved in constructing sentences. It is argued that the final lay-out of the formulating module, which is characterized by the separation of 'syntactic' and 'phonological' planning phases, is not reached until the age of approximately 3, when the child develops from a 'telegraphic speaker' into a syntactically more mature language user. Chapter 5, finally, is devoted to the process of monitoring. It is argued that different types of speech revision serve different functions, which are subserved by different modes of the monitoring process. The first mode is dedicated to the maintenance of optimal speech performance, given the current level of ability. The alternate mode is dedicated to the exploration and improvement of language abilities.

The final chapter of this dissertation attempts to integrate the empirical studies into a model for the development of language production. Some attention is given to the relation between the acquisition of language (knowledge), i.e., what is learned and how it is learned, and the development of the production mechanisms. It is argued that the fundamental architectural characteristics of the mature language production system as outlined in the previous section (modularity, hierarchy, incremental function) are not 'developmentally invariant', but are gradually attained in the course of language acquisition.

2

SPONTANEOUS WORD FRAGMENTATIONS IN CHILDREN: EVIDENCE FOR THE SYLLABLE AS A UNIT IN SPEECH PRODUCTION¹

2.0 ABSTRACT

Part-word repetitions and word-internal pauses which occurred in two 2-3 year old boys' recorded spontaneous speech were analyzed. A common framework for the assessment of these two types of fragmentations was employed in which interruptions of the articulatory process were distinguished from restarts. Interruptions occurred in monosyllabic as well as in polysyllabic words. In polysyllabic words, interruptions mostly preserved CV(C) units. In these cases, they were followed by immediate restarts, i.e. the continuation of articulation from the point of interruption onwards. In cases where interruptions distorted CV(C) structure, a high proportion of retraced restarts was found. Retraced restarts involved either the word beginning (full retracing) or an intervocalic consonant directly preceding the place of interruption (partial retracing). These results support the hypothesis that the production of speech involves syllable-sized articulatory units. Supplementary results on the locations of speech interruptions show correspondences with results of elicited syllabification experiments. Some consequences for a theory of the development of speech production are discussed.

2.1 INTRODUCTION

Analyses of two corpora of child utterances, aimed at establishing a possible relationship between speech disfluencies and language development, revealed a considerable number of instances of disturbed speech in which words were unintentionally fragmented into smaller parts. These word fragmentations, occurring either in the form of word-internal pauses or of part-word repetitions, appear to constitute a valuable source of data for the exploration of speech production processes in children. Each fragmentation can be considered to proceed in two phases: (1) the *interruption*, i.e. stopping the articulatory process, and (2) the *restart*, i.e.

¹ *Journal of Phonetics*, 16(1988), 187-202.

the continuation of articulation. This study describes and analyses these two phases of fragmentation in terms of the structural properties of the words in which they occur. The primary goal of these analyses is to shed some light on the issue of *units* in speech production and their ontogenesis.

A discussion of production units in speech should acknowledge the distinction between *planning* and *execution* (Cohen 1966). Speech planning is assumed to incorporate several processing stages, such as message generation, the construction of sentence frames that are able to convey the message structure and the retrieval of words from lexical memory that adequately represent the relevant concepts (cf. Garrett 1975, Levelt 1983). The final result is a so-called 'phonetic representation' of an intended stretch of speech. The execution of this speech plan involves the translation of the phonetic string into sets of neural commands for the articulators, and articulation proper.

Speech error research suggests that the basic unit, i.e. the 'chunk' of information that is operated upon as an indivisible whole, in computing the phonetic representation corresponds to the phoneme (Boomer and Laver 1969, Fromkin 1971, Shattuck-Hufnagel 1983). Among the larger-than-phoneme elements, the syllable has received considerable attention. However, intrusions and transpositions of syllables are so rare that one is inclined to dismiss the syllable as a planning unit. (Shattuck-Hufnagel 1979, 1983) The role syllables play in speech planning seems to be confined to constraining the ordering of phonemes. It has repeatedly been established that the alternation of vowels and consonants, which is captured by the notion 'syllable', is virtually never disturbed in speech errors. Moreover, in phoneme transpositions, the syllabic positions of the reversed elements are almost always identical (Boomer & Laver 1968, MacKay 1970a). Another indication of the organizing role of syllabic structure is MacKay's (1972) finding that in blends of polysyllabic words (e.g. department + behavior → behortment) the source words were more often broken between syllables than within syllables (see MacKay 1982 for a theoretical account of these and related errors). Further speech error evidence (MacKay 1972), as well as experimental results (Treiman 1983), suggests that the constraining role of syllables in planning is implemented through the specification of phonemes as onsets, peaks and codas (cf. Fudge 1969) in the phonetic representation.

On the level of speech execution there is an inclination to consider syllables as the best candidates for processing units. Fry (1964) has argued that the syllable captures the complex but harmonic co-operation of articulatory muscles which constitutes the rhythmical nature of speech. Thus, articulation can be thought to proceed in gestures of syllable size, which are initiated by corresponding clusters of neural impulses (see also Shaffer 1984). There appears to be no direct support for this hypothesis at the neuro-muscular level. Corroborative evidence is provided by studies on coarticulation (Fujimura 1979), speech timing (cf. Farnetani & Kori 1986, Nooteboom & Cohen 1984) and allophonic variation (Maddieson 1985). Moreover, research into speech synthesis indicates that concatenation of syllable-sized speech samples produces reasonably acceptable speech, whereas for instance phoneme concatenation requires excessive adaptation to produce similar results (Fujimura & Lovins 1978). A model for the interface between speech planning and articulation which nicely

agrees with the suggestions from speech synthesis has recently been proposed by Crompton (1982). Crompton argues that this interface, the 'articulatory programmer', contains a library of syllable-sized articulatory routines, which are addressed through a system based on the syllabic constituents onset, peak and coda, which are assumed to specify the ordering of units in the input phonetic representation.

Everything stated so far applies to the mature speech production system. Much less can be said about the development of speech production planning and execution. Apparently, slips of the tongue in children are either so infrequent (cf. Warren 1986), or so difficult to spot amidst other imperfections, that the question as to the development of planning units is still largely unanswered. The only systematic study to date was performed by MacKay (1970b), who analyzed some 23 spoonerisms observed by R. Meringer in 3-6 year old children. Mackay's results seem to imply that, just as in adults, phonemes are the planning units which are fitted into syllabic structures. However, although MacKay's results appear to be unequivocal with respect to the level of processing involved, they are not very informative from a developmental point of view, as a result of not differentiating between ages.

Developmental data have been provided by experimental studies of word fragmentation in children. A general result of these studies is that the ability to break up words into syllable-sized units appears at an early age and before the ability to fragment syllables into phonemes (Liberman, Shankweiler, Fisher & Carter 1974, Fox & Routh 1975). The boundaries of the syllable-sized units which are produced by children in these tasks appear to be affected by various articulatory and suprasegmental attributes of the words (Fallows 1981, Collier & De Schutter 1985, Van den Broecke & Westers 1986). Treiman (1985) purports that as an intermediate stage between word fragmentation into syllables and word fragmentation into phonemes, children are able to separate syllable onsets from rhymes.

Although these studies seem to point at a developmental priority of syllable sized units over phonemes, it is hard to establish on what processing level in speech production this developmental relation holds. Effects of articulatory factors are suggestive of the execution level. On the other hand, the deliberate nature of the task suggests the involvement of planning. There may even be a third possibility, since it has recently been argued that deliberate manipulation of speech may involve a level of representation distinct from those which function in normal speech production (Cowan, Braine & Leavitt 1985). This 'metaphonological' level of representation appears to integrate different strands of information that are relevant to the task at hand: articulatory, phonological, and even -at least in literate adults- orthographic. (cf. Cowan *et al.* 1985, Collier & De Schutter 1985, Read *et al.* 1986). In summary it seems fair to state that the meaning of elicited fragmentation experiments vis-à-vis the development of natural speech production processes and structures is not easy to assess.

Spontaneous fragmentations -like the ones that will be presented below- do not seem to pose these interpretative problems. Since spontaneous fragmentations involve neither a spontaneous change of the speech plan -the parts that result from the fragmentation originate from the same word-, nor an elicited manipulation, there is no need to assume that they refer

to speech planning. Thus, the data that will be presented may be taken to primarily reflect properties of the *execution* level of speech production. The aim of the present study is twofold: First, it attempts to provide new evidence for the claim that syllables are basic units in speech execution. Second, the results will be compared to those of elicited fragmentation experiments, in order to illuminate the correspondences and differences in spontaneous and elicited fragmentation. This is expected to contribute to a better understanding of the development of speech production.

2.2 METHOD

2.2.1 SUBJECTS

The research project on speech disturbances and language development from which the present study originates, makes use of taperecordings of speech delivered by two boys, N and T. A comparison of the ages and mean lengths of utterances (MLU, see Brown 1973) presented in Table 2.1 indicates a difference in developmental rate between the two subjects. N was approximately 9 months older than T during the recording period, but nevertheless his MLUs show considerable overlap with those of T. Thus, N may be qualified as a 'slow' language learner in comparison to T.

This characterization agrees with the differences in phonological development between the two children. At the time of the first recording N had a rather impoverished sound inventory, mainly characterized by pervasive fronting. However, during the period in which recordings were made, this pattern was gradually replaced by a more mature phonological system. Presently, N's speech fully conforms to standards for children of his age. T, on the other hand, showed a particularly rich speech sound inventory from the first recording session onwards.

2.2.2 RECORDING AND TRANSCRIPTION

An approximate total of 25 hours of recordings per child was collected. The recording sessions were evenly spread over time, so that roughly one hour of tape became available for each week. The recordings were made under various ordinary domestic circumstances. Usually, the children were engaged in a conversation with one of their parents. The recording equipment was of ordinary (non-professional) quality. It was usually placed in the direct vicinity of the child, so as to optimally pick up the child's speech.

Approximately 17 hours of recordings per child were transcribed by two independently working, phonetically trained transcribers. The children's speech was broadly transcribed in IPA supplemented with nonstandard diacritics indicating disfluencies and conspicuous aspects of prosody. The adult interlocutor's speech was written down in Dutch orthography. The transcribed tapes cover four 3-5 week periods, which are evenly distributed over the total recording period (see Table 2.1).

The independently produced provisional transcriptions of the children's utterances were compared to generate definitive versions. Discrepancies between the transcriptions were resolved by joint listening to the tapes and negotiation. If the transcribers could not reach agreement on either the segmental transcription or the identification of disfluency, the disputed utterances, or the relevant parts thereof were dismissed from subsequent analysis.

Table 2.I An overview of the transcriptions constituting the corpora T and N

week numbers	total recording time (minutes)	age(min/max) years;months-days	MLU(min/max)	Number of utterances
<i>Corpus T</i>				
1-4	300	2;3-22/2,4-16	1.88-2.17	2050
9-12	240	2;5-17/2,7-9	2.09-3.24	2261
16-20	300	2;8-2/2,9-5	2.35-2.52	2675
24-26	210	2;10-23/2,11-22	2.61-2.86	1711
<i>Corpus N</i>				
1-3	210	3;0-21/3;2-12	2.28-2.42	2291
7-10	240	3;4-4/3;5-0	2.31-2.58	3304
15-18	240	3;6-0/3;7-3	2.17-2.83	3964
21-25	300	3;8-1/3;10-17	2.93-3.89	4266

2.2.3 DATA CLASSIFICATION AND ANALYSIS

Two types of speech disturbances were singled out for the purpose of this study, viz part-word repetitions and word-internal pauses. Part-word repetitions involve the -literal-repetition of a word fragment consisting of one or several phonemes. This fragment can either be word initial, word medial or word final. Accordingly, the part-word repetitions have been labelled repetitions of word beginnings (Rb); word-medial repetitions (Rm) and repetitions of word endings (Re). In word-internal pauses (WIPs), words are fragmented by clearly discernable, dysrhythmic breaks in the pronunciation, usually accompanied by a silent interval of variable duration. Examples are given in Table 2.II.

Although these two classes of fragmentations initially impress the observer as quite different, they can easily be unified within a common process-oriented framework. In each fragmentation, two aspects can be discerned: the *interruption*, i.e., the point in the flow of speech where articulation breaks down; and the *restart*, i.e., the point where articulation is resumed (cf. Levelt 1983). In a WIP, the interruption and the restart are located at the same point. Thus, the word 'aardappel' (potato), pronounced [ˈɑrdɑpəl], would be interrupted for instance after the [d] and restarted at the [ɑ]. In the remainder of the text, WIPs will be marked by dashes, as in [ɑrd-ɑpəl].

In repetitions of word beginnings, the word is interrupted 'half way', and the restart involves backtracking to the word beginning. Thus, instead of continuing articulation at the [α] upon an interruption after [d], 'aardappel' is restarted from its beginning. This is labelled a *fully retraced restart*. The transcribed examples of these instances mark the repetitions by a plus sign [ard+ardαpəl]

In word-medial repetitions the restart involves *partial* retracing, i.e., retracing to a point before the interruption, but *not* to the beginning of the word. A partially retraced restart after the previously mentioned interruption of 'aardappel', could for instance incorporate the [d] only. This would be coded as [ard+dαpəl]

Table 2 II Some examples of the different classes of word fragmentations

<i>Word-internal pauses (WIP)</i>		
fɾaxoto-cjə	(vrachtautootje [<i>lorry</i>])	[T032-134] ²
Rɔ-zɛiɔjəs	(roziɔntjes [<i>raisins</i>])	[T241-94]
heis-tam	(hijskraan [<i>crane</i>])	[N101-149]
<i>Part word repetitions</i>		
<i>(a) word-initial (Rb)</i>		
f+falɪndətjə	(vlindertje [<i>butterfly</i>])	[T031-147]
tə+tlɪatɔm	(telefoon [<i>telephone</i>])	[N233-30]
<i>(b) word medial (Rm)</i>		
ɔR+Rə	(toren [<i>tower</i>])	[T202-12]
pɔt+tlɪnə	(boormachine [<i>drill</i>])	[N181-126]
<i>(c) word final (Re)</i>		
ɛyt+t	(uit [<i>out</i>])	[T162-41]
mαx+x	(mag [<i>may</i>])	[N212-257]

Repetitions of word endings do not fit well in the interruption-restart framework because they occur after correct completion of the word. Consider, for example, the word final repetition [ardαpəl+αpəl]. It is clear that the word 'aardappel' is not interrupted at all. There is only a partially retraced restart which amounts to a kind of echo of the word's last portion.

Word-internal pauses and part-word repetitions in which the intended word could not be reliably reconstructed were discarded from the analyses. If several identical fragmentations - i.e., involving the same interruptions and restarts in the same words-- followed one another directly within one utterance or in consecutive utterances, only the first one was included in

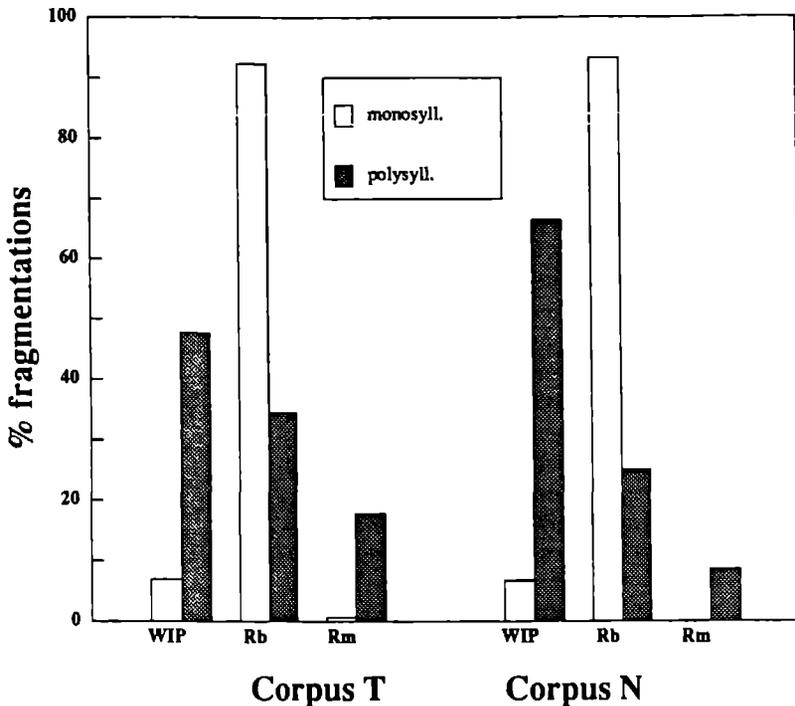
² The codes in square brackets indicate the location of the examples in the corpora. They refer to the corpus (T or N), the sequence number of the week of recording (01-26), the sequence number of the episode within the current week, and, after the dash, the sequence number of the utterance.

data analyses. This was done to prevent 'speech play' or practice sequences, which were known to occur occasionally, from exerting a biasing influence on the results.

2.3 RESULTS

The total data set consists of 549 interpretable word fragmentations, 370 in corpus T, 179 in corpus N. Repetitions of word endings are very uncommon: less than 2% of all fragmentations. These will be excluded from further analyses.

Figure 2.1. The percentages of word-internal pauses (WIP), repetitions of word-beginnings (Rb), and word-medial repetitions (Rm) in monosyllabic and polysyllabic words.



A considerable number of fragmentations (39.4% in corpus T, 34.1% in corpus N) involve monosyllabic words. This finding clearly indicates that interruptions can distort syllables. However, Figure 2.1 reveals a conspicuous difference in the distribution of the various fragmentation types over monosyllabic and polysyllabic words. Word-internal

pauses (WIP) and word-medial repetitions (Rm) occur predominantly in polysyllabic words, whereas repetitions of word beginnings (Rb) more frequently occur in monosyllabic words. These distribution differences are significant in both corpora (T: $\chi^2 = 118.66$, $df = 2$, $p < .0001$; N: $\chi^2 = 74.04$, $df = 2$, $p < .0001$). In terms of the interruption-restarting framework, this result implies that an interruption of a polysyllabic word is usually followed by an immediate restart or a partial retracing (see examples 1-2), whereas interrupted monosyllables are usually restarted from the beginning (example 3).

- (1) $\tau\alpha\pi\iota\text{-}\tau\epsilon\iota\eta$ (kapitein [*captain*]) [N161- 22]
- (2) $\sigma\omega\iota\eta\text{-}\eta\eta\alpha$ (zingen [*sing*]) [T251-174]
- (3) $s\text{-}s\omega\nu$ (zon [*sun*]) [T011-104]

This finding should be evaluated in the light of the fact that an interruption in a monosyllabic word destroys the syllabic structure (by definition), whereas an interruption in a polysyllabic word may or may not do so. Thus, the tendency to fully restore a word upon its interruption may be affected by the degree of damage done to the syllables. The next section will go further into this, by examining the interrelationships between interruption location and restarting in polysyllabic words. The remaining sections deal with some factors that may affect the exact localization of interruptions in both monosyllabic and polysyllabic words.

2.3.1 FRAGMENTATIONS IN POLYSYLLABIC WORDS

Any attempt at exploring the interdependency of word fragmentation and syllabic structure inevitably leads to the problem of determining syllable boundaries. In order to know whether an interruption preserves or distorts a syllable, one would like know where one syllable ends and the next one begins. However, there is no undisputable way of deciding this in advance for the present data. Phonological approaches to syllable boundaries are subject to controversy, and, more importantly, they are based on data that are radically different from those analysed here. Therefore, an inductive approach will be pursued in order to derive a 'behavioral definition' of the syllable and its boundaries (see also Van den Broecke & Westers 1986). A single presupposition underlies this approach, namely that vowels correspond to syllable cores and that consonant (-clusters) involve syllable transitions. The results of the present analyses may, and in fact will be compared to some phonological proposals concerning syllabification.

In the following discussion, interruptions are classified according to their position in the full IPA representation of the word as it would have been without fragmentation. Thus, interruptions that fall before, after or within intervocalic consonants or consonant clusters (henceforth: *intervocalic* interruptions, see examples 4-9) are distinguished from interruptions that fall either between or just after word-initial consonants, or just before or between word-final consonants (henceforth: *marginal* interruptions, examples 10-13). The position of an intervocalic interruption may be further specified according to whether the first segment that follows it (in the intact word) is a consonant (examples 4,5,8,9) or a vowel (examples 6,7).

- (4) pɑð-ti (passagier [*passenger*]) [N233-294]
- (5) mɑn-dɑRei (mandarijn [*tangerine*]) [T251- 44]
- (6) taf+fo (tafel [*table*]) [N151- 43]
- (7) pipəm+moencjə (pepermuntje [*peppermint*]) [T044- 64]
- (8) pɑn+pɑntə (panter [*panther*]) [N242-410]
- (9) pɑ+pɑpətɑp (appelsap [*apple juice*]) [T021- 12]
- (10) pɑsitn-s (passagiers [*passengers*]) [N233-176]
- (11) k-œjə (kusje [*kiss*]) [T161-220]
- (12) t+tesə (deze [*this*]) [N222- 43]
- (13) b+bebəcjə (babietje [*baby*]) [T101- 90]

Table 2.III. Observed and expected frequencies of three types of interruptions in polysyllabic words

	Marginal	Intervocalic/ consonant	Intervocalic/ vowel	Total
<i>Corpus T:</i> Observed	48 (21.8%)	129 (58.6%)	43 (19.5%)	220 (100%)
Expected	65 (29.5%)	87 (39.5%)	68 (30.9%)	220 (100%)
<i>Corpus N:</i> Observed	12 (10.3%)	88 (75.9%)	16 (13.8%)	116 (100%)
Expected	31 (26.7%)	48 (41.4%)	37 (31.9%)	116 (100%)

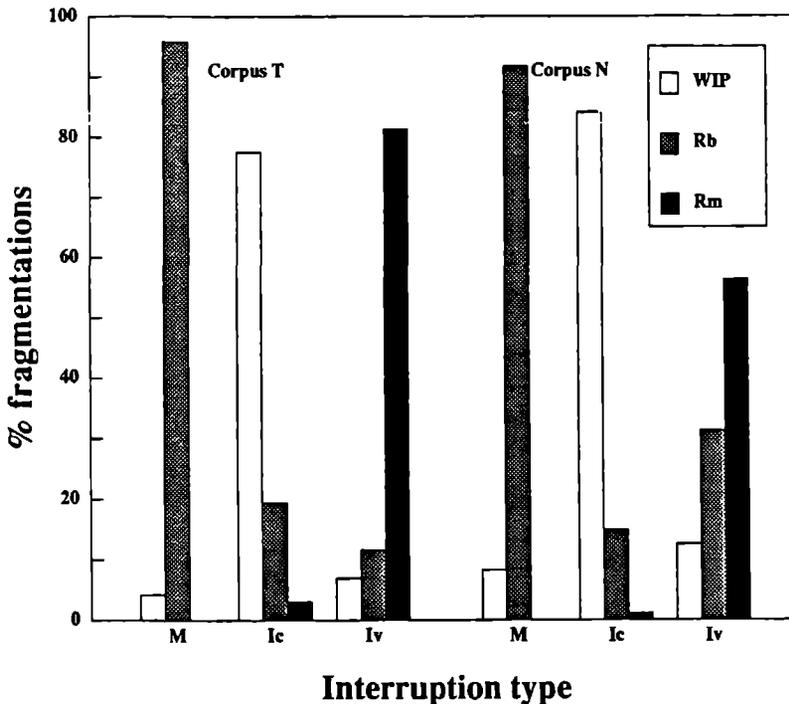
The numbers of marginal and intervocalic interruptions in polysyllabic words are presented in Table 2.III. The figures suggest a preference for intervocalic interruptions that precede consonants in both corpora. In order to evaluate whether this impression constitutes a statistically significant result, we need an estimation of the hypothetical pattern of results under the assumption of a random localization of interruptions. Starting from the IPA transcription of the words, the quotient of the number of phoneme transitions in one of the three categories (marginal; intervocalic/consonant or intervocalic/vowel) and the total number of phoneme transitions was taken as a valid estimation of the expected probability of an interruption in that category. For example, the word 'aardappel' (potato), pronounced ['ɑrdɑpəl], contains 6 phoneme transitions. There are five intervocalic transitions, 3 of which ([a]-[r]; [r]-[d]; [ɑ]-[p]) involve a consonant on the right side. In the 2 remaining intervocalic transitions a vowel occurs on the right side ([d]-[ɑ]; [p]-[ə]). Thus, the odds that an interruption will 'land' on an intervocalic location preceding a consonant are 3 out of 6, or 0.50, against 2 out of 6 (0.33) for an intervocalic position preceding a vowel. Consequently, the expected likelihood of a marginal interruption is 1 minus (0.50+0.33), which equals 0.17.

The expected probabilities for all words were averaged to produce expected proportions for the total set. These proportions were multiplied by the total number of observations to obtain expected frequencies of the three types of interruption (see Table 2.III), which were tested against the observed frequencies by means of chi-square tests. The observed

distributions of interruptions appear to significantly deviate from chance expectations in both corpus T ($\chi^2 = 16.35$, $df = 2$, $p < .001$) and corpus N ($\chi^2 = 28.48$, $df = 2$, $p < .0001$). The interruption type that contributes most to the obtained chi-squared values is intervocalic/preconsonantal, which sustains the impression that the results reflect a preference for this type of interruption.

A breakdown of interruption locations over fragmentation types in Figure 2.2 reveals that marginal interruptions are most frequently associated with Rbs, intervocalic preconsonantal interruptions with WIPs; and intervocalic interruptions preceding a vowel with Rms. This distributional difference is significant for corpus T ($\chi^2 = 247.76$, $df = 4$, $p < .0001$). For corpus N, testing conditions were less than optimal, since 4 out of 9 cells produced expected frequencies of less than 5 (Leach 1979). Nevertheless, the test result ($\chi^2 = 91.37$, $df = 4$, $p < .0001$) can be considered to support the findings in corpus T.

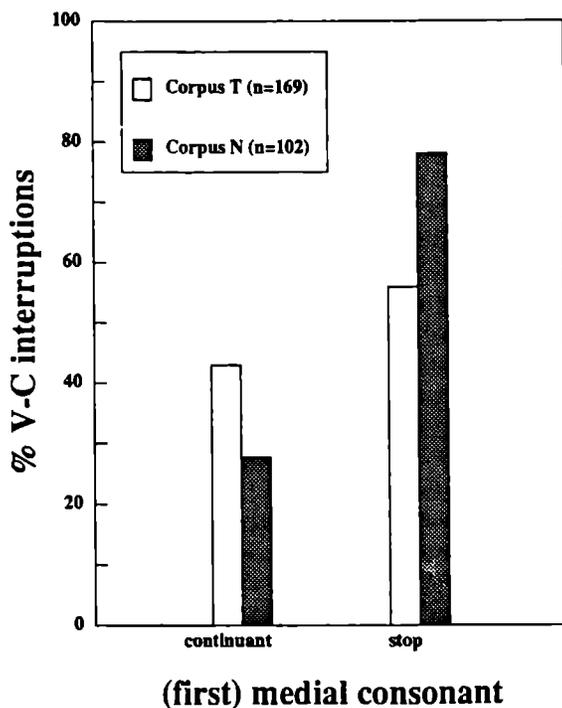
Figure 2.2 The percentages of word-internal pauses (WIP) repetitions of word beginnings (Rb) and word-medial repetitions (Rm) in polysyllabic words as a function of the type of interruption: marginal (M), intervocalic/before a consonant (Ic), or intervocalic/before a vowel (Iv)



In terms of the interruption-restart framework, these results imply that marginal interruptions, all of which occur word-initially, are followed by full retracing, i.e., restarting from the word beginning. Intervocalic interruptions that precede a vowel are generally followed by partial retracing. It appears that all of the partially retraced restarts in both corpora (with one exception in corpus T) begin with a consonant that precedes the place of interruption (see examples 6-7). Intervocalic interruptions preceding consonants appear to be generally associated with immediate restarts, i.e., exactly from the point of interruption.

These interdependencies of interruption type and restarting (as indicated by fragmentation class) suggest an organization of speech in terms of CV(C) units. However, the interruptions per se agree only in part with the apparent CV(C) organization: 129 (58.6%) in corpus T, and 88 (75.9%) in corpus N. Apparently, other factors also affect the position of interruptions. These will be discussed in the following sections.

Figure 2.3 The percentages of interruptions between a vowel and the subsequent medial consonant as a function of the type of consonant (continuant vs. stop)



2.3.2 FACTORS AFFECTING INTERVOCALIC INTERRUPTIONS

Elicited syllabification studies suggest three variables that may affect the location of an interruption: (1) the manner of articulation of medial consonants; (2) (phonological) length of vowels; and (3) lexical stress. In the present data, the role of each of these factors will be evaluated by comparing the proportions of interruptions preceding the medial consonant(s), as in examples 14 - 16, with the proportion of interruptions falling after or within medial consonants, as in examples 17 - 19.

- (14) he-pələ (helpen [*help*]) [T023- 75]
- (15) poxə-tənt (bovenkant [*top side*]) [N031-180]
- (16) pɑ-kjə (pakje [*present*]) [N211-483]
- (17) es-kimo (eskimo) [T205-110]
- (18) ɔm-hox (omhoog [*upward*]) [N242-156]
- (19) pʀanit-ɑuto (brandweerauto [*fire engine*]) [T102-231]

Figure 2.3 shows the proportion of interruptions falling just before the medial consonant(s) as a function of the quality of the (first) medial consonant. In both corpora, this proportion is higher when the (first) medial consonant is a stop than when it is a continuant, indicating that stop consonants tend to be separated from the preceding vowel, whereas continuants tend to 'stick' to it. However, the difference reaches significance in corpus N only ($\chi^2 = 24.13$, $df = 1$, $p < .001$).

The effect of the quality of the preceding vowel on the place of interruption is shown in Figure 2.4. The vowels are split up into three categories: (1) short (lax) vowels, (2) long (tense) vowels and diphthongs; and (3) the schwa. It appears that long vowels/diphthongs and schwas are more often associated with interruptions before medial consonants than are short vowels. This distributional difference reaches significance in both corpus T ($\chi^2 = 26.39$, $df = 2$, $p < .001$) and corpus N ($\chi^2 = 11.69$, $df = 2$, $p < .005$).

These findings bear a resemblance to the phonological observation that short vowels (in Dutch) have to occur in closed (CVC) syllables, whereas long vowels, diphthongs and schwas can also occur in open (CV) syllables (cf. Van der Hulst 1985). In this connection, it is interesting to have a look at the interruptions around syllable transitions that consist of a single consonant. In 56 cases (in both corpora) the medial consonant is preceded by a short vowel. In 25 of these (44.6%) the interruption occurs after the consonant. In 15 cases, the post-consonantal interruption is followed by a retraced restart which involves only the consonant directly preceding the interruption, as in (20). These cases constitute what could be called a behavioral analogue to ambisyllabicity. This 'ambisyllabic' pattern is slightly less frequent in cases where a long vowel, diphthong or schwa precedes the medial consonant: 24 out of 110 interruptions (21.8%) are post-consonantal; 22 of these are followed by partially retraced restarts. So, the predominant interruption-restart pattern after a long vowel, diphthong or schwa corresponds to (21).

- (20) plɑ| +jə (plasje [*piddle*]) [T203- 70]
- (21) amna-xə (aanhangwagen [*trailer*]) [N023-358]

Figure 2.4. The percentages of interruptions between a vowel and the subsequent medial consonant as a function of the length of the vowel (short; long or diphthong; schwa).

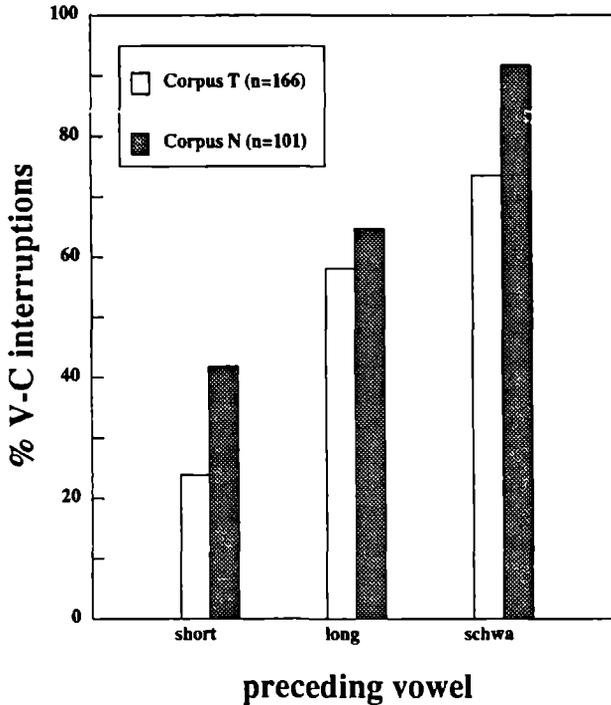
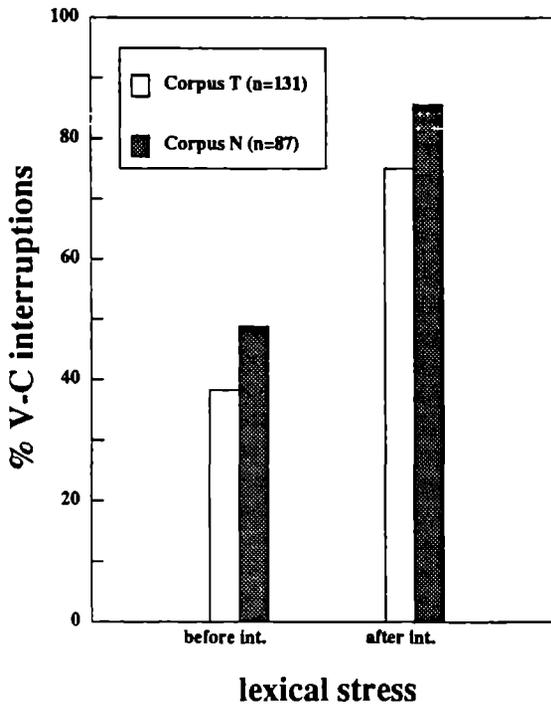


Figure 2.5 shows the effect of lexical stress on the location of interruptions. Only those cases are included in which the vowel bearing primary stress is located either directly before or after the interruption. The results indicate that when lexical stress precedes the interruption, the medial consonants are less often separated from the preceding vowel than when stress follows the interruption. This effect is significant in corpus T only ($\chi^2 = 9.23$, $df = 1$, $p < .005$). The absence of a significant effect in corpus N is presumably due to the limited number of cases (7) in which lexical stress followed the interruption. Nevertheless, the results from both corpora appear to agree in supporting the conclusion that medial consonants tend to 'stick' to stressed vowels. It should be noted that this tendency may be partially responsible for the high proportion of pre-consonantal interruptions after schwas, since schwas typically are reduced non-stressed vowels.

Figure 2.5 The percentages of interruptions between a vowel and the subsequent medial consonant as a function of the position of lexical stress: before the interruption vs. after the interruption



2.3.3 EFFECTS OF MORPHOLOGICAL STRUCTURE

In order to evaluate whether the morphological composition of words influences fragmentation, a criterion for morphological complexity is needed that is objectively related to the lexical inventory of the children. It was decided that a word could only be considered morphologically complex if at least one of its constituting morphemes occurred independently in the vocabulary up to the point in time when the (fragmented) compound was spotted. In the case of inflected or derived words, this freely occurring part had to be the stem, of course. This criterion implied that some words had to be considered simple at one point in time and compound at a later point, if one of the constituting morphemes had appeared independently in the interval between the two occurrences.

Table 2.IV Distribution of morpheme preserving and -distorting interruptions over marginal pre-consonantal and pre-vocalic positions

	Corpus T		Corpus N	
	morpheme distorting	morpheme preserving	morpheme distorting	morpheme preserving
marginal	8 (20 0%)	2 (4 3%)	4 (14 3%)	1 (2 5%)
pre-consonant	24 (60 0%)	32 (69 6%)	23 (82 1%)	35 (87 5%)
pre-vowel	8 (20 0%)	12 (26 1%)	1 (3 6%)	4 (10%)
Total	40 (100%)	46 (100%)	28 (100%)	40 (100%)

According to our criterion, 39.1% of the fragmented polysyllabic words in corpus T, 58 6% in corpus N, are morphologically complex. These figures suggest that morphological complexity is not a major determining factor in fragmentation, which appears to be sustained by the pattern of interruptions in morphologically complex words. Table 2.IV indicates that the preference for morpheme preserving interruptions is slight. Furthermore, non-significant chi-square values seem to indicate that the distribution of interruptions over syllable preserving and -distorting positions is not affected by the effect with respect to morphological boundaries.

Therefore, a better way to assess the influence of morphological structure seems to be to evaluate whether interruptions show a preference for syllable transitions that coincide with a morpheme boundary over syllable transitions that do not coincide with a morpheme boundary.

Table 2.V Distribution of interruptions over syllable transitions coinciding with morpheme boundaries and syllable transitions not coinciding with morpheme boundaries

	Corpus T	Corpus N
morpheme boundary	15 (51 7%)	21 (77 8%)
no morpheme boundary	14 (48 3%)	6 (22 2%)
Total	29 (100%)	27 (100%)

Table 2.V summarizes the interruptions in polysyllabic polymorphemic words. To be able to test for a preference for morpheme boundaries, only words that had at least one morpheme boundary less than the number of syllable transitions were selected. To evaluate whether the proportions of morpheme-preserving interruptions exceeded chance values, expected proportions were computed. The expected probability of an interruption occurring

at a morpheme boundary is equal to the quotient of the number of syllable transitions involving a morpheme boundary and the total number of syllable transitions. For example, the word 'unbelievable' contains 4 syllable transitions and two morpheme boundaries. Therefore, the expected probability that an interruption will fall on a syllable transition involving a morpheme boundary is 2/4, or .50.

The average expected proportions are .49 for corpus T, and .48 for corpus N. The observed proportion in corpus T does not significantly deviate from chance in a binomial test. For corpus N, on the other hand, a significant result ($p < .005$) was obtained, which seems to indicate a preference for interrupting at syllable transitions that coincide with morpheme boundaries. Furthermore, Table 2.VI suggests that lexical morpheme boundaries are more often preserved than stem-affix boundaries in corpus N ($\chi^2 = 16.94$, $df = 1$, $p < .001$). This effect did not occur in corpus T (see Table 2.VI). Thus, although the number of relevant observations is small, the overall pattern of results seems to underscore the rather limited role of morphological structure in interrupting.

To conclude this section, the relation between morphological structure and *restarting* will be briefly considered. It is clear that all repetitions of word beginnings (Rb) involve retracing to a morpheme boundary, namely the word onset. Furthermore, in word-internal pauses, only those that involve morpheme preserving interruptions also involve restarting on morpheme boundaries, by definition. Of the 53 WIPs in polymorphemic words in corpus T, 33 (62.3%) are morpheme preserving and thus incorporate a (non-retraced) restart at a morpheme boundary. In corpus N, this number is 34 out of 53 (64.2%). Of the word-medial repetitions (Rms), 20 occurred in polymorphemic words in corpus T, of which 13 (65%) involve retracing to a morpheme boundary. In corpus N, 1 of the 4 Rms in polymorphemic words involves retracing to a morpheme boundary.

Table 2.VI. Morpheme preserving and -distorting interruptions in bimorphemic affixed words vs. bimorphemic lexical compounds

	Corpus T		Corpus N	
	lexical compounds	affixed words	lexical compounds	affixed words
morpheme distorting	7 (41.2%)	17 (56.7%)	2 (8.7%)	19 (70.4%)
morpheme preserving	10 (58.8%)	13 (43.3%)	21 (91.3%)	8 (29.6%)
Total	17 (100%)	30 (100%)	23 (100%)	27 (100%)

2.3.4 SYLLABLE-DISTORTING INTERRUPTIONS

Of all 363 fragmentations (excluding repetitions of word endings) in corpus T, 191 (52.6%) distort the syllable structure of words; 48 (13.2%) involve 'marginal' interruptions in

polysyllabic words, 143 (39.4%) interrupt monosyllabic words. In corpus N, fragmentations involving syllable distorting interruptions amount to 72 (40.9%). Twelve (6.8%) consist of 'marginal' interruptions in polysyllabic words, 60 (34.1%) interrupt monosyllables. The distribution of interruption locations in CVC monosyllables is shown in Table 2.VII. Few interruptions occur in initial or final clusters. The majority falls either between onset and vowel or between vowel and final consonant (cluster). Of these two, the pre-vocalic position is preferred over the post-vocalic position, as indicated by a binomial test ($p = .05$, one-tailed) in both corpora. This result suggests that the vocalic core of monosyllables is more tightly attached to the final consonants than to the initial consonants. Similar proposals have been derived from both phonological analyses (e.g. Fudge 1969) and experimental data (Treiman 1985).

Table 2.VII. The distribution of interruptions over different positions in CVC monosyllables.

	In onset cluster	Location of interruption			Total
		between onset & vowel	between vowel & final cons.	in final cluster	
Corpus T	8 (10.1%)	43 (54.4%)	27 (34.2%)	1 (1.3%)	79 (100%)
Corpus N	- (-)	29 (61.7%)	16 (34.%)	2 (4.3%)	47 (100%)

2.4 DISCUSSION

Spontaneous word fragmentations appear to show some fairly systematic features. Monosyllabic words are almost always fully restarted after an interruption. In polysyllabic words, most interruptions occur just before intervocalic consonants. In these cases, the interruption is followed by an immediate restart. If an interruption occurs somewhere else in the word, restarting usually involves retracing, either to the medial consonant that directly precedes the place of interruption (if there is one), or to the word onset. The role of morphemes is relatively limited. There is an inclination to fully restore words, and in corpus N a preference for interrupting on syllable transitions that coincide with morpheme boundaries in lexical compounds was found. In sum, the results seem to support the hypothesis that speech production, on the level of execution, is organized primarily in syllable sized units. These units appear to preferably assume CV(C) shapes. This agrees with speculations concerning the 'canonical' or 'archetypical' nature of the CV syllable (Collier & De Schutter 1985).

Case studies invariably evoke the problem of generalizability. In this connection, it is useful to recall that N and T differed quite a lot in rate and stage of language development.

Moreover, they showed a considerable difference in articulatory maturity. Despite these differences, the pattern of results appears to be essentially the same in both children. Consequently, we feel that the results can be considered representative for a larger population. The question that remains is whether the results agree with those of related studies.

It appears that the results of this study and those of elicited syllabification experiments show some notable resemblances. The experimental studies indicated that stressed syllables tend to 'attract' consonants (Fallows 1981). Moreover, long vowels are more often separated from the subsequent consonants than short vowels (Collier & De Schutter 1985); and stop consonants are more often separated from the preceding vowel than continuants (Van den Broecke & Westers 1986). Each of these effects recurred in the present data. These correspondences suggest that elicited syllabifications, just like spontaneous fragmentations, primarily reflect characteristics of the execution level of speech production. One finding that supports this conclusion is the tendency to interrupt *before* stop consonants and *after* continuants, which seems to be related to the amount of stricture in the articulatory channel. Stated simply: stops are 'ideal' places for interruption because of the total articulatory closure (cf. Van den Broecke & Westers 1986).

This study has also provided some results that are analogous to phonological analyses of syllabification in Dutch. In particular, the proposal that short vowels have to be 'checked' by a consonant, and its consequence that single medial consonants following short vowels are linked to both the preceding and the following syllable (cf. Van der Hulst 1985) has a parallel in the present results. Maddieson (1985) has argued that the association between short vowels and closed syllables reflects a universal characteristic of speech production, which is 'phonologized' in some languages (e.g. Dutch). The correspondence between the articulatory data of this study and the phonological analysis of Dutch syllabification seems to be in agreement with Maddieson's hypothesis.

The results of this study are compatible with previous findings that point at the predominant role of the syllable in the development of speech (Ingram 1978). Recently, Kent & Bauer (1985) have argued that the CV syllable 'can be likened to discrete motor patterns that ethologists have called by names such as "fixed action patterns" (...) "typical form" (...) "fixed motor pattern" (...) (p. 517). Apparently, syllables are the genetically given articulatory units that can be probed in both younger and older children. The manipulation of phoneme-sized units, either deliberate (fragmentation) or accidental (speech errors), which points at the functioning of phonetic representations over and above the articulatory level of processing, can only be witnessed in older children and adults. This seems to suggest that during the early stages of development, the speech production mechanism only incorporates the 'phylogenetically old' (cf. MacNeilage 1985) articulatory level. The planning level apparently emerges later in development, presumably in response to the rapid growth of the vocabulary, which calls for an efficient rule-based interface between lexicon and articulatory apparatus.

3

INCIDENTAL WORD AND SOUND ERRORS IN YOUNG SPEAKERS: CLUES TO THE DEVELOPMENT OF LEXICAL REPRESENTATION AND PROCESSING¹

3.0 ABSTRACT

Incidental speech errors from two Dutch boys (ages 2 and 3) were extracted from transcribed speech corpora. Incidental errors are defined as relatively infrequent deviations from the child's current linguistic standard. They are assumed to reflect transitory failures in the process of language generation, and may thus provide a window onto the representations and processes involved. The analyses focus on lexical errors and sound errors. Most frequent among the lexical errors were substitutions. In over 60% of these, the words involved were either semantically or 'episodically' related. About 60% of all lexical substitutions affected function words. When content words were substituted, the intruding word and the substituted word strongly tended to correspond in length and stress-bearing vowel. These correspondences were not affected by the presence or absence of a conceptual relation. The findings suggest that (1) word meaning representations may to some extent be episodically organized; (2) the retrieval of word meaning and the retrieval of word form may be more closely intertwined in these children than in adults; (3) function words, as a category, are not yet fully differentiated from content words. Over 60% of the sound errors can be construed as failures of articulatory control. Most of these errors are analogous to 'systematic' phonological processes in younger children, such as consonant harmony and syllable deletion. A small proportion of sound errors showed characteristics of segmental misselections or misorderings. This finding is in agreement with the hypothesis that roughly after age 2, phonological segments emerge as constituents of word form representations.

¹ Submitted for publication.

3.1 INTRODUCTION

Child language research is, to a large extent, research into speech errors. Two types of errors can be distinguished. The first type, which is most often studied, encompasses the deviations of children's language from the language that is being acquired². I will call these *systematic errors*. Systematic errors are relatively frequent, either in token or in type. Prototypical examples are morphological overregularizations such as the substitution of 'go-ed' for 'went' or 'mouses' for 'mice'. Also included in this category are children's typical phonological substitutions, as in the pronunciation of 'fish' as 'fis' (Berko & Brown 1960). Lexical substitutions can also occur systematically. For instance, my son has stubbornly used the word *terwijl* (while) instead of *in plaats van* (instead of) for several years, as in 'hij nam de rode TERWIJL de paarse' (he took the red one while the purple one).

The second, less often studied type of errors, *incidental errors*, is the subject of this investigation. Incidental errors are defined as relatively infrequent deviations from the child's own standard of language use. Some examples of such errors, taken from my son's diary, are given below³.

- (1) oh! nog HAGEDISJE [haxə'diʃə] (←hagelslag ['haxəlslɑx]) (*oh! another lizard* [←chocolate strands]) [age 3,3-24]
- (2) dat boom is drie centimeter lang dat boom is drie CENTIMANG (*that tree is three centimeters long that tree is three centimong*) [3,7-10]
- (3) wie wil d'r nog een BOLIEBOL (←oliebol) (*who wants another boil ball* [←'oil ball']) [3,11-9]

The difference between systematic and incidental errors can be illustrated by the contrast between the error under (1), where *hagedisje* is substituted for *hagelslag*, and the previously mentioned confusal of *while* and *instead*. In the latter case, each time when my son intended to express the meaning of 'instead of', he came up with the form *while*. Thus we could say that, from the adult point of view, his mental lexicon encompassed a 'faulty' link between the meaning of 'instead of' and the form 'terwijl'. In the case of error (1), no such structural 'fault' can be supposed, since the child normally used 'hagelslag' and 'hagedis' correctly. Consequently, it seems reasonable to assume that an 'accident' happened during the retrieval of the intended word form, so that 'hagedis' surfaced instead of 'hagelslag'. This accident, however, may reveal some interesting things about the child's lexicon, for instance that words with similar initial syllables are somehow interconnected. Thus, incidental errors may

² Defining children's deviations from adult language as 'errors' does not imply a denial of the own character and the integrity of the child's linguistic system (see Bowerman 1985, pp. 1263-4).

³ In all of the examples in this paper the following notational conventions are applicable: (1) the erroneous string is printed in small capitals; (2) if necessary, the phonetic realization is indicated in square bracketed IPA transcriptions; (3) the intended utterance is either provided by a subsequent self-correction, which is preceded by square-bracketed double slashes, or by a parenthesized entry preceded by a leftward arrow; (4) literal English translations are printed in italics; (5) In cases where words were not completed, but a reliable guess at what was intended could nevertheless be made, the deleted parts are enclosed in brackets.

provide a window onto the architecture of the (developing) language system, i.e., the way in which linguistic knowledge is represented and processed.

The present study deals with the 'incidental errors' that occurred in the spontaneous speech of two 2-3 year old boys. These are analyzed and interpreted in an attempt to gain insight in the development of a pivotal aspect of language production, viz. the retrieval, access and articulation of lexical items. An obvious null hypothesis in such an endeavor is that the mechanism underlying language production is the same for children and mature speakers. This hypothesis is usually pre-supposed in most, if not all studies of language development, and it has been said that it ought to be, in order to allow the composition of an explanatorily adequate developmental theory (Pinker 1984). Thus, the development of language is seen as the accumulation of knowledge in an otherwise unchanging computational mechanism. Consequently, children's incidental speech errors are not expected to principally differ from those of adults.

Alternatively, it may be hypothesized that as knowledge of language accumulates and changes, representation and processing change as well. Such an interdependency between linguistic knowledge and linguistic processing is demonstrated by a simple example. Adult speakers appear to incidentally produce non-intended words that are semantically related to the intended items, as in 'eat your soup with a FORK'. It is often argued that such lapses happen because the mental representation of the word *fork* is connected to that of *spoon*, so that when the activation of *spoon* increases, *fork* is also activated to some extent and may, due to various circumstances, reach a selection threshold sooner than *spoon* (cf., Aitchison 1987). It is clear that such an error would not occur if *fork* and *spoon* were not related in the speaker's lexicon, or, stated differently, if the speaker were to possess no knowledge of the semantic relation between the two words. In this way, incidental errors, i.e., language production slips may reflect the structure of linguistic knowledge. This example suggests that as linguistic knowledge is acquired, representation and processing may change accordingly. Consequently, incidental errors in developing language users are expected to be qualitatively different from those in adults. I will call this the *change* hypothesis.

The few published investigations of children's incidental errors appear to reach rather divergent conclusions with respect to the above hypotheses. MacKay (1970) analyzed 23 phoneme transpositions produced by 3 to 6 year old children, which were collected and published by Meringer (1908). In adult speakers transposed phonemes tended to occur in stressed syllables; they were neighbours to identical phonemes, and they occupied corresponding positions in the syllable. Each of these tendencies recurred in the child data, albeit less strongly. For instance, whereas 90% of all phoneme transpositions in adults involved phonemes in corresponding syllable positions, position agreement was only 70% in children. MacKay concluded that the differences between children and adults are of a quantitative, rather than a qualitative nature, and may reflect the children's lack of skill in language production as compared to mature speakers.

The results obtained by Stemberger (1989) in the most recent as well as the most extensive study of children's incidental errors seem to support Mackay's point of view. The author collected almost 600 syntactic, lexical, and phonological errors in the course of a

diary study of language acquisition in his two daughters between ages 1 and 6. Stemberger reports similarities as well as differences between the error patterns of his daughters and those of adults. Among the similarities were the proportions of lexical blends and lexical substitutions in adults and children. Lexical substitutions were constrained by lexical category in both children and adults. As regards phonological errors, the child data and the adult data yielded similar proportions of vowel- and consonant-errors. In both children and adults the interacting segments were highly similar in terms of distinctive features and syllabic position. Finally, both children and adults tended to slip into phonotactically legal phoneme strings and to morphologically and phonologically accommodate the elements surrounding intrusions. Children differed from adults in that they produced fewer morphological and syntactic errors. In the lexical domain, it appeared that substitutions involving phonologically similar words occurred more often in children than in adults. Moreover, in the phonological domain, adults produced more non-contextual segmental substitutions, whereas the child data incorporated a larger number of non-contextual segmental additions. Also, the child data yielded a higher proportion of single feature errors than the adult data. Finally, a difference which is discussed extensively by Stemberger is a significantly larger proportion of perseveratory errors in children as compared to adults. Stemberger concludes that most of the differences are gradual rather than principal, and that thus '[a]dult language production mechanisms are largely in place and operating normally from a very early point in language acquisition, possibly from the very beginning' (Stemberger 1989: 186).

Bowerman (1978) analyzed a set of lexical substitution errors she observed in her two daughters between 2 and 4 years of age. Usually these errors involved words that were semantically affiliated, as in the substitution of *put* for *make*, or *behind* for *after*. The remarkable thing about these substitutions was that their frequency seemed to increase rapidly during a relatively short period. Nevertheless, it was clear that these errors were not systematic, since semantically and syntactically correct use of the words prevailed. The question then arises as to why such errors would quite suddenly start to appear with a considerable frequency. Bowerman suggests that this may reflect a 'reorganization' in the children's lexical semantic knowledge. She argues that during the time before the 'error peak' the children had an adequate knowledge of the meanings of words like *put* and *make*, or *after* and *behind*, and could thus use them correctly, but lacked knowledge of the abstract semantic relations between them. When these semantic relations were discovered, the structure of lexical memory changed as to encompass 'links' between semantically related entries. This interfered with lexical selection during the production of speech and resulted in a temporarily increased occurrence of substitution errors.

Aitchison & Straf (1982) compared the attributes of malapropisms (substitutions by phonologically similar words) in children (up till age 12) and adults by means of multivariate analysis. They found that in adults as well as in children, the interacting words usually shared *initial consonants*, *number of syllables* and *stress-bearing vowels*. It appeared however, that if the involved words shared less than three of these attributes, the remaining correspondences were different for adults and children. In adults, the *initial consonant* was

almost invariably identical, whereas in children *number of syllables* appeared to be the strongest factor. Aitchison and Straf concluded that in children's lexical memories, prosodic attributes of words, i.e., syllabic length and stress-bearing syllable, are more important organizational principles than in adults.

Briefly summarized, all of these investigations admit that children and adults differ, but there are two points of view with regard to the nature of this difference. On the one hand, it is argued that the difference is merely 'quantitative'. The language production system in children is largely the same as in adults, but it does not work as smoothly, or as optimally controlled. On the other hand differences are purported to be of a more qualitative type, along the lines of the *change hypothesis* pointed out above. Two factors potentially contribute to this dissent. First, differences in the type of errors studied may contribute to the dissent. It is conceivable that "qualitative" developmental differences occur in one part of the language system, for instance the lexicon, but not in another, e.g., phonological processing. Secondly, differences in the ages and age ranges studied may contribute to the disagreement. It is clear that if data from a large age range are pooled, developmental trends may be obscured. Moreover, it is of considerable importance *which* age range is investigated. Generally speaking, one would expect that children in the early phases of language acquisition (between ages 1 and 4) deviate more from adults than older children.

The present study focuses on lexical representation and processing, i.e., the representation and retrieval of word meaning, and the representation, retrieval and pronunciation of word form, in young speakers within a relatively narrow age range (between 2;3 and 3;10). Analyses of production errors in adults as well as experimental studies have revealed that the retrieval of word meaning and the retrieval of word form are relatively independent, hierarchically ordered processes, although some 'bottom-up' feedback from word form level to word meaning level may occur (Dell & Reich 1981, Bock 1987, Levelt 1989). Whether the same distinction holds for 2-3 year old children, will be investigated in the present study by evaluating the role of conceptual and phonological similarities in lexical errors.

The structure of word meaning representation in adults is as yet largely unknown, but it has become clear that entries for words that are semantically related (through co-ordination, superordination or synonymy) are somehow connected in the mental lexicon. Hence, errors like the substitution of *fork* for *spoon* (cf. Hotopf 1980a), or a blend like 'He's a born SAILURE' (←succes + failure) (Aitchison 1987) can occur. In view of Bowerman's (1978) results, it can be suspected that 'semantic fields' are not yet fully developed in the mental lexicons of 2-3 year old children. An analysis of the conceptual correspondences and differences between words involved in lexical errors may shed some further light on this issue.

Apart from the semantic features, lexical entries in the adult lexicon are assumed to contain syntactic features which indicate word class and syntactic arguments (Levelt 1989). This is reflected by the tendency of lexical misselections to be strongly constrained by word class (Nooteboom 1969). Naturalistic, experimental as well as clinical studies provide convergent evidence for a computational differences between open class (content) and and

closed class (function) words. (Garrett 1982). The retrieval of closed class words is in many cases dependent upon the syntactic outline of the intended sentence, which, in turn, depends on the syntactic properties of content words. In the present study, some attention will be given to the role of word class in lexical errors.

Speech errors in which phonological segments are anticipated or transposed suggest that word form representations in adults comprise these elements as basic units (Shattuck-Hufnagel 1979). Suprasegmental information, such as word length in syllables, and the location of primary stress, appears to be represented independently of segmental content (Brown & McNeill 1966). The pronunciation of words is enabled by the translation of segment strings into -presumably syllabic- articulatory programs, which are subsequently executed. Recently, a model of articulatory representation and processing was proposed by Browman and Goldstein (1989). These authors state that articulatory representations (programs) contain the parameters that determine the dynamical and temporal characteristics of articulatory gestures. Such gestures are movements of coordinative articulatory systems, rather than of single articulators. Five systems are distinguished: the laryngeal system, which induces the voiced-voiceless distinction; the velic system, which controls nasalisation, and three oral systems: tongue body, tongue tip and lips, which underlie the classical place and manner features. Within this framework, several speech phenomena, for instance differences between careful and casual speech, and (diachronic) phonological processes, are interpreted as alterations of the gestural lay-out. Gestures may be added or deleted, or their parameters may be altered. An example of the latter is the 'reduction' of stop consonants to fricatives in casual speech, which entails an alteration of the constriction parameter for one of the oral subsystems. Also, gestures may be shifted in the temporal domain, so that the acoustic consequences of a particular gesture are 'hidden' by those of another, overlapping gesture.

Child phonologists have suggested that phonological representations built from segments do not emerge until after the first 50-100 words or so have been acquired (Waterson 1971, Ferguson & Farwell 1975, Wode 1985). Early word forms are supposed to be 'unanalyzed' articulatory routines (Menn 1983). The analysis of the sound errors in the present corpus is aimed at discriminating between *phonological* errors, i.e., errors in the selection or ordering of segment-sized units, and *articulatory* errors, i.e., errors in the programming and control of articulatory movements.

Methodological considerations

Before the data can be presented and discussed, some remarks need to be made about the manner in which they were collected, and its consequences for the comparison of children and adults. The essential methodological problem in studying incidental errors in children is to distinguish them from systematic ones. In order to be able to evaluate whether an error is systematic or not, one needs to have a detailed picture of the child's linguistic behavior. This seems to rule out investigations based on observational notes, unless the observer has a sustained day-to-day contact with the child, as to allow for an evaluation of the child's linguistic standards. Such was the case in both the Bowerman (1978) and Stemberger (1989) studies. Stemberger in particular mentions his efforts to make notes on all of his daughters'

new words, pronunciations and syntactic constructions, in order to evaluate the status of errors. Aitchison & Straf (1982) seem to have left the judgement on incidentality to the children's caretakers, and MacKay (1970) appears to have used his intuitions concerning typical systematic errors in order to separate them from incidental errors.

The present study is based on transcriptions of weekly tape recordings. Thus, the potential systematicity of an error could be evaluated by checking whether identical or almost identical errors occurred elsewhere in the transcriptions, and if so, whether they could be ascribed to a rule. However, evaluating *each* error would have been an almost impossible task. Therefore, two less cumbersome methods to track potential incidental errors were used. First, the two persons who transcribed the corpora from which the data in this research are drawn selected instances of error that they felt were 'non-systematic'. This was called 'spotting'. Since these transcribers, by virtue of their task, had had extended 'contact' with the subjects, they were considered to have developed a good impression of the subjects' linguistic standards, and thus of non-systematic deviations. The second method was to include instances of self-correction. This in itself may be dangerous since it has been suggested that children self-correct not only incidental but also systematic errors (Clark 1982). However, according to the two transcribers' evaluations, the set of self-corrections did not contain systematic lexical or phonetic errors.

This method of error corpus compilation differs in important respects from the one most often used in adult speech error research. In adult studies, corpora are usually compiled from informal 'on-the-spot' transcriptions of errors that are accidentally overheard by the investigator or by others. Since the observer's linguistic make-up may be assumed to be roughly equivalent to that of his subjects, she is able to compare what was actually said by the subject with her own prediction of what should have been said, assuming a tendency to deliver 'ideal' utterances (Clark & Clark 1977). Thus, speech errors are not only signalled, they may be immediately classified as well with respect to the units (word, segment, etc.) and processes (anticipation, substitution, etc.) involved. But there is a price to be paid for the use of this method: bias. Apart from the fact that an observer is unlikely to notice all speech errors, errors that are not systematically related to the rules of language may be systematically overlooked (Cutler 1982).

In the method of error corpus compilation used in this study, error detection was assigned to different agents: to the children themselves in the case of self-corrections and to the adult observers in 'spotting'. Irrespective of whether the errors were spotted or detected by self-perception (in self-corrections), the classificatory work was dissociated from the signalling phase. A potential advantage of this method is that since the classifications and analyses, particularly those of sound errors, are based on detailed transcriptions of tape-recorded speech, they may be expected to be relatively unbiased and finegrained. There is also some reason for caution, however. The obvious tactic to evaluate whether language production mechanisms change during development is to compare the children's error patterns with those observed in adults. However, it is not known whether the 'classical' method of error corpus compilation and methods like the one used in this study yield

comparable results. Consequently, some reluctance in comparing the present findings with findings in adult speakers seems to be warranted.

3.2 METHOD

3.2.1 SUBJECTS, RECORDING AND TRANSCRIPTION

The speech corpus on which the present study is based consists of transcripts of two Dutch boys' home-taped spontaneous speech. One of the children was my son (henceforth: N); the other will be called T⁴. Approximately one hour of recording per week was collected during a period of 8-9 months. T was observed from age 2;4 to 3;0, N from 3;0 to 3;10. Mean lengths of utterances (MLU) were computed according to Browns's (1973) criteria. T's MLUs were 1.9 at the beginning of the observation period, and 2.9 at the end. N's MLUs were 2.3 and 3.9, at beginning and end respectively. These values suggest that in spite of the age difference, the children show a considerable overlap in stage of grammatical development. Phonologically, the two children performed quite differently. T showed a particularly rich and well-developed speech sound inventory, whereas N showed many of the simplification processes that are associated with earlier stages of development, in particular fronting.

For each child, four samples of the recordings, each roughly covering one month (i.e., four to five hrs. of recording) were orthographically as well as phonetically transcribed by two independently working phonetically trained transcribers. Definitive transcripts were obtained by comparing the initial versions and negotiating acceptable alternatives for parts that did not converge. If the transcribers could not reach an agreement on the correct transcription of an utterance, it was excluded from further analyses.

3.2.2 THE ERROR CORPUS

As was mentioned in the Introduction, the error corpus was compiled out of self-corrections and 'spotted' errors. In order to spot sound errors, the two transcribers independently worked through the definitive transcripts. Only those instances that were spotted by both transcribers and could not be shown to be systematic were selected for further analyses. Self-corrections were identified and evaluated in the course of the transcription phase of the data gathering. Only those instances of hesitation were considered to be self-corrections that involved a -- prosodically marked-- interruption and a retracing that involved a change as well as a clear continuation of the original utterance. Self-corrections involving appropriateness failures, i.e., utterances that are unacceptable from a pragmatic point of view, but which are not grammatically or phonetically deviant (Levelt 1983), were discarded.

⁴ This boy is also subject in an analysis by Loekie Elbers of a speech error episode involving a 'tip-of-the-tongue' phenomenon and some lexical blends (Elbers 1985).

3.3 RESULTS

3.3.1 GENERAL OVERVIEW

Table 3 I shows the numbers of non-corrected and self-corrected errors in the two corpora. It is easy to see that corrected errors form the majority of the items in the corpora. A count of the number of words --excluding *yes*'s, *no*'s, interjections and routine expressions-- yields a total of 14,079 in corpus T. N's corpus contains 24,830 words. This means that T produced one error in every 76 words. The figures for N yield an error rate of one in every 112 words. Unfortunately, these figures cannot be compared to error rate estimates in adults, as these seem to be unavailable.

Table 3 I Non corrected and self-corrected errors

Corpus	Non-corrected	Self corrected	Total
	Errors	Errors	
T	32	154	186
N	21	210	231
Total	53	364	417

Table 3 II Speech errors distribution over levels of linguistic description

Level	Corpus T		Corpus N	
	non-corrected	corrected	non-corrected	corrected
Sound	26 (81.3%)	57 (37.0%)	17 (81.0%)	67 (31.9%)
Morphemic	- (-)	1 (0.6%)	1 (4.8%)	5 (2.4%)
Lexical	6 (18.7%)	28 (18.2%)	3 (14.3%)	69 (32.9%)
Syntactic	- (-)	54 (35.1%)	- (-)	43 (20.5%)
Prosodic	- (-)	1 (0.6%)	- (-)	2 (1.0%)
Unclear	- (-)	13 (8.4%)	- (-)	24 (11.4%)
Total	32 (100%)	154 (100%)	21 (100%)	210 (100%)

All errors were assigned to one of the following categories:

- (1) sound errors, i.e., errors affecting individual speech sounds or sound sequences,

- (2) morphemic errors, i.e., errors affecting the structure of compound words;
- (3) lexical errors, i.e., errors affecting words;
- (3) syntactic errors, i.e., errors affecting the sentential lay-out;
- (5) prosodic errors, i.e., errors affecting stress and intonation.

Table 3.II presents the numbers of errors in these categories. It should be stressed that the labels in this table are used in a strictly descriptive sense. A considerable proportion of errors (8 - 11%) could not be classified. The two corpora do not seem to diverge very much in terms of distributions of error classes. Syntactic errors are somewhat more frequent in T than in N, whereas in the case of lexical errors the balance is tilted in the opposite direction.

The results regarding sound errors and lexical errors will be presented, interpreted and compared to adult data in two separate sections.

3.3.2 SOUND ERRORS

The affected parts of words

All sound errors were classified with regard to the parts of words they affected: (1) initial sounds; (2) final sounds; (3) stressed vowel; (4) number of syllables (cf. Aitchison & Chiat 1981). These categories were not mutually exclusive. An example of an error which affects the initial sound is:

- (4) POG (←nog) keer (*another time*) (roughly: again) [T162-182]⁵

Final sound impairment is witnessed in:

- (5) de TORET (←toren) (*the tower*) [N241-390]

In example (6), the stressed vowel is changed, and in (7) the number of syllables is affected.

- (6) TA(RT) [tɑ(r)t] [//] taart [tart] eten (*pie eat*) [T123- 60]
- (7) KER (←Kermit) moet hand in ə mond (*Kermit must hand in mouth*) [T186-115]

Table 3.III presents the numbers of sound errors in each of these four categories. For each category, the number of valid cases is indicated. When this number is less than maximal, this implies that in some cases evaluation of the full extent of the damage was prevented, due to, for instance, an interruption of the erroneous string. In both corpora final sounds were most often lost or changed, followed by initial sounds, stressed vowel and number of syllables, in that order.

Sound error classes

Five relatively homogeneous classes of sound errors were distinguished. The first class contains *syllable omissions*, as in example (8).

- (8) doet LES (←Leslie) stout ben (*does Leslie naughty is*) [T012- 49]

⁵ The examples taken from the corpus are followed by a code which encompasses (1) the corpus identification (T or N); (2) tape number (01-26); (3) the number of the session on the tape; and (4) the utterance number in the transcript. Full data are available from the author.

Table 3.III. Parts of words affected by sound errors.

	corpus T		corpus N	
	valid cases (max=83)	number affected	valid cases (max=84)	number affected
Initial sound	83 (100%)	40 (48.2%)	84 (100%)	36 (42.9%)
Final sound	61 (100%)	30 (49.2%)	57 (100%)	33 (57.9%)
Stressed vowel	78 (100%)	21 (25.3%)	77 (100%)	27 (35.1%)
N. syllables	62 (100%)	4 (6.5%)	61 (100%)	3 (4.9%)

The next three classes can be described as substitutions of single features⁶. In *consonant harmonization* errors, either the place or the manner feature of the target sound was substituted so as to conform to the place or manner feature of a neighbouring consonant within the syllable (examples 9, 10). In (9), the place of articulation of the first consonant has shifted from bilabial to alveolar, which agrees with the place of articulation of the final consonant. In (10), the fricative *ch* [x] is substituted by [s], which is alveolar, as is the subsequent [t].

(9) NET ə a [//] met ə appel (*with apple*) [T032- 11]

(10) bouw jij die VRASTAUTO [//] vrachtauto? (*build you that lorry*) [N032-121]

In *natural class substitutions*, either place or manner features of the target sound are altered, so that a new sound within the same natural class results. In contrast to consonant harmonization, there is no 'harmonizing' within the syllable. In example (11), the alveolar plosive [t] is substituted by the velar plosive [k], and in (12), the velar fricative [x] substitutes the velar plosive [k].

(11) KONINKJE (←konijntje) (*rabbit*) [T092-157]

(12) ik [Ix] (←ik [Ik]) mag ook hout halen (*I may also wood collect*) [N241-347]

The fourth class, *vowel shift*, contains substitutions of vowels by other vowels that are slightly dislocated either in the front-back dimension, as in (13), or in the high-low dimension, as in (14).

(13) dit is rode BEL [//] bal (*this is red ball*) [T041-163]

⁶ Consonants were classified according to 6 places of articulation: bilabial, labio-dental, alveolar, palatal, velar, uvular and glottal, and 6 manners of articulation: plosive, nasal, fricative, lateral, trill and glide. The voiced-voiceless distinction was disregarded. Vowels were classified on the high-low dimension, the back-front dimension and the rounded-unrounded dimension.

(14) ik heb KAPU(T) [//] kapot 'maakt (*I 've broken*) [N251- 68]

Articulatory context may be of some importance in the genesis of these three types of errors. All consonant harmony errors (by definition) as well as most natural class substitutions and vowel shifts were either preceded or followed by an element possessing the articulatory feature that corresponded to the incorrect one in the erroneous segment (see table 3.IV).

A fifth category, labeled *slur*, contains some string substitutions, whose transcribed representations indicate an articulatory 'weakening': stops become fricatives, or even glides, vowels are nasalized, and there is an overall impression of 'sloppiness' (example 15). Also, some apparent omissions of fricative and approximant consonants were assigned to this category. Although the IPA representations suggest otherwise, the perceptual impression of the latter errors was that of a failure to constrict the articulatory channel fast and accurately enough to produce the appropriate sound (examples 16, 17).

(15) ik ben [Içwɛ] [//] ik ben [ɪk ben] niet lief (*I am not sweet*) [T161-225]

(16) OEFJE ['ufjə] [//] Roefje ['Rufjə] eet pap (*Roefje eats porridge*) [T044- 25]

(17) ELP [//] help je mij? (*help you me*) [N221-424]

As can be deduced from Table 3.V, the above categories (syllable deletion, consonant harmony, natural class substitution, vowel shift, slur) account for 62.7% of all sound errors in T, and for 64.3% in N.

Table 3.IV. Effects of articulatory context in single feature errors

	Corpus T	Corpus N
No influence	11 (31.4%)	7 (17.5%)
Feature Anticipation	13 (37.1%)	19 (47.5%)
Feature Perseveration	11 (31.4%)	14 (35.0%)
Total	35 (100%)	40 (100%)

Among the remaining sound errors there is a small set which seems to involve misselection or misordering of phonological segments⁷. Twenty of these 'phonological' errors were found in T, which amounts to 24.1% of the sound errors, and 12 in N (14.3%). A necessary condition for the occurrence of this type of errors is the analysis of word form

⁷ It could be argued that these errors involve simultaneous alterations of -at least- two features (place and manner). However, it is easy to show that this is very unlikely. In T's corpus, 35 single feature errors were observed, which yields a probability of occurrence of .0025 per word. If it is assumed that feature substitutions are independent events, the probability of simultaneously changing two features is about 6×10^{-6} . This probability would predict less than one such error in the whole corpus. For N's corpus, the figures are in the same order of magnitude.

representations into phonological segments. In T, as many phonological errors occurred in the first half of the corpus (from age 2;3 to 2;7), as in the second half (from 2;8 to 2;11). Thus, the frequency of phonological errors was 1 in every 628 words in the first half, and 1 in every 780 words in the second half of the observation period; a slight decline. In N, on the other hand, only 1 phonological error occurred in the first half of the observation period (from age 3;0 to 3;5). This corresponds to a frequency of 1 in every 8508 words. The remaining 11 phonological errors occurred in the second half (age: 3;6-3;10), which yields a rate of 1 in every 1484 words. These figures suggest that segmentation of word forms into segments started later in N than in T.

The phonological errors include exchanges (ex. 18) and shifts (19), as well as some perseverations (an apparent source segment precedes the error; ex. 20, 21); anticipations (an apparent source segment follows the error; 22, 23); and non-contextual changes (no apparent source segment; example 24).

- (18) dat is LUIST JEUK (←juist leuk) (*that is just funny*)
 (19) ag em [ɑxəm] (←mag ə [mɑxə]) wel (roughly: *it's allowed*)
 (20) vliegtuig VLITTEN (←zitten) (*aeroplane sit*) [T102-164]
 (21) hier staat VRACHTWAGEG (←vrachtwagen) (*here stands lorry*) [N181-102]
 (22) ALLEMOEL (←allemaal) moet je branden (*all must you burn*) [T204- 85]
 (23) DJEURTJES (←deurtjes) (*doors*) [N153- 62]
 (24) KLANG (←slang) (*snake*) [T252- 51]

Table 3.V. Sound error categories.

	Corpus T	Corpus N
Consonant Harmony	5 (6%)	8 (9.5%)
Natural Class	17 (20.5%)	17 (20.2%)
Vowel Shift	13 (15.7%)	15 (17.9%)
Slur	14 (16.9%)	13 (15.5%)
Syllable Omission	3 (3.6%)	1 (1.2%)
Phonological Error	20 (24.1%)	12 (14.3%)
Else	11 (13.3%)	18 (21.4%)
Total	83 (100%)	84 (100%)

Summed over both corpora, 13 anticipations (40.6%), 11 perseverations (34.4%), and 8 non-contextual errors (25%) were observed. In 20 out of the 24 cases in which an apparent source segment could be identified (83.3%), this segment occupied a syllable position identical to that of the target segment. Syllable onsets were slightly more often affected in these errors than codas ($n=16$ [50%] vs. $n=14$ [43.8%], respectively); syllabic nuclei were affected in two

cases. In 6 out of the 13 cases (46.2%) in which this could be evaluated, the lefthand neighbour segments of target and source elements were identical. Thirty errors (93.8%) occurred in words that are usually considered 'open class' (N, V, Adj).

The remaining sound errors (T: 13.2%; N: 21.4%) seem to constitute a mixed bag. Most of these errors allow several interpretations. Example (25), for instance might involve the substitution of [ɔ] for [œ], or it might be an early interrupted lexical error, for instance the intrusion of 'nog' (yet).

(25) NO [nɔ] [//] nou [nœ] andere boef (*now another villain*) [N211-173]

Discussion

The characteristics of the phonological errors in the present corpus are slightly different from those of similar errors in adult speakers. In contrast to Stemberger's (1989) findings, perseverations were not more frequent than anticipatory errors. On the other hand, the proportion of anticipations in N and T (40.6%) is still smaller than in adults; for example, Nootboom (1969) observed 75% anticipations. A relatively high proportion of non-contextual errors was found (approximately 25%). By comparison: Stemberger reports 4.8% non-contextual errors in children and 14.5% in adults. Söderpalm (1979) found 15.7% non-contextual phonological errors in normal adults (in contrast to aphasic adults, who produced 80% non-contextual phonological errors).

The occurrence of phonological errors in T and N indicates that lexical representations incorporating phonological segments are emerging. Since the corpora studied have a restricted extension in time, it cannot, however, be evaluated whether or not phonological errors occur before age 2, which would be ruled out by the hypothesis that early word representations are unanalyzed. However, a difference between the two subjects was observed. In T, phonological errors surfaced all over the observation period, whereas in N, virtually all phonological errors were observed in the second half of the corpus. Thus, it could be concluded that the analysis of word forms was well under way in T, but had just started in N. It is useful to recall that N, although chronologically older, was phonologically backward as compared to T. Presumably, there is a correlation between the emergence of segmented representations and the rate and stage of phonological development in terms of (the increase of) speech sound inventory and (the disappearance of) simplificatory processes.

The errors affecting single articulatory features are particularly interesting. It seems that the proportions of these errors (42.2% in T, 47.6% in N) is much higher than in adults. For instance, Shattuck-Hufnagel and Klatt (1979) found fewer than 12 feature exchanges in a corpus of almost 3000 sound errors. It has been argued that features are not independent elements in speech planning. Nootboom (1969), for instance, states that "if distinctive features behaved like more-or-less independent elements just as phonemes do, one would expect to find a number of cases of the anticipation of one distinctive feature, without resulting in the sameness of the two phonemes involved. Thus, for instance /p/ becoming /b/ under the influence of a following /z/." (Nootboom 1969: 149). The consonant harmony

errors in the present corpus fit in precisely with this description. Does this imply that features are 'independent elements' in 2-3 year olds' speech planning?

The most economic and prudent answer to this question seems to be 'no'. Single feature substitutions (in consonant harmony errors, natural class errors and vowel shifts) can be nicely accommodated by Browman and Goldstein's (1989) model, by assuming that they reflect the alteration of parameters in the articulatory program. In such errors, either the parameter for the *place* of constriction, or the parameter for the *amount* of constriction of one of the oral gestures is altered. Moreover, in quite a number of cases the alteration seemed to be induced by the nature of the preceding or subsequent gestures. Thus in such cases, a parameter value seems to be 'mistimed'. If single feature errors of the type observed here are errors of articulatory programming, it is easy to see why they are not (or almost never) found in adults, and relatively often in children. It can be assumed that articulatory programming (gestural assemblage) in adults is over-learned and highly automatic, even more so than phonological planning (Studdert-Kennedy 1986). However, in children, i.e., 'apprentice speakers', articulatory programming is not over-learned at all. Consequently, the chance that errors will happen is much larger.

Two other error categories, 'slur' errors and syllable omissions appear to be articulatory as well. Slur errors seem to reflect gestural reductions. In other words: the parameters for the amount of constriction are set to lower values. Syllable omissions do not seem to involve alterations of gestural parameters. Rather, they may be assumed to be omissions of complete articulatory routines (Wijnen 1988).

The incidental single feature errors as well as the syllable omissions in the present corpus are similar to the systematic sound errors in younger children (cf. Menn 1978). This would suggest a developmental relation between systematic errors and incidental errors. Beginning speakers can be assumed to be even less proficient in articulatory programming than 2-3 year old children. As a consequence, articulatory errors, i.e., feature errors, are the rule rather than the exception. Somewhat older children are better articulatory programmers, but may still incidentally 'regress', producing the same errors they used to regularly produce at an earlier stage of development. Thus, the gradual disappearance of the 'processes' of child phonology over time may to a large extent be seen as the increase of articulatory skill.

3.3.3 MORPHEMIC ERRORS

Seven errors affecting the structure of compound words were found, one in T, six in N. Four were omissions (26, 27, 28, 29), three were substitutions (30, 31, 32).

- (26) hij 's niet op de KA(MER) [/] slaapkamer (*he 's not in the room [//] bed room*) [T112-39]
- (27) zo een stukje andere kant KNIP [/] afknippen zo (*a piece other side cut*) [N091-209]
- (28) uh... SCHOORVEGER (←schoorsteenveger) (*chimney cleaner*) [N092-113]
- (29) niet... PA(KKEN) [/] afpakken (*don't take away*) [N154-204]
- (30) AF [/] op(ge)geten (*eaten up*) [N161-120]
- (31) AFBOU(WEN) [/] opbouwen (*build up*) [N241-169]

(32) OVERTEN [//] zometeen (*shortly*) [N241-350]

N seems to have some peculiar problem with the morpheme *af*. It figures twice in omissions and an equal number of times in substitutions. In the substitutions it replaces *op*. Both *op* and *af* have several senses. *Op* may mean 'upon', 'upward' as well as 'finished'. *Af* can signify 'downward' and 'finished'. Thus, the two morphemes are conceptually related in a complex and somewhat paradoxical manner. At least some of these relations should be mentally represented in order for the substitutions to occur. The last substitution is remarkable in that the substituting string (*over*) is a morpheme but the substituted string (*zome*) is not, at least from an adult point of view. Apparently, the child has misanalysed the target word as 'zome+teen' (instead of *zo+met+een*). The target string and the substituting string are phonologically similar. At any rate, these errors seem to imply that compound words have been analyzed into the compounding morphemes.

3.3.4 LEXICAL ERRORS

Table 3 VI presents an overview of the different types of errors at the lexical level. It appears that almost all are substitutions. Two blends and two exchanges are found, all in corpus T

Table 3.VI Types of lexical errors

	Corpus T	Corpus N
Substitutions	30 (88.2%)	72 (100%)
Exchanges	2 (5.9%)	- (-)
Blends	2 (5.9%)	- (-)
Total	34 (100%)	72 (100%)

Substitutions

Six substitutions (3 in corpus T, 3 in N) appear to be contextually determined, in that the intrusion can be traced to a word in the context:

- (33) T: en televisie 'keken. Mother: en televisie gekeken. T: enne potje 'KEKE
(←(ge)zeten) (*and potty looked* [←*sat*]) [T022-32]
- (34) oma (←opa) en oma (*gramps and gran*) [T183-126]
- (35) als de KRAK kapot is [//] als de paddestoel kapot is, krak zegt de paddestoel (*when the crack broke is [//] when the toadstool broke is crack says the toadstool*) [T173-109]
- (36) inne container kan ook paar CONTAINER [tom'tenə] (←stenen ['tenə]) (*in container can also few stones*) [N091-80]
- (37) ik doe ook licht OOK [//] aan (*I do too light too [//] on*) [N102-17]

(38) voor hier KOEIEN ['tuja] (←voor [tuə]) koeien. (*for here for cows*) [N151-172]

The two exchanges (simultaneous double substitutions) in corpus T are, by definition, contextual as well:

(39) dat is KONIJN van SCHADUW (←schaduw van konijn) (*that is rabbit of shadow*) [T123-155]

(40) gaat ie HELPEN. jou vragen of je HUILEN wil (*goes he help. ask if you cry want to*) [T186- 84]

Conceptual Relations

All lexical substitutions (except for the exchanges), were checked for conceptual relations between the intruding and the substituted words. Two types of conceptual relations were apparent in the data set, which were labeled (1) *semantic* and (2) *episodic*. Table 3.VII shows the numbers of lexical substitutions falling in each of the two categories. It appears that a considerable portion of substitutions, 24.1% in T and 40.3% in N, did not reflect any conceptual relation at all.

The largest category, semantic substitutions, contains those cases in which the target word and the intruding word belong to the same semantic domain. Many semantic substitutions involved "formally" related words, such as pronouns (41, 42) or modal auxiliaries (43, 44). Examples (41) and (42) seem to involve substitutions of the feature for deictic value. In (43) and (44), 'modality features' are altered. Also, a number of somewhat peculiar replacements of deictic adverbs by demonstrative pronouns sharing the intended deictic value, and vice versa, were included in this category (45). Corpus T contained 9 (31%) substitutions involving 'formally' related words. In corpus N, 24 (33.3%) substitutions of this type were found.

(41) DIT is [/] dat is voor verf (*this is [//] that is for paint*) [N182-310]

(42) JIJ [/] ik ben al groot (*you [//] I am already big*) [T182- 11]

(43) ik MAG [/] ik moet het in papier doen (*I may [//] I must it in paper do*) [T241- 65]

(44) MOET je [/] kan je met de deur dan doen? (*must you [//] can you with the door then do?*) [N172-267]

(45) DAT [/] daar zit monsters in (*that [//] there sit monsters in*) [N222-487]

Another subset of semantic substitutions contained words that were related in the 'referential' domain. Eight (27.6%) of these were found in corpus T, and 11 (15.3%) in corpus N. Among these cases are some substitutions of spatial prepositions, such as (46) and (47). Most 'referentially' semantic substitutions (6 in corpus N, 5 in corpus T) involved coordinates or co-hyponyms, as in (48) and (49).

(46) IN [/] op de huis (*in [//] on the house*) [T182- 88]

(47) kan OP [/] in grond (*can [//] on in ground*) [N161-177]

(48) en dat is BLA(UW) [/] geel (*and that is blue [//] yellow*) [T103- 25]

(49) MAM(A) [/] papa (*mommy [//] daddy*) [N031- 12]

The second category of substitutions involving conceptually related words, *episodic* substitutions, contains cases in which the targets and intrusions seem to be related through an association between the persons, objects or events they signify in the child's representation of, or general knowledge and expectations about the situational context. Example (50) reflects a canonical association of two acts: breaking something and throwing something away. In cases like (51), the words involved represented prominent and associated elements in a picture-book story N was being told. Finally, some substitutions were found in which the intruding word represented a canonical, highly typical element in the ongoing event. Examples (52) and (53) occurred while N and his father were playing with Lego construction materials. The intruding as well as the intended words refer to objects that were quite routinely built, or at least considered, during such play sessions.

- (50) niet WEGGOOI(EN) [//] niet kapotmaken (*don't throw away [//] don't break*) [N023-187]
 (51) is BRAND [//] is huis weer schoon (*is fire [//] is house again clean*) [N071-247].
 (52) kan daar HUIS [//] autootje bouwen (*can there house [//] car build*) [N032- 75]
 (53) ik speel in KRAAN [//] in bus 'slapen heeft (*I play in crane [//] in bus slept have*) [N101- 388]

Table 3.VII. Conceptual relations between targets and intrusions in lexical substitutions.

	Corpus T	Corpus N
Semantic	17 (58.6%)	35 (48.6%)
Episodic	5 (17.2%)	8 (11.1%)
None	7 (24.1%)	29 (40.3%)
Total	29 (100%)*	72 (100%)

*in one case in corpus T the intruding word could not be reliably reconstructed.

Formal Correspondences

To evaluate whether word form affects lexical substitution, each target-intrusion pair was scored for similarity on four aspects of word structure: (1) initial sound(s), (2) final sound(s), (3) stressed vowel and (4) number of syllables. Example (54) is a substitution in which target and intrusion share initial sounds. Word final sounds of target and intrusion are similar in (55). Stressed vowels are identical in (56). Example (57) is a substitution in which the numbers of syllables of the involved words match.

- (54) ik MAG [//] ik moet 't in papier doen (*I may [//] I must it in paper do*) [T241- 65]
 (55) MOET [//] gaat ie heel hard zingen (*must [//] goes he very loud sing*) [N153- 53]

(56) LOE(KIE) [//] Roef kan wel praten (*Loekie [//] Roef can talk*) [T263- 14]

(57) ik wil even SPELEN [//] praten (*I want play [//] talk*) [N161- 367]

Table 3.VIII shows the observed proportions of matches between substituting and substituted words on each of the four structural factors. Substitutions in which the target was either a noun, an adjective or a main verb (i.e., a content word) were treated separately from those in which the target was a pronoun, an article, a preposition, a non-adjectival adverb or an auxiliary verb (i.e., a function word).

Table 3.VIII. Numbers of matches between targets and intrusions on four word form characteristics in substitutions of content words and function words.

	Corpus T		Corpus N	
	Content Words	Function Words	Content Words	Function Words
N of cases	12 (100%)	17 (100%)	25 (100%)	47 (100%)
Initial sound	2 (16.7%)	1 (5.9%)	6 (24.0%)	16 (34.%)
Final sound	3 (25.0%)	3 (17.6%)	10 (40.0%)	7 (14.9%)
Stressed vowel	7 (58.3%)	1 (5.9%)	6 (24.0%)	3 (6.4%)
N. syllables	11 (91.7%)	17 (100%)	20 (80.0%)	42 (89.4%)

In order to evaluate the statistical significance of the proportions of matches, they were compared to expected proportions given a random pairing of substituting and substituted words. The expected proportion of matches on each of the four structure factors was estimated by the scalar product of two vectors containing the observed proportions of each of the values of that structural factor in the sets of substituting and substituted words (cf., Dell & Reich 1981). The observed proportions of matches (see Table 3.VIII) were tested against the estimated chance values in binomial tests (Siegel 1956, p. 36 ff.), with $p = .01$. It appeared that in the function word cases none of the observed proportions of matches significantly exceeded chance expectations. In the content word set, on the other hand, the observed proportions of matches on the factors *number of syllables* and *stressed vowel* reached significance in both corpora, as well as the factor *final sounds* in corpus N. This means that substituted and substituting content words tend to be similar with regard to number of syllables and stressed vowel, and in N, final sounds.

Table 3.IX. Stressed vowel (a) and number of syllable (b) matches in conceptually related and unrelated content word substitutions.

(a) <i>Stressed vowel</i>	Corpus T			Corpus N		
	match	no-match	Total	match	no-match	Total
Conceptually related	5 (55.6%)	4 (44.4%)	9 (100%)	4 (36.4%)	7 (63.6%)	11 (100%)
Not related	2 (66.7%)	1 (33.3%)	3 (100%)	2 (14.3%)	12 (85.7%)	14 (100%)
Total	7 (58.3%)	5 (41.7%)	12 (100%)	6 (24%)	19 (76%)	25 (100%)

(b) <i>N. syllables</i>	Corpus T			Corpus N		
	match	no-match	Total	match	no-match	Total
Conceptually related	8 (88.9%)	1 (11.1%)	9 (100%)	9 (81.8%)	2 (18.2%)	11 (100%)
Not related	3 (100%)	- (-)	3 (100%)	11 (78.6%)	3 (21.4%)	14 (100%)
Total	11 (91.7%)	1 (8.3%)	12 (100%)	20 (80%)	5 (20%)	25 (100%)

Table 3.IX provides a breakdown of the matches in number of syllables and stress-bearing vowel over word substitutions which either or not involved conceptually related content words. The figures in these tables do not suggest that proportions of matches on these two word form characteristics are affected by the presence or absence of a conceptual relation between the words in the substitution. This is confirmed by non-significant results in Fisher's Exact Test for all four crosstabulations.

In the above paragraphs, words were differentiated by grammatical category, content versus function words in particular. To conclude this section, Table 3.X presents a confusion matrix of the grammatical categories of substituting and substituted words. At first sight, there is not much confusion: 77.8% (N) to 80% (T) of all target words are substituted by words from the same category. A remarkably large proportion of substitutions (65.3% in N; 56.7% in T) affects auxiliary verbs, articles, pronouns, adverbs, and prepositions. These proportions are slightly larger than the proportion of function words in the speech corpora from which the error data were drawn: T's corpus contains 52.8% function words, N's corpus 61.1%.

Table 3.X Confusion matrices of the categories of target words and intrusions in lexical substitutions

<i>Corpus T</i>	Intrusion											Total
	Noun	Adj	Verb	Aux	Art	Pro	Adv	Prep	Conj	Intj	???	
Noun	3					2				1		6(20%)
Adj		3										3(10 0%)
T Verb			3								1	4(13 3%)
a Aux				5								5(16 7%)
r Art					2	1						3(10 0%)
g Pro						3						3(10 0%)
e Adv							1	1				2(6 7%)
t Prep									4			4(13 3%)
Conj										-		-(-)
Intj										-		-(-)
???											-	-(-)
Total	3	3	3	5	2	6	1	5	-	1	1	30
	10%	10%	10%	16 7%	6 7%	20%	3 3%	16 7	-	3 3%	3 3%	(100%)

Table 3.X (continued)

<i>Corpus N</i>	Intrusion											Total
	Noun	Adj	Verb	Aux	Art	Pro	Adv	Prep	Conj	Intj	???	
Noun	9					1						10(13 8%)
Adj		-										-(-)
T Verb	1		8	6								15(20 8%)
a Aux			1	13								14(19 4%)
r Art					9		1					10(13 9%)
g Pro						6						6(8 3%)
e Adv						5	3					8(11 1%)
t Prep	1								8			9(12 5%)
Conj										-		-(-)
Intj										-		-(-)
???											-	-(-)
Total	11	-	9	19	9	12	4	8	-	-	-	72
	15 3%	-	12 5%	26 4%	12 5%	16 7%	5 6%	11 1%	-	-	-	(100%)

There appear to be some categories that are quite frequently confused, particularly in N, viz. Adv and Pro, and Aux and V. Adv-Pro confusions most often are substitutions of demonstrative pronouns for locative adverbs that agree in deictic value (example 58). An example of Aux-V substitution is (59). When the auxiliary verbs are subclassified into modals, copulae and a general class, it appears that many substitutions are inter-categorical (60, 61).

(58) DAT [//] daar ben ik met Jopie mee'rejen (*that [//] there have I with Jopie driven along*) [N222-182]

(59) IS dat [//] doe dat nou? (*is that [//] do that now?*) [N101- 58]

(60) MOET(mod) [//] heef(gen) ik zo 'bouwd (*must [//] has I built*) [N171-649]

(61) hij IS(cop) [//] hij kan(mod) ook nog (*he is [//] he can also*) [N242-143]

Blends

Two instances of two words merging into one non-existent form were observed. One of these blends, (62), results from two semantically related words, *zebra* and *giraffe*. The other one, (63), appears to be a fusion of two subsequent words within the same utterance which share some phonological characteristics (i.e., the vowel [u]):

(62) de ZEWRAF [T121-168]

(63) ook ROEL [rul] [//] groen [xrun] stoel [stul] (*also green chair*) [T184- 25]

Discussion

It is difficult to compare the proportions of word substitutions involving semantically related words in T and N to those of adults, because the results from adult studies tend to be rather diverse. According to Hotopf's (1980a) results, approximately 35% of the word substitutions in adults involved semantically related words, Dell & Reich's (1981) data yield 45%, and Stemberger (1989) reports 83% semantic word substitutions. One of the reasons for this diversity seems to be that each investigator applies different criteria for semantic relatedness. On the basis of Stemberger's (1989) comparison between adults and children, it might be concluded that semantic substitutions occur less often in children (60%) than in adults (83%). Stemberger is reluctant to draw this conclusion, however, because of the discrepancy between his data on adults and those reported by others. The proportions found in N and T, however, together with Stemberger's results seem to present a nice developmental pattern, in that the proportion of semantic substitutions seems to increase with age. This pattern agrees with the hypothesis that 'semantic fields' in the lexicon, i.e., interconnected clusters of entries for semantically related words, gradually emerge during language development. Thus, in very young speakers, a different organization of lexical entries may prevail. The substitutions involving episodically related words in T and N suggest that in beginning speakers the organization of the lexicon may be linked to perceived functional relations between the entities to which words refer (Nelson 1983).

Interacting lexical items in content word substitutions showed a tendency to match in two --prosodic-- attributes, viz. the number of syllables and the vowel bearing lexical stress.

Also in sound errors, these two attributes proved to be particularly 'error proof'. These findings are consistent with hypotheses stressing the fundamental role and developmental primacy of prosodic attributes in early lexical form representations (Menn 1983, Chiat 1983, Gleitman, Landau & Wanner 1988). However, data from adults show that prosodic attributes maintain their prominent role in the organization of lexical form information. Fay & Cutler (1977) found that the interacting words in a corpus of malapropisms shared the number of syllables in 87% of the cases. Stress patterns were similar in 98% of the cases. Still, there may be a difference between children's and adults' lexical form representations, albeit a subtle one. The results of Aitchison & Straf (1982), as well as those of Dell & Reich (1981) indicate that in addition to prosodic information, segmental 'content', particularly the initial segments, determines the organization of word form representations in adults to a considerable extent. In young speakers' lexicons, the present results suggest, the organizational role of initial segments may be definitely smaller, if not altogether absent. This might be connected to the idea that many word forms in 2-3 year old children are not yet fully analyzed into segmental constituents.

It could not be shown that conceptually related word pairs in substitutions were less often phonologically similar than conceptually unrelated words. This seems to differ from what was found in adults. Dell & Reich (1981) observed that although in all substitutions phonological similarities between the interacting words exceeded chance values, conceptually related words were less often phonologically similar than unrelated words. Dell & Reich propose a model of lexical retrieval in which the selection of word meaning representations may interact with the selection of phonological forms. Such an interaction seems to be more pervasive in T and N than in adults. This might imply that the activation of word meaning and the retrieval of word form in young children are less discrete processing stages than in adults.

The lexical class constraint on word substitutions in T and N seems to be somewhat weaker than is usually found in adults. Nootboom (1969), analysing a small corpus of substitutions, ($n=21$) found 100% lexical class matches; and Fay & Cutler (1977) report 99% matches in a corpus of 183 malapropisms. The relatively low proportion of lexical class matches in T and N might reflect an imperfect syntactic categorization in the developing lexicon. This would seem to agree with the conjecture that the syntactic categorization of the lexicon gradually develops, as some so-called 'discontinuity' theories of syntactic development predict (cf., Gleitman 1981).

A striking difference between T and N's lexical substitutions and those of adults concerns the proportion of function words involved. Function words are only marginally involved in adult substitutions: Nootboom (1969) found three substitutions of prepositions in a set of 21; Hotopf (1980a, b) reports percentages of function word substitutions between 0 and 5. The disproportionately low rate of function word errors, as compared to content word errors in adults appears to reflect the computational difference between these two classes. Thus, the finding that the proportions of function word substitutions are not conspicuously smaller than the proportions of function words (tokens) in the full corpora (on the contrary) may be explained by assuming that the computational differences have not yet fully emerged in 2 to

3 year old children⁸. Additionally, in view of the between-category substitutions, it could be hypothesized that a 'reorganization' of the lexicon along the lines of Bowerman's (1978) proposal is in progress, in which function words are integrated within syntactically defined 'lexical fields' in the lexicon.

3.4 CONCLUSION

It was noted in the Introduction that previous investigations of children's incidental errors are somewhat contradictory as regards their answer to the question: "are children's and adults' language mechanisms different?". Some studies support the conclusion that there are only gradual ("quantitative") differences. This would imply that children's mechanisms are essentially similar to those of adults, but may be less well controlled. On the other hand, other studies support the idea that more qualitative differences occur as well. This would imply that the child's language production system differs from the adult system. In other words: the language production mechanisms would be subject to developmental change.

The results of this investigation are to some extent ambiguous, due to the limited size of the corpus, the method by which the corpus was compiled and the consequent hazard in comparisons with adult data. Also, it appears that results from adults' speech error studies are not altogether consistent, which adds to a certain degree of indeterminacy in the present discussion. Nevertheless, some -prudent- conclusions regarding the above controversy may be drawn: The results of this investigation confirm that there are differences between young children and adults in lexical processing and representation. Some of these differences appear to be of the gradual, "quantitative" sort, whereas others may be classified as "qualitative".

The single feature -purportedly articulatory- errors in this corpus are not reported for adults. This may be due to differences in corpus compilation. On the other hand, if it is not, this difference may be assigned to the "gradual" category: it is not necessary to assume that children's and adults' articulatory processes differ in any *principal* manner. Rather, it could be argued that children are less well in control of their articulatory system. Neither do the *phonological* (segmental) errors in the present corpus seem to point at essential differences between children and adults regarding phonological processing. However, the present study also provides some new supportive evidence for the conjecture that at some time during development, segmented phonological representations are not yet available, which implies

⁸ The disproportionately low percentage of function words involved in speech errors in adults may also be related to their phonological characteristics. Function words are 'phonological minor class', i.e., they are unstressed (unstressable), segmentally reduced, often clitic elements. In written language, function words do not possess these characteristics or their visual analogues. Hotopf (1980b) observed that the percentage of (sound) errors affecting function words is much higher in writing than in speech: approximately 56%. This observation leads to the speculation that the high proportion of errors affecting function words in the present subjects as compared to adults indicates that function words are not yet -phonologically-differentiated from content words.

the absence of an intermediate phonological planning stage between the retrieval of word meaning and articulation. This, clearly, implies a "qualitative" developmental difference.

As in adults, conceptual and formal (phonological) similarities of words appear to play some role in lexical substitutions in the present corpus. This suggests that a basic organizational principle of the lexicon, similarity, is the same for children and adults. However, "qualitative" differences are observed in the *kinds* of similarities underlying the lexical representation. *Semantic fields* seem to be not yet fully developed in children. There are some indications that the organization of lexical meaning at early ages is connected to episodic knowledge. At the level of word form, *prosodic* features appear to be more important in the organization of the lexicon than segmental features. Finally, the computational distinction between function words and content words that is observed in adults appears to be less clear-cut in young children.

In summary, it seems that the "quantitative" and "qualitative" differences between adults' and children's speech errors refer to different aspects of the language production apparatus. "Quantitative", or gradual, differences, are related to the basic processes of activation and retrieval, which do not seem to change essentially during development. However, the representations underlying the production of words, their structure and organisation, -the architecture of the mental lexicon- seem to alter during development, which is responsible for "qualitative" differences between adults' and children's speech errors.

4.0 ABSTRACT

This is an exploratory case study of the relation between speech output disturbances (disfluencies) and the development of language production processes. The data consist of transcribed speech samples of a Dutch boy between 2;4 and 2;11. The period of observation captures the early phase of the transition from 'pre-grammatical' to grammatical language. The frequency of occurrence of disfluencies (i.e., repetitions, revisions and incomplete phrases) shows a significant increase and a subsequent decline. Whereas in the first half of the observation period the disfluencies are distributed relatively randomly over sentences, in the second half they tend to concentrate in function words and sentence-initial words. The decline of disfluency rate is shown to be related to an abundant use of a few 'syntactic frames'. It is argued that these results reflect the emergence of a component in the speech production apparatus which is specifically dedicated to serial-order planning.

4.1 INTRODUCTION

'When we turn to studies of development of psychological mechanisms in language production and comprehension there is a relative paucity of information' John Marshall complained in 1979 (Marshall 1979:448) and he is still largely right today, particularly with respect to production. Although most child language research is based on spontaneously produced speech, the predominant approach is competence-oriented. This perspective originated in the early days, when language acquisition was considered equivalent with syntax acquisition, and has persevered through shifts of the focus of attention towards semantics (e.g. Schaerlaekens 1973, Brown 1973) and, still later, pragmatic and interactive aspects of language (e.g. Bruner 1975). In each of these areas, researchers have been trying to formulate competence rules that would underlie children's behavior, and have described development in terms of extension, refinement and reorganization of rule systems.

¹ A slightly different version of this chapter will appear in the *Journal of Child Language*

This study takes a different perspective. Instead of 'the body of knowledge' that children acquire in learning to speak, the 'psychological mechanism in language production' is examined. The basic question that is addressed by this research is: does the architecture of the speech production system change during the period in which language is acquired. It will be argued that the answer is affirmative: The transition from 'pre-grammatical' language to morpho-syntactically governed language, which is roughly captured by Brown's (1973) stage II, appears to be associated with an essential modification of the planning mechanism underlying speech production. The context -both methodological and theoretical- for this argument is supplied by some recent studies of language production in mature speakers, which will be briefly discussed below.

4.1.1 SENTENCE PRODUCTION IN ADULTS

According to recent insights, the preparation of spoken utterances involves several levels of processing. In general, three major components are distinguished: (1) the conceptualizer, which generates -non-linguistic- messages; (2) the formulator, i.e., a processing component which moulds the message into linguistic shape; and (3) the articulator, which generates and executes articulatory motor programs (Fromkin 1971, Levelt 1989).

An important hypothesis, put forth by Fromkin (1971) and elaborated by Garrett (1975, 1980), is that formulating consists of two complementary substages. The primary evidence for this hypothesis comes from systematic distributional differences between two types of speech errors, sound exchanges and word exchanges. Garrett (1975, 1980) observed that most word exchanges involve lexical items from different phrases within the same clause (although some cross clause boundaries) that belong to the same lexical class. Sound exchanges, on the other hand, usually occur within the same phrase, and the words from which the exchanging sounds originate may belong to different lexical classes. Garrett argues that word exchanges originate at a level of processing which selects open class lexical items and maps them onto functional syntactic relations. At this functional substage of formulating, neither the serial order nor the phonological layout of lexical items has yet been actualized. Sound exchanges, on the other hand, originate at the second, positional substage of formulating, which creates ordered and phonologically explicit representations on the basis of developing functional representations and the appropriate word forms (Levelt 1983). A third class of exchange errors, the so-called stranding errors, was observed, in which lexical morphemes incorporated in morphologically complex forms exchange, leaving their associated affixes behind, as it were. The distributional properties of this error type are similar to those of sound exchanges. Consequently, Garrett argues that stranding errors originate during the computation of positional representations, which can be viewed as the 'insertion' of open-class words into 'slots' in a syntactic frame made up of closed class words and syntactically active affixes.

The speech error evidence suggests that the sentence or clause is the formulator's primary planning domain. This appears to be confirmed by studies of hesitations in speech. It has been established (cf. Goldman-Eisler 1968) that hesitations, i.e., transitory speech

disturbances such as pauses, repeats and false starts are related to the assignment of processing capacity to planning. Boomer (1965) counted all hesitation pauses in samples of spontaneous speech and found that most of them occurred near the beginning of clauses². In a recent extensive study, Holmes (1988) found that not only silent pauses, but also filled pauses and repetitions (of sounds, words and phrases) occurred significantly more often at clause-initial positions than at clause-internal positions. Additionally, she collected evidence which suggests that some 'deep clauses' may be independently planned, depending on their functional relation to a connected surface clause. Constituents (within clauses) may also function as -secondary- planning units. Maclay & Osgood (1959) observed that repetitions typically involved function words (particularly pronouns, determiners, prepositions and conjunctions) which occurred at constituent-initial positions (see also Clark & Clark 1977). Moreover, corrections of content (open class) words more often involved retracing the antecedent items (mostly function words) than corrections of function words.

It has been suggested that hesitations, such as repetitions and filled pauses specifically reflect difficulties in coordinating lexical selection (functional level planning) and the construction of syntactic frames (positional level planning) (Maclay & Osgood 1959, Butterworth 1980, Garrett 1982). Some experimental results appear to sustain this suggestion. Although Garrett's original hypothesis envisioned functional planning and positional planning as strictly hierarchically ordered processing stages, recent studies suggest otherwise. For instance, Dell & Reich (1981) observed a clear lexical bias in phonological errors, as well as a significant degree of phonological similarity between the interacting content words in semantically based substitution errors. These findings suggest that the selection of word meaning representations (functional level) and the access to word forms (positional level) are interactive. Recent experimental findings indicate that when a word form is difficult to access, speakers may opt for a sentence structure that allows this word to be mentioned relatively late (Levelt & Maassen 1981, Bock 1987). Thus, decreased accessibility of a word form, which hampers positional level processing, may induce re-allocation of functional syntactic roles at the functional level. Interestingly, Bock (1987) found that in the cases where such problems of coordination and subsequent 'corrective planning' could be expected to occur, sentences were more often hesitantly initiated than in cases where sentence formulation was not interfered with.

In summary, the primary unit in sentence formulation in adult speakers is the sentence or clause. Formulation consists of two substages, functional planning, which is dedicated to lexical selection and the computation of functional syntactic relations, and positional planning, which is dedicated to syntactic frame building and the ordering of phonologically defined lexical items. Speech hesitations reflect the occurrence of sentence planning processes, in particular involving the coordination of the two substages of formulating.

² In fact, Boomer defined clauses in phonological terms, but this is of slight importance for the present discussion, since onsets of phonological and syntactic clauses more often than not coincide.

4.1.2 SPEECH PLANNING IN CHILDREN

Can the production of speech in children be analyzed in a manner that is similar to the approaches outlined in the above section? If one inspects the developmental psycholinguistic literature, it may seem as if children neither hesitate nor slip. The latter might be true (cf. Warren 1986), although it could perhaps reflect the difficulty of recognizing incidental speech errors amidst an excess of imperfections that are due to linguistic immaturity. However, children do hesitate, but it appears that the interest in this phenomenon has been largely confined to a research tradition that has not been very intimate to (psycho)linguistics, namely speech pathology. Consequently, the terminology is different; repetitions, false starts, as well as some other disturbances, are usually jointly labeled 'disfluency'.

The relevant literature in this field indicates that children exhibit considerable variation in the frequency of disfluency, but that, generally, the amount of disfluent speech peaks in the preschool years and decreases subsequently (Davis 1939, Yairi & Clifton 1972, Bjerkan 1980, Yairi 1982). The majority of children's disfluencies are repetitions and revisions (Yairi 1981, Wexler & Mysak 1982), which are phenomenologically very similar to those of adults. Moreover, a number of studies show that children's disfluencies - just like adults' hesitations - tend to occur at syntactically significant positions in utterances, such as clause boundaries and closed class words at the beginning of major constituents (Bloodstein & Gantwerk 1967, Helmreich & Bloodstein 1973, Bernstein 1981, Bloodstein & Grossman 1981, Wall, Starkweather & Cairns 1981). It has been suggested that this distributional pattern reflects the allocation of processing capacity to the planning of stretches of speech that correspond to syntactic units (Bloodstein 1974, Wall *et al.* 1981, Nelson 1984).

The basic similarities between hesitation patterns in adults and disfluency patterns in children seem to suggest that the processing structures underlying speech production are developmentally invariant. There are, however, some reasons to doubt this conclusion. First, most studies of developmental disfluency represent a large sample approach in which subjects from a wide range of ages are pooled, so that developmental tendencies are likely to be obscured. Second, the children in these studies had generally reached the age of 4 years or older. At this age children have generally reached a level of language competence that is -in the essential aspects of grammar- roughly equivalent to that of adults (Schaerlaekens & Gillis 1987). Thus, it can be concluded that the development of disfluency as related to speech production in the earlier phases of language development has not yet been analyzed. The widely reported, but hitherto unexplained disfluency peak occurs during these stages. The present study attempts to relate this phenomenon to the development of the speech planning mechanism, which is hypothesized to be associated with specific developments in linguistic competence.

Between the ages 2 and 4 important changes occur in children's language which mark the transition from 'pre-grammatical' or 'telegraphic' speech to 'grammatical' speech. During this stage (roughly stage II in Brown's (1973) scheme), the set of grammatical morphemes is rapidly extended and differentiated as a category from open class vocabulary. Morpho-phonological and morpho-syntactic processes become productive. It appears that these new

elements of grammar are those which are handled at the level of positional planning in Garrett's model of sentence formulation. Consequently, it can be conjectured that their emergence in child language is reflective of the development of a positional planning component in the speech production system. This hypothesis will be referred to as the Development of the Formulator Hypothesis. It will be clear that this hypothesis raises two questions. First, in what way can it be tested, or, in other words, what predictions does it make? The second question is, of course: if positional planning is not present as of the first multi-word sentence, what mechanism can be thought to underlie these utterances? The latter question will be addressed later on in this paper, but an answer will inevitably be incomplete and rather speculative.

As regards the first question, a prediction can be made with respect to the distribution of disfluencies. In the fully developed formulating mechanism, disfluencies arise as a result of planning activity -particularly: the coordination of functional and positional planning- at the boundaries of clauses or sentences and at phrase-initial closed-class words. It can be argued that as long as the formulating mechanism has not reached its eventual two-stage architecture, disfluencies will not be specifically concentrated in the aforementioned loci. Hence, it can be expected that the 'mature' distribution of disfluency will gradually emerge over time.

The present study attempts to test this prediction by means of a longitudinal distributional analysis of the developmental disfluency of a 2-year-old Dutch boy. In addition to this, an attempt will be made to explain the increase and subsequent decline of disfluency which occurred during the period of observation in terms of the Development of the Formulator Hypothesis. A single subject approach, of course, demands reluctance in generalizing the findings. However, in view of the wide inter-individual variability in rate and pattern of both language acquisition and the development of disfluency (Yairi 1982), it was considered the most appropriate approach for a detailed explorative study.

This paper will proceed as follows. First, some preliminary quantitative results with respect to the development of sentence length and the frequency of disfluencies will be presented. Then, in order to corroborate the assumption that the kind of grammatical development which is expected during this stage of development is actually taking place in the subject, some data regarding the changing status of closed class words, will be presented. Subsequently, the distribution of repetitions with respect to lexical classes and sentence boundaries are analyzed. The next section deals with the question of whether distributional data of another type of disfluencies, viz. self-corrections, corroborate the repetition results. Finally, the developmental course of the frequency of disfluencies is investigated.

4.2 METHOD

4.2.1 SUBJECT

The data set for this study consists of a corpus of utterances transcribed from tape-recordings of one Dutch boy, T, between 2;3.22 and 2;11.22. T had started to use multi-word utterances

around 2;2. The mean lengths of utterance in morphemes (Brown 1973) obtained from the corpus identify T as a stage II child during the period of observation (see table 4.I). T's speech and hearing were normal; he was not identified as a stutterer.

4.2.2 RECORDING AND TRANSCRIPTION

An approximate total of 25 hours of recordings was collected. The recording sessions were evenly spread over time, so that roughly one hour of tape became available for each week. The recordings were made under various ordinary domestic circumstances. Usually, T was engaged in a conversation with his mother. The recording equipment was of ordinary (non-professional) quality. It was normally put in the direct vicinity of the child, so as to optimally pick up the child's speech.

Approximately 17 hours of recording were transcribed by two independently working, phonetically trained transcribers. T's speech was transcribed in IPA supplemented with nonstandard diacritics indicating disfluencies and conspicuous aspects of prosody (sentence accents and marked intonation). The adult interlocutor's speech was written down in Dutch orthography. The transcribed tapes cover four periods of 3 to 5 weeks, which are evenly spread over the total period of observation (see table 4.I)³.

Table 4.I. An overview of the corpus.

period	week numbers	total recording time (minutes)	chronological age	average MLU	Number of utts.
1	1-4	300	2;3.22/2;4.16	1.98	2050
2	9-12	240	2;5.21/2;7.9	2.6	2261
3	16-20	300	2;8.2/2;9.5	2.64	2675
4	24-26	210	2;10.23/2;11.22	2.73	1711
Totals		1050			8697

The independently produced provisional transcriptions of T's utterances were compared to generate definitive versions. Discrepancies between the transcriptions were resolved by joint listening to the tapes and negotiation. If the transcribers could not reach agreement on either the segmental transcription or the identification of disfluency, the disputed utterances, or the relevant parts thereof were dismissed from subsequent analysis. The types of disfluency that were distinguished were: repetitions (of sounds, words, or phrases), self-corrections, incomplete sentences, sentence-initial 'warm-ups' and tensed prolongations. Some examples of these types are given in Table 4.II.

³ There is one exception. The first two weeks and the second two weeks of the second period are separated by a four weeks' holiday.

As the notion 'sentence' is central to the hypothesis underlying this research and as formal grammatical definitions of the sentence are not readily applicable to child language, it is necessary to point out how sentences were defined in this study. The primary criterion in deciding whether a string of words would be considered a sentence was 'intonational integrity'. Thus, a discontinuity in the melodic contour of a string of words was considered to be a sentence boundary, unless an assessment of semantic or pragmatic attributes, based on 'rich interpretation' suggested otherwise. Experimental results (Branigan 1979) corroborate the validity of this operational criterion. It should be stressed that this criterion was employed throughout the period of observation. Hence, the term 'sentence' as it appears in the ensuing analyses, always refers to operationally similar units. Furthermore, it should be pointed out that decisions regarding the segmentation of sentences, just as those regarding segmental transcription and the identification of disfluency, were submitted to the criterion of consensus between the two transcribers.

Table 4.II. Examples of speech disfluencies.

-
- (1) Repetitions:
- (a) sound:
 - k... kerstboom (T012- 67)
 - ch...christmas tree
 - (b) word:
 - ik... ik ben ook pap gegeten (T111- 28)
 - I... I am also porridge eaten (I also ate porridge)
 - (c) phrase:
 - heb je... heb je hier hand? (T184- 78)
 - have you.. have you here hand (do you have a hand here)
- (2) Self-corrections:
- doet die sch... doet schoen nou? (T111-303)
 - does that sh... does shoe now (what does that shoe do?)
- (3) Incomplete sentences:
- eh... dat is... (T111- 89)
 - ah... that is...
- (4) 'Warm-ups':
- /ndzdz/... door de slang (T041- 34)
 - /ndzdz/... through the tube
- (5) Tensed prolongations:
- n::iet waar (T185- 8)
 - n::ot true
-

4.3 RESULTS

4.3.1 SENTENCE LENGTH

Figure 4.1 shows the development of mean sentence length over the total period of observation. The index differs in two aspects from Brown's (1973) MLU. First, it is expressed in numbers of words, i.e., items that are recognized as such by a competent native speaker, rather than morphemes. This appears to prevent a number of ad hoc decisions regarding the segmentation of words into morphemes. Second, the statistic is computed on a subset of utterances excluding *yes*'s, *no*'s, vocatives and some standard or memorized expressions (e.g., social routines, counting, nursery rhymes), so that it can be considered a reasonably valid estimation of sentence length tendencies in 'non-formulaic' language. In the first period (week 1 through 4) sentence length is relatively stable around 1.85 words, with the exception of a dip in week 3. Period 2 shows an increase from 2.13 to 3.06. Utterance length in period 3 is again relatively stable, this time between 2.7 and 2.9. In period 4 a slight overall increase was found.

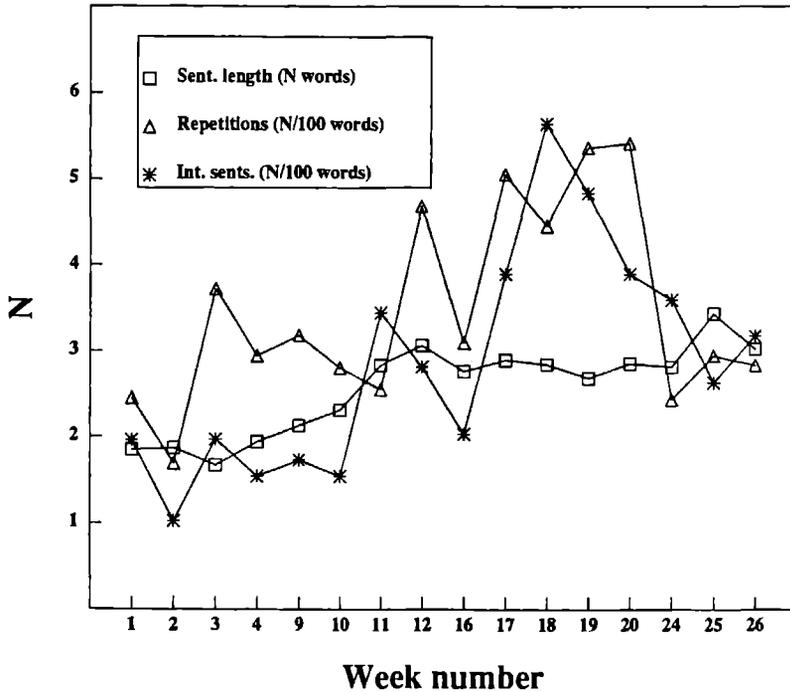
4.3.2 OVERALL DISFLUENCY

The majority of disfluencies are repetitions, revisions and incomplete phrases, as is indicated by Table 4.III. Figure 4.1 shows the development of the frequency of these types of disfluency, expressed as the total number of instances per 100 words. Both the indexes for repetition and for the combined category of revisions and incomplete sentences appear to increase between period 1 and period 3, and decrease from period 3 to period 4. Chi-square tests confirm that the proportions of occurrences of these two types of disfluency vary significantly across periods (repetitions: $\chi^2 = 21.53$, $df = 3$, $p < .001$; revisions/incomplete sentences: $\chi^2 = 34.34$, $df = 3$, $p < .001$). Taken together, these results imply that the amount of disfluency increases until a peak is reached in period 3, and declines subsequently.

Table 4.III. The numbers of self-corrections, incomplete sentences, repetitions and other disfluencies in the four periods of the corpus.

Period	Self-correction	Incompl.sent.	Repetitions	Other	Total
1	20 (11.3%)	28 (15.8%)	75 (42.4%)	54 (30.5%)	177 (100%)
2	45 (14.1%)	79 (24.7%)	137 (42.8%)	59 (18.4%)	320 (100%)
3	62 (13.0%)	150 (31.5%)	202 (42.4%)	62 (13.0%)	476 (100%)
4	37 (14.0%)	75 (28.3%)	100 (37.7%)	53 (20.9%)	265 (100%)
Total	164 (13.2%)	332 (26.8%)	514 (41.5%)	228 (18.4%)	1238 (100%)

Figure 4.1. The mean sentence length (in numbers of words); repetition rate (raw numbers per 100 words); and the total number of interrupted sentences (incomplete sentences and self-corrections) per 100 words, as a function of week of recording (1-4: period 1; 9-12: period 2; 16-20: period 3; 24-26: period 4).



4.3.3 LANGUAGE CHANGE

According to the Development of the Formulator Hypothesis, the emergence of positional processing in speech production is associated with particular linguistic developments such as the emergence of closed class vocabulary and the development of morphological processes. In T, quantitative as well as some qualitative observations with respect to the development of function words confirm that the child is in the critical period. The quantitative data concern growth and frequency of use of closed class vocabulary. Words in the corpus were categorized and counted. Nouns, adjectives, and verbs were regarded as content words. Determiners, (non-adjectival) adverbs, pronouns, prepositions and conjunctives were regarded as function words. In Period 1 of the corpus, a total number of 59 different function

words (types) was counted. This number increased by 29 (49.2%) in Period 2 and by another 13 (16.7%) in Period 3. Figures regarding the use of function words underscore their growing importance. In Period 1, only 27.8% of all word tokens are function words. This figure almost doubles to 50% in Period 4.

Some data regarding the use of prepositions by T underscore the changing status of function words during this developmental stage. In adult language, most prepositions can be considered two-place predicates. The arguments could be tentatively called 'subject' and 'oblique' (cf., Keenan & Comrie 1977). In a sentence like 'A cat walks on the hot tin roof', 'a cat' is the subject argument of 'on', and 'the hot tin roof' is the oblique argument. All expressions containing prepositions in T's corpus were counted and classified according to the number and types of arguments involved. Thus, four types of expressions resulted: (1) subject argument only (e.g. 'zonnetje op' [sun on], meaning: there is a sun on something, i.e., T's plate, as suggested by the context); (2) oblique argument only (e.g. 'op het bordje' [on the plate]); (3) subject argument and 'empty' oblique argument, expressed by the indefinite adverb 'er' (e.g. 'pit er uit halen' [take pip out of]); (4) two full arguments (e.g. 'dit is zwarte trein op brug' [this is black train on bridge]).

Table 4.IV displays the proportions of prepositions in each of the four different contexts throughout the corpus. It appears that in period 1, the majority of all prepositions (88.6%) are accompanied by just one argument. In 36.7% of the cases, this is the subject argument. In period 2, the amount of subject-only constructions is dramatically reduced to 4.1%. At the same time, full-fledged relational use of prepositions emerges, as is indicated by the increase of two-argument constructions from 6.3% in period 1 to 32.2% in period 2, and a subsequent growth to 48.0% in period 4. These results seem to imply that at the outset of the observation period prepositions function as (unspecific) modifiers (cf., McNeill 1966) and subsequently change into relational words. Similar patterns of development have been observed before (Tomasello 1987).

Table 4.IV. The numbers of prepositions in either of four contexts of use.

Period	Subject only	Oblique arg. only	Subject and 'er'	Subject and oblique args.	Total
1	29 (36.7%)	41 (51.9%)	4 (5.1%)	5 (6.3%)	9 (100%)
2	6 (4.1%)	84 (57.5%)	9 (6.2%)	47 (32.2%)	146 (100%)
3	13 (7.3%)	86 (48.0%)	8 (4.5%)	72 (40.2%)	179 (100%)
4	1 (0.7%)	69 (46.0%)	8 (5.3%)	72 (48.0%)	150 (100%)
Total	49 (8.8%)	280 (50.5%)	29 (5.2%)	196 (35.4%)	554 (100%)

It is of some importance to note that the relation that is denoted by a preposition is grammatically encoded by the order of the arguments. Thus, acquiring the relational character of prepositions, as it is observed in T, seems to pose the necessity of learning to

plan the order of sentence elements. That this may cause initial trouble is illustrated by some incidental and, therefore, striking reversals which were noted by T's mother in her diary:

- (1) lepel mette appesap (intended: 'appelsap met lepel' [*apple juice with spoon*])
- (2) bed inne pop (intended: 'pop inne bed' [*doll in bed*])
- (3) boot zit in pappa beer (intended: 'pappa beer zit in boot' [*daddy bear sits in boat*])

4.3.4 REPETITIONS AND LEXICAL CLASSES

The distribution of disfluencies in mature speakers is known to be affected by the open class-closed class distinction. Consequently, it can be predicted that if this distinction is acquired during the period of observation, the distribution of disfluency will change concurrently. To test this prediction, the numbers of function words and content words affected by word- and sound repetitions in each of the four periods were counted. Table 4.V indicates that the proportion of function words in the set of words affected by repetitions appears to increase gradually from period 1 to 3. This change is reflected by a significant chi-square ($\chi^2 = 32.19$; $df = 3$; $p < .001$). In order to establish whether the proportions of content and function words involved in repetitions differed from those in fluent speech, a random sample of fluently pronounced words was drawn from the corpus. The numbers of content and function words in the fluent random sample are indicated in Table 4.V. The figures in this table suggest that the proportions of content words and function words in the repetition and fluent samples do not differ much in periods 1 and 2. In periods 3 and 4, however, the proportion of function words seems to be larger in the repetition sample than in the fluent sample. Thus, it seems that, in concordance with the above prediction, repetitions are approximately randomly distributed with respect to word class in the first two periods, whereas, in periods 3 and 4, they concentrate in function words.

In order to statistically substantiate this conclusion, Table 4.V was submitted to loglinear analysis, which is aimed at finding a linear model which captures the most parsimonious combination of factors (in this case: period, sample [repetitions vs. fluent] and word class) and interactions of factors that optimally predicts the observed data. It was established, however, by means of likelihood ratio tests that none of the parameters in the full loglinear model could be set to zero. This means that only the so-called 'saturated' model, with non-zero parameters at all levels (main effects, second order interactions, third order interactions) gives a sufficient fit to the data, which is uninformative. It is still possible, however, to test which parameters are mainly responsible for this 'non-zero' test result. In view of the above prediction we are particularly interested in whether the increase in the proportion of function words as a function of time (period) is different for the two samples (repetitions vs. fluent speech). Specifically, it was tested whether the ratios of the proportions of function words were identical in the two samples for each pair of successive periods. Since there are four periods, three hypotheses were tested. Estimates of the relevant parameters were obtained by maximum likelihood estimation. Pearson χ^2 statistics were calculated for each of the three hypotheses (for details, see Haberman 1974). For the first hypothesis, contrasting period 1 with period 2, the Pearson χ^2 statistic had a value of 0.7021 ($p = .402$). For the second

hypothesis, contrasting period 2 and period 3, Pearson $\chi^2 = 12.25$ ($p = .0005$), and for the third hypothesis, contrasting periods 3 and 4, Pearson $\chi^2 = 5.55$ ($p = .018$).

These results confirm the impression given by the figures in Table 4.V. A clear significant 'shift' in the distribution of repetitions occurs between periods 2 and 3, resulting in a disproportionate number of function words involved in repetitions, as compared to fluent speech. The significant test result on the third hypothesis confirms the impression that the difference between fluent and non-fluent samples diminishes in period 4.

Table 4.V. The numbers of content words and function words affected by word- and sound repetitions and in a fluent random sample.

Period	Repetitions		Total
	content words	function words	
1	47 (69.1%)	21 (30.9%)	68 (100%)
2	65 (52.0%)	60 (48.0%)	125 (100%)
3	53 (30.9%)	118 (69.1%)	171 (100%)
4	39 (42.9%)	52 (57.1%)	91 (100%)
Total	204 (44.8%)	251 (55.2%)	455 (100%)

Period	Fluent random sample		Total
	content words	function words	
1	185 (63.6%)	106 (36.4%)	291 (100%)
2	254 (53.0%)	225 (47.0%)	479 (100%)
3	348 (54.8%)	287 (45.2%)	635 (100%)
4	247 (49.9%)	248 (50.1%)	495 (100%)
Total	1034 (54.4%)	866 (45.6%)	1900 (100%)

An alternative explanation for this repetition 'shift' could be stated in terms of vocabulary growth. When many new words are acquired, many new articulatory patterns have to be exercised, which could lead to a considerable number of pronunciation breakdowns. Indeed, as was indicated in the previous section, the number of function words (types) increased during the time of observation. However, explanations of disfluency rate in terms of vocabulary increase have to be rejected, since they make the wrong prediction with respect to the content words. During the same time in which the number of function words grew, the number of content words grew as well, and much faster at that. For example, a total of 180 nouns was counted in period 1, which almost doubled during period 2 ($N=352$). Another 127 (36.1%) were added in period 3. In spite of this explosive growth in vocabulary size, the amount of repetitions in content words seemed to reduce rather than grow.

4.3.5 SENTENCE BOUNDARIES

The Development of the Formulator Hypothesis predicts that in the course of development disfluencies should shift toward sentence boundaries. In order to test this prediction, the distribution of repetitions over sentence positions was examined. Table 4.VI shows the numbers of repetitions at sentence-initial positions in each of the four periods. These values were tested against the average estimated chance that a repetition would occur in a sentence-initial word, given a random distribution of repetitions over all words in the sentence. The estimated chance values are: .38 for Period 1; .28 for Period 2; .29 for Period 3 and .25 for Period 4. Binomial test results were non-significant for period 1 ($z = 1.139$; $p > .10$) and period 2 ($z = 0.600$; $p > .20$), but significant for periods 3 ($z = 6.158$, $p < .0001$, one-tailed) and 4 ($z = 2.782$, $p < .005$, one-tailed). Thus, in the first two periods, the distribution of repetitions over sentence positions does not differ from chance expectations, whereas in periods 3 and 4, repetitions occur more often on sentence-initial words than is predicted by chance estimates. In other words, in the course of time repetitions appear to 'shift' towards sentence boundaries.

Table 4.VI. The distribution of words affected by repetitions over sentence-initial and non-initial positions

Period	Sentence-initial position	Non-sentence-init. position	Total
1	20 (47.6%)	22 (52.4%)	42 (100%)
2	30 (31.3%)	66 (68.8%)	96 (100%)
3	70 (53.4%)	61 (46.6%)	131 (100%)
4	29 (39.7%)	44 (60.3%)	73 (100%)
Total	149 (43.6%)	193 (56.4%)	342 (100%)

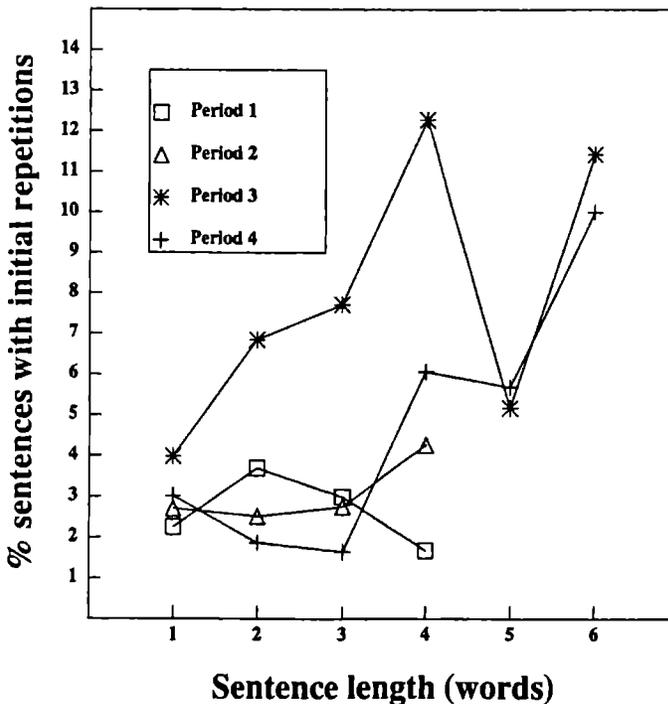
The validity of this 'repetition shift' as an argument in favour of the Development of the Formulator Hypothesis rests on the assumption that repetitions in the present subject are reflective of planning activity. It has been found that the amount of speech planning is positively correlated to the size of the planning domain (cf. Butterworth 1980, Elbers 1983). Consequently, it can be predicted that if disfluency reflects planning activity, long sentences should yield higher proportions of disfluency than short sentences, particularly at syntactic boundaries, where the bulk of planning is assumed to take place.

Figure 4.2 depicts the relation between sentence length and the probability of sentence-initial disfluency for each of the four periods in the corpus. It appears that in periods 1 and 2, the proportions of sentences with a repetition in the first word does not systematically vary across samples of sentences with different lengths (Period 1: $\chi^2 = 1.93$, $df = 3$; Period 2: $\chi^2 = 8.04$, $df = 4$). In periods 3 and 4, however, the proportion of sentences with initial repetitions

increases as a function of sentence length (Period 3: $\chi^2 = 14.07$, $df = 5$, $p < .02$; Period 4: $\chi^2 = 17.73$, $df = 5$, $p < .01$). Thus, there seems to be no evidence for a relation between sentence length and initial repetition in the first half of the corpus, whereas in the second half the probability of sentence-initial repetition is positively correlated with sentence length. This finding confirms that planning of speech in sentence-sized units does not emerge until period 3.

In summary, the repetition data seem to reflect the genesis of a speech planning mechanism that possesses some of the essential characteristics of the mature system. In the following sections two questions will be addressed: First, do other disfluencies corroborate the developmental pattern as suggested by the repetitions? Second, can the Development of the Formulator Hypothesis account for the development of disfluency rate?

Figure 4.2. The percentage of sentences incorporating sentence-initial repetitions as a function of sentence length (in words) for each of the four periods.



4.3.6 INTERRUPTED SENTENCES AND SELF-CORRECTIONS

Sentences are usually interrupted because the speaker has detected some infelicity or error. The occasion for an interruption, and, more importantly in view of the present analysis, its locus in the sentence, can, however, only be assessed if the speaker provides a clue, in the form of an overt repair. Thus, the considerable amount of incomplete sentences -i.e., sentences that are interrupted, but not repaired- in T's corpus is not very helpful in the exploration of production processes. We are left with the suggestion that the increase of incomplete sentences from period 1 to period 3 may reflect the increasing processing difficulty associated with the hypothesized reorganization of the speech planning mechanism.

The number of self-corrections, i.e., interruptions and subsequent repairs, in T's corpus was 164, of which 152 occurred in fully interpretable multi-word sentences. In the following paragraphs, two aspects of spontaneous self-corrections will be discussed which seem to be relevant for the Development of the Formulator Hypothesis. First, we will have a look at the distribution of errors over sentence positions, and secondly, we will analyze the pattern of restarting after interruption and repair.

The corrected errors were divided into three categories: phonological, lexical and syntactic. Phonological errors involved substitutions of speech sounds, such as

- (4) treetje ['trecə] [//] treintje ['treincə] op (*trait* [//] *train on*) [T022-71]
- (5) is ə bebisj ['bebi:] [//] babietje ['bebicə] in ə bed he? (*is baby* [//] *baby in bed eh?*) [T101-90]

Lexical errors involved word substitutions:

- (6) hier rood [//] paars (*here red* [//] *purple*) [T121-216]
- (7) in [//] op de huis (*in* [//] *on the house*) [T182-88]

Syntactic errors involved apparent deletions or misorderings:

- (8) moet ə [//] ik moet ə poepje doen (*have to* [//] *I have to make poopoo*) [T123-135]
- (9) zit [//] de Kermit kikker zit (*sit* [//] *the Kermit frog sit*) [T185-70]

On the basis of the repetition data it was argued that the hypothesized reorganization of the speech production mechanism, i.e., the emergence of positional planning, gets under way approximately between period 2 and 3 in the corpus. Thus, as of period 3, a significant amount of planning activity can be assumed to take place at sentence beginnings. If it is assumed that processing capacity is limited, it can be predicted that when much of this capacity is assigned to planning, this may interfere with the execution of subsequent steps in speech production, for instance the preparation of phonetic programs and articulation. Consequently, an increase of speech-sound related errors at sentence-initial positions can be expected to occur as of period 3.

Table 4.VII. The distribution of phonological errors and words over sentence positions.

<i>Errors</i>			
Period	Sent.-Initial	Other	Total
1+2	7 (31.8%)	15 (68.2%)	22 (100%)
3+4	14 (50%)	14 (50%)	28 (100%)
Total	21 (42%)	29 (58%)	50 (100%)

<i>Words</i>			
Period	Sent.-Initial	Other	Total
1+2	22 (28.2%)	56 (71.8%)	78 (100%)
3+4	28 (25.9%)	80 (74.1%)	108 (100%)
Total	50 (26.9%)	136 (73.1%)	186 (100%)

Table 4.VII contains the numbers of sentence-initial and non-sentence-initial phonological (self-corrected) errors, as well as the numbers of words in sentence-initial and other positions in the affected sentences, which can be interpreted as chance estimates of the distribution of errors. Due to the sparseness of the observations, the first two periods and the last two periods have been collapsed. It can be read from table 4.VII that the percentage of phonological errors at sentence-initial positions increases from 31.8% to 50%. The percentage of sentence-initial words, on the other hand decreases from 28.2% in the first two periods to 25.9% in the last two periods. Thus, in periods 3 and 4 there are almost twice as many phonological errors in sentence-initial positions than is predicted by chance estimates.

Table 4.VII was submitted to loglinear analysis, in order to assess the interactions between the factors Sample (errors vs. words), Period and Sentence Position. The most restricted model that yielded a sufficient fit to the data included parameters for each of the main effects, as well as for the interaction of Sample and Sentence position. The interpretation of this model is that Sentence Position interacts with Sample, independently of Period (Fienberg 1981). Thus, unfortunately, the impression that the difference between observed distribution of errors and estimated distribution (words) is affected by period can not be statistically substantiated.

Table 4.VIII. The numbers of instant repairs and retraced restarts in self-corrections of errors involving words in second or subsequent positions.

Period	Instant repair	Retracing to sentence bound.	Other retraced restarts	Total
1	6 (75%)	1 (12.5%)	1 (12.5%)	8 (100%)
2	19 (86.4%)	2 (9.1%)	1 (4.5%)	22 (100%)
3	14 (53.8%)	10 (38.5%)	2 (7.7%)	26 (100%)
4	15 (62.5%)	9 (37.5%)	0 (0%)	24 (100%)
Total	54 (67.5%)	22 (27.5%)	4 (5.0%)	80 (100%)

A final observation regarding the self-corrections regards the pattern of restarting as a function of age. When a speaker repairs a part of an utterance, s/he may resume speaking at the error location, immediately substituting a new element for the erroneous one, or s/he may repeat some elements which directly preceded the error. The latter case is called a 'retraced restart', the former an 'instant repair'. Levelt (1983) found that adult speakers of Dutch virtually always restart at a syntactic boundary, but at the same time he established that this is virtually inevitable in a right-branching language. The present analysis will be confined to sentence boundaries. Table 4.VIII summarizes the numbers of immediate and retraced restarts upon errors in non-sentence-initial words. (None of the sentence-initial errors were followed by a retraced restart). The figures show an increase of retraced restarts such that the ratio of retraced restart to instant repairs in periods 1 and 2 differs significantly from the ratio in periods 3 and 4 ($\chi^2 = 4.39$, $df = 1$, $p < .05$). Moreover, the restarts increasingly occur at sentence boundaries. These results support the conjecture that the developmental changes between periods 1 and 2 on the one hand, and periods 3 and 4 on the other, involve the emergence of sentences as units in speech planning.

4.3.7 THE RISE AND FALL OF DISFLUENCY

Up till now the analyses were focused on the distribution of disfluency. The distributional changes of disfluencies were argued to reflect the emergence of positional planning. Now, the discussion will return to the frequency of occurrence of disfluencies. The question that needs to be addressed is whether the growth and subsequent decline of the disfluency rate can be explained within the framework of the Development of the Formulator Hypothesis.

Let us first, however, consider an alternative proposition. There is a significant correlation between mean sentence length (in words) and mean total number of repetitions and revisions over time ($r = 0.53$, $t = 2.34$, $df = 14$, $p < .05$, two-tailed). It could be argued that the developmental increase of disfluency rate is due to the increase of sentence length, given the assumption that longer sentences demand more planning, and hence yield more disfluencies. It should be recalled, however, that the growth of disfluency is observed in spite of the fact that disfluency rate is expressed in a measure that is independent of sentence

length (i.e., number of occurrences per 100 words, see Figure 4.1). Consequently, it can be concluded that the growth of disfluency is disproportional to the increase of utterance length.

This conclusion is unequivocally supported by an analysis of disfluency rate in which sentence length is controlled. For the subsets of 2-word utterances within the four periods of T's corpus, the mean disfluency rate (total repetitions and self-corrections per 100 words) was computed. These values, as well as the associated standard deviations, are summarized in Table 4.IX. A one-way ANOVA indicates that the disfluency rate varies significantly over periods ($F_{(3,1312)} = 4.182, p < .01$). Thus, sentences that are equivalent from a statistical point of view yield different degrees of production difficulty in different periods. In sum, it can be concluded that although increasing sentence length may contribute to the developmental increase of disfluency, it appears subsidiary to some other factor.

Table 4.IX Disfluency rate (mean total repetitions and revisions per 100 words) in two-word sentences in each of the four periods

Period	Number of observations	Mean disfluency	Standard deviation
1	407	3.194	15.365
2	319	4.232	19.570
3	321	6.854	22.003
4	269	2.045	11.650

The factor suggested by the Development of the Formulator Hypothesis is the development of new computational routines, which are dedicated to serial order planning. It can be imagined that the 'implementation' of these routines demands a considerable portion of processing capacity, which interferes with speech delivery and thus causes the remarkable increase of disfluency. The subsequent decline of disfluency can be explained as well within this framework. It can be thought to reflect an increase of automaticity in sentence formulation, which is associated with a reduction in the processing capacity allocated to planning.

The development of automaticity may be helped by practising, i.e., repeatedly performing the same, or similar actions (cf. Bock 1982). There is a phenomenon in the present corpus that is suggestive of practising. In the second half of the corpus, particularly in period 4, T's speech became increasingly stereotypical. An analysis of sentence schemes revealed an increasing number of sentences that were started by a pronoun and a verb (or auxiliary) -in either order ((Pro-V,V-Pro)-X). This construction has been reported to occur frequently in Dutch child language (cf. Verhulst-Schlichting 1985). Table 4.X indicates the proportions of sentences with a Pro-V-X frame in each period. It is remarkable that in period 4, when disfluency is declining as compared to the previous period, over a quarter of all sentences fit the frame. This is suggestive of a relation between sentence frame variability and disfluency rate.

Table 4.X. The numbers of uninterrupted, non-formulaic, fully interpretable sentences, the subset of sentences with more than two words; the subset of sentences fitting the Pro-V-X frame

Period	Total N of sentences	N of sent. >2 words	Pro-V-X frames
1	1201	261 (21.7%)	72 (6%)
2	1339	650 (48.5%)	183 (13.7%)
3	1381	733 (53.1%)	248 (18%)
4	1067	632 (59.2%)	288 (27%)
Total	4988	2276 (45.6%)	791 (15.9%)

A comparison of disfluency rates (i.e., mean numbers of revisions and repetitions per 100 words) between sentences involving the Pro-V-X frame and other sentences is summarized in table 4.XI. It appears that in Periods 3 and 4 non-frame sentences are significantly more disfluent than frame sentences, notwithstanding the fact that all frame sentences -by definition- incorporate at least 3 words (viz. pro + V + minimally one other word) and therefore are on average longer than non-frame sentences.

Table 4.XI Disfluency rates (mean total repetitions and revisions per 100 words) in sentences corresponding to the Pro-V-X frame and in other (non-frame) sentences

Period	Frame	Non-frame	t statistic	df	one-tailed p
1	5.39	4.00	0.77	87	.222
2	6.09	6.72	-0.49	337	.313
3	6.08	10.91	-4.14	797	.001
4	4.44	7.56	-3.07	1030	.001

It does not seem to matter whether or not T consciously (or: intentionally) employs the sentence frame Pro-V-X. Whatever the case, the frequency of its use appears to be a significant factor in reducing disfluency. Moreover, it may explain the decline of the distributional effects from Period 3 to Period 4 that was repeatedly observed. A final, important observation is that the disfluency reducing effect of the use of sentence frames is only significantly present from Period 3 onwards. This finding suggests that as of Period 3, sentence frames and 'lexical content' have become separate entities in the preparation of speech, which support the claims made by the Development of the Formulator Hypothesis.

4.4 DISCUSSION

Perhaps the most important outcome of this study is that it demonstrates that 'performance oriented' studies of child language, analogous to those in adults, are feasible and may provide some fresh insights into developmental processes that may supplement the results of competence studies. The findings can be summarized as follows. A significant increase in disfluency rate is observed between age 2;4 and 2;9, followed by a decline. The bulk of disfluency is formed by repetitions, revisions and incomplete phrases. Concurrently with the increase of the frequency of occurrence of disfluencies, their distributional patterns change. Repetitions concentrate in function words. Repetitions and, possibly, speech errors 'shift' toward sentence-initial positions, and the length of utterances comes to affect the proportion of sentence-initial disfluency. Moreover, the number of self-corrections involving retraced restarts shows an increase. In short, the pattern of disfluency that emerges in the second half of the observation period is remarkably similar to the hesitation patterns in adults.

These results are in agreement with the Development of the Formulator Hypothesis. According to this hypothesis, the type of planning that is observed developing in T is positional level planning, which is specifically dedicated to computing serially ordered representations in accordance with the demands of developing morpho-syntax. Supportive evidence for the development of positional planning is provided by the results regarding sentence frames. The notion 'sentence frame' has figured before in several accounts of language learning. It has been argued, for instance, that sentence frames are (partly) unanalyzed strings of words which children employ, by means of variation and extension, to construct linguistic knowledge (cf. Peters 1983). Thus, these frames are seen as a 'point of departure' for the developmental process. The frames that are observed in the present data, however, consist of syntactic categories, and can be viewed as a 'result' of development. They may be thought to reflect the emergence of syntactic frames as autonomous computational structures in the preparation of speech, which is the hallmark of positional level planning. Finally, not only the changes in distribution of disfluencies, but also the development of disfluency rate can be accounted for by the Development of the Formulator Hypothesis. Disfluencies in mature speakers were argued to specifically reflect the coordination of functional level planning and positional level planning. It can be argued that the increase of disfluency in T reflects the vast problems of coordinating different levels of processing in the developing two-stage sentence planning mechanism.

Of course, these interpretations raise the question as to the nature of the speech production mechanism before the two-stage formulating module is in place. Is there planning in 'telegraphic speech'? Not more than a rather vague and speculative answer can be given at this moment. It has been argued that children who have started to use multi-word utterances try to express various semantic relations (cf. Brown 1973, Schaeerlaekens 1973, Golinkoff 1981), and one should expect this to require some sort of prior decision making, at least with respect to the selection of words and their assignment to the intended semantic roles. Furthermore, durational and intonational data obtained by Branigan (1979) seem to imply that early multi-word utterances are integrated within a single prosodic format. Therefore,

some kind of planning must be assumed to occur with the advent of multi-word sentences. In speculative terms, I would propose to call this 'integrated planning'. This term is intended to indicate that the functions which are separated in Garrett's model, viz. on the one hand selection of lexical items and mapping these onto functional relations (which, at this stage of development could be entirely defined in terms of semantic roles) and, on the other hand, serial ordering and morpho-phonological planning, are not yet differentiated. This rather speculative idea illuminates the affinity of the Development of the Formulator Hypothesis to theories of language development that stress the discontinuity between early, semantically based, and subsequent, syntactically based grammars. (cf. Gleitman 1981, Gleitman & Wanner 1982). It should also be clear that the proposed developments in the language production apparatus are not indifferent to the development of linguistic knowledge. Rather, the Development of the Formulator Hypothesis assumes a close connection between alterations in the child's knowledge of language (for instance, regarding the assignment of words to syntactic categories) and the development of performance.

Can it be assumed that the developmental process that is suggested on the basis of T's disfluency data occurs in all children? It has been observed that nearly all children show disfluency peaks between roughly 2 and 3 years of age (Yairi 1982). Since the developmental process as depicted by the Development of the Formulator Hypothesis was argued to be responsible for increases of disfluency, the generality of fluency deterioration between ages 2 and 3 could imply the generality of the developmental process as sketched by the Development of the Formulator Hypothesis. However, there are massive inter-individual differences in the degree of fluency deterioration and rate of recovery. It is clear that for the Development of the Formulator Hypothesis to be truly valid, it should be able to accommodate this variation. Thus further research along the lines set out in this study is warranted.

A particularly interesting and clinically relevant problem to which the Development of the Formulator Hypothesis might be applied concerns the ontogenesis of stuttering. Some speech pathologists think that stuttering sprouts from 'normal' developmental disfluency, while others argue that there are significant qualitative differences between 'pathological' and 'normal' disfluency patterns from the onset onward (cf. Yairi & Lewis 1984). The results of the present study show some interesting correspondences to those obtained from children that were identified as stutterers (Bloodstein & Gantwerk 1967; Wall *et al.* 1981, Elbers 1983). The distributional pattern of disfluency that was found in stuttering children is similar to the pattern of disfluency in the second half of the present corpus. This is suggestive of a continuity between 'normal' disfluency and stuttering, not only in terms of overt behavior, but also in terms of underlying process. It is tempting to speculate that 'pathological' disfluency may be the symptom of a developmental problem in language production.

It has been suggested that a reduction in the variability of language output, i.e., stereotyped behavior, may be helpful in the development of automaticity of language production (Bock 1982). The present study indicates that a decline in disfluency, which followed the spectacular increase associated with the emergence of positional planning, is -at least partially- linked to an increase in the use of fixed sentence frames, which agrees with

Bock's proposal. Increased disfluency is the result of imperfect functioning of a newly acquired system; practising, i.e., repeatedly using a restricted set of output formats, helps in making the system run smoothly. Perhaps children whose speech is persistently disfluent fail to invent appropriate practising strategies. It might be worthwhile to investigate whether childhood stuttering is reduced by interventions that aim at (temporarily) restricting output variability.

5.0 ABSTRACT

Three types of speech revisions were studied in longitudinal speech samples of two Dutch boys around age 3: self-corrections, replacements and clarifications. Self-corrections are spontaneous revisions which involve an interruption of the ongoing utterance. Replacements are non-hesitatory alterations of preceding utterances and clarifications are revisions upon interlocutors' (non-specific) requests. Analyses of interruptions and restart patterns in self-corrections suggest slight differences with adult speakers. The repair operations in each of the three classes of revisions were classified with respect to linguistic level of description (phonological, lexical or syntactic) and analyzed with respect to their effects (improvement vs. non-improvement of the linguistic quality) and developmental trends. The results suggest that self-corrections on the one hand, and clarifications and replacements on the other represent different modes of the speech monitoring/revision process and fulfill different functions in the developing speaker.

5.1 INTRODUCTION

Speakers, young and old alike, revise their utterances, either spontaneously, or when a listener asks them to. Listener's requests for clarification can be very precise, as in example (1).

- (1) A: I'm going to hippotize you
B: You're going to what?
A: hyp...notize you

In the present study, however, revisions upon non-specific requests, such as 'huh?', 'what?' or 'what did you say?', (henceforth: *clarifications*) will be analyzed. In such cases, the speaker has to guess, as it were, the reason for the communicative failure. Thus, in this regard, revisions upon non-specific requests are similar to self-induced revisions, in which -by definition- the speaker autonomously decides what was wrong in the original utterance.

Self-initiated revisions can be divided into two subtypes: *replacement sequences* and *self-corrections*. A replacement sequence (Weir 1962, Braine 1973) consists of several utterances produced in succession, which share a considerable portion of verbal content, while at the same time some aspects or elements are added, deleted or substituted, e.g.:

- (2) mommy book
 mommy that book
 mommy book that

In such sequences, the first of each pair of consecutive utterances is an original utterance, the second a replacement. A self-correction is a speech revision which, in contrast to a replacement, typically involves an interruption of the ongoing utterance, e.g.:

- (3) I don't [won]... uh ... I don't want to go

Consequently, self-corrections are often classified as speech hesitations (cf., Maclay & Osgood 1958).

In studies of language use in adults, self-correction is the type of speech revision that has attracted the most attention. In particular, extensive analyses have been made of the attributes of self-corrections that mark them as hesitations: interruption loci, editing terms and restart patterns (Nooteboom 1980, Levelt 1983). Although the occurrence of self-corrections in young children's speech has been acknowledged for some time, developmentally focused descriptions of these attributes have not yet been produced. The first goal, therefore, of this study is to provide a descriptive analysis of two phases in self-correction in immature speakers, viz. *interrupting* and *restarting*. By comparing the results of these analyses to those reported for adults, it will be possible to contribute to a picture of the development of monitoring and speech repair within the framework of the development of language production skills.

The second aim of this study is to contribute to our understanding of the *function* of speech revisions for the developing language user. As a point of departure, E. Clark's (1982, Clark & Hecht 1983) *coordination theory* of speech revision will be taken. The coordination theory states, in brief, that children correct themselves in order to match their expressive language in terms of form and function with the language that is addressed to them. In order to test some assumptions and predictions of the coordination theory, self-corrections, replacements as well as clarifications will be comparatively analyzed with respect to the types of alterations (repairs) they involve; the effects of these repairs on the quality of utterances; and developmental changes in their distribution.

It is assumed that the three types of speech revision are based on one and the same processing scheme, which encompasses *monitoring*, *evaluating* and *repairing*. Section 5.1.2 gives a short overview of these three processing steps, which is largely based on studies of self-correction in adult speakers. In section 5.1.3, coordination theory, which implies a straightforward assumption on the nature of evaluating, is summarized, and some preliminary criticisms are formulated. First, however, a concise overview of some previous studies of speech revision in children will be presented.

5.1.1 THE ONTOGENESIS OF SPEECH REVISIONS

Replacements, clarifications as well as self-corrections as defined above have all been previously studied in young children. The aims and methods in these investigations, however, tend to diverge. Moreover, the three types of revision have never been comparatively analyzed in the same subjects. In connection to the developmental function of speech revisions, it would be particularly interesting to know (a) which aspects of utterances are altered; (b) whether preferences for specific alterations are subject to developmental change; and (c) whether alterations are 'progressive', i.e., whether they result in more complex utterances, particularly, utterances which approximate adults standards.

Replacement sequences were first reported by Weir (1962), in her study of the bed-time soliloquies of a single 2-year-old child. Weir observed three types: *build-ups*, *break-downs* and *completions*. In build-ups, an initial utterance is contained in a subsequently uttered longer utterance, as in example (1).

- (4) donkey
 fix the donkey

Break-downs are the opposite of build-ups, so to speak, i.e., they encompass partial repetitions. Completions consist of two consecutively produced utterances which can be interpreted as supplementary fragments of one meaningful sentence.

Braine's (1973) observations confirm Weir's suggestion that the occurrence of replacement sequences is not restricted to the context of bed-time monologues. Braine noticed numerous build-ups in transcriptions of the tape-recorded speech of four 2-year-old children. According to Braine, these sequences possess the following characteristics:

- (1) There is no detectable change in the speech-eliciting situation which would indicate a change of meaning in the consecutive utterances;
- (2) Longer utterances contain the lexical morphemes of the preceding shorter ones;
- (3) The longer utterances are more recent acquisitions.

An example of the latter characteristic is the following sequence:

- (5) man car
 man in car
 man in the car

The original utterance contains only content words; the relation between the two concepts is not explicitly marked. In the replacements, first the preposition which captures the -spatial-relation, and subsequently, a determiner are added. Each of these two function words, as well as the phrasal construction into which they enter are relatively late acquisitions as compared to the words and structure of the original utterance. Braine found that build-ups often consist of an initial predicative utterance, followed by the same utterance, supplemented with a subject noun phrase., e.g.:

- (6) all messy
 coffeepot all messy

Bloom, Miller & Hood (1975) studied, among other things, the structural and conceptual dependencies of successive utterances in 2-year-olds. They observed that the most frequent type of structurally related sequences were expansions, i.e., build-ups. Bloom *et al.* further found that the typical replacement sequence consisted of a two-constituent utterance that is expanded into a three-constituent utterance. In summary, the results from Braine and Bloom *et al.* seem to suggest that replacements are usually expansions, in which constituents are added which, from an adult point of view, could not have been omitted in the first place. In this sense, such sequences are 'progressive'.

Children as young as age 2 not only spontaneously alter their utterances, they are also capable of doing this upon requests for clarification. An experiment by Gallagher (1977) has shown that even upon non-specific requests, 2-year-olds tend to alter their utterances. Gallagher interviewed children at 21-29 months of age for approximately one hour. At regular intervals, twenty times in all, she pretended not to understand what the child had just said, by asking 'what?'. This prompting was not determined by the quality of the child's preceding utterance, only by the passage of time. It appeared that all children predominantly produced more revisions (either of the phonetic form or of the syntactic lay-out of the utterance) than literal repetitions. The youngest subjects mainly changed the phonetic form of their utterances, whereas the older children more frequently altered sentence structure. It appeared that about 50% of the youngest children's phonetic changes could be interpreted as closer approximations to the adult model. In syntactic revisions, the subjects preferred the elimination of constituents or, in other words, partial repetition. Thus, it seems that these revisions are not any more 'progressive' than the phonetic alterations.

Somewhat different results were obtained by Käsermann (1980) and Konefal and Fokes (1984). Käsermann elicited repairs from 20 to 24 month old children in conversational contexts using the non-specific request 'hm?'. She observed that her subjects made phonological, lexical and syntactic alterations. Usually, these changes led to closer approximations of the adult standard. Konefal and Fokes (1984) replicated Gallagher's study with 2-, 3- and 5-year old children. A difference in the procedure was that the interviewers attempted to request for clarification upon real communicative breakdowns. Konefal and Fokes observed that the tendency to literally repeat utterances declined with age, whereas the tendency to revise increased. The authors ignored phonetic alterations. In the syntactic alterations they observed that the proportion of constituent reductions (break-downs) decreased with age, whereas elaborations (build-ups) and reorderings increased. The authors suggest that this shift is dependent upon the development of syntactic abilities.

Spontaneous self-repairs in 3 English speaking children between 2;2 and 3;7 were studied by Eve Clark (1982). Over 500 repairs were transcribed from tape recordings of the children interacting with other persons. Clark distinguished phonological, morphological, lexical and syntactic repairs. It was found that the frequency of phonological repairs steadily declined with age. At the same time, syntactic repairs increased in frequency. Most of these repairs, Clark claims, are 'progressive', i.e., approximations of adult standards. Unfortunately, it is not quite clear what is meant by the term '(self-) repair'. Clark's examples suggest that the corpus consists of interruptive revisions (i.e., self-corrections, in the

terminology of this study), but there is a remark in her paper which suggests that other types of revision are included as well. Clark writes, referring to a subset in her corpus, viz., lexical repairs:

The repairs made in these categories [i.e., lexical repairs, F.W.] conformed exactly to the characterization given by Schegloff and his colleagues for self-initiated repairs. They were introduced *spontaneously* by the child, *nearly always within the same turn*, or -very rarely- in the child's following turn (Clark 1982: 185-6, italics mine).

This statement seems to imply that a number of repairs in Clark's corpus agree with the operational definitions of replacements and clarifications that were given above. Moreover, some of the examples presented by Clark (1982) suggest that the criterion that a repair should encompass an overt *alteration* was not consequently applied. In particular in the category of phonological repairs, several examples seem to be mere (partial) repetitions of sound sequences, which are known to occur frequently in 2 to 3 year old children (Wijnen 1988), e.g.:

- (7) w- w- where's a big ones?
hair o- on your arms? (Clark 1982:183).

In summary, children appear to revise utterances, either spontaneously (replacement sequences), or on request (clarifications). In doing so they produce both more complex (or adult-like) and less complex utterances. The focus of revision seems to shift with age: generally, younger children tend to alter phonetic aspects, whereas older children tend to alter syntactic aspects. Also, the types of alterations appear to change with age. It is not yet clarified, however, whether these generalizations also hold for self-corrections.

5.1.2 REVISION IN SPEECH: PROCESSING STEPS

In spite of their apparent differences, it is assumed that the three types of revision are based on the same psychological mechanism, which encompasses three processing steps: First, the speaker has to 'keep an eye' on the results of utterance generation. Second, she has to compare what was said with some internal criterion or standard. Finally, she has to generate a new utterance in which acceptable elements are kept and unacceptable elements are changed. These three operations, which are labeled *monitoring*, *evaluating*, and *repairing*, respectively, will be discussed in the following paragraphs.

Monitoring

The most important question concerning monitoring concerns the 'channel' by which production processes and their results are perceived. There are three competing answers to this question, which can be labeled *production theory*, *perception theory* and *network theory* (Levelt 1983, 1989). The production theory (cf. Laver 1980) claims that each of the intermediate mechanisms in speech planning has its own monitoring device built in, so that errors may be detected before a component has delivered a complete (intermediate) product. The perception theory claims that monitoring one's own speech is achieved by the same

mechanisms that underly the comprehension of the speech of others. In contrast to the production and perception theories, the network theory (MacKay 1987), is a connectionist theory. It supposes that both language production and language perception are subserved by a single network of simple processors, or nodes, which represent linguistic units at various levels of aggregation: propositions, concepts, words, syllables, and so forth. The encoding of an utterance corresponds to the spreading of activation from a high level node down to lower level nodes. In case of an error, a wrong node has reached too high a level of activation. Since activation not only spreads 'downward', but also 'upward', this will result in an increase of activation of higher level nodes other than the ones which represent the intended structures. Since 'upward' spreading of activation is identified with perception, errors (i.e., non-intended patterns of activation) are instantaneously perceived.

At present, the the perception theory appears to be the most satisfactory of these three theories (Levelt 1989). In contrast to the production and network theories, it is compatible with certain characteristics of self-correction behavior, such as the repeatedly occurring delays of speech interruptions (which signal error detection) with respect to the locus of an error (Nooteboom 1980, Levelt 1983). Moreover, the perception theory has some theoretical advantages over the other two. First, it assumes a global distinction between the production and perception systems, whereas the network theory collapses these two, which seems very unrealistic in view of the, for instance, neurological evidence. Moreover, it is more economic than the production theory, since it ascribes the monitoring function to mechanisms that are part and parcel of the language comprehension apparatus.

Evaluating: the nature of the internal standard

The interruption of speech in self-correcting is assumed to be induced by a mismatch between representations resulting from the perceptual analyses of the output speech and representations which act as an internal standard. Evidently, this internal standard must contain a version of the conceptual representation that underlies the output utterance, otherwise speakers would not be able to check whether what they utter corresponds to what they intend to communicate. However, speakers also appear to monitor for errors against linguistic standards, i.e., errors of pronunciation, morphology and syntax (Levelt 1989). It is quite clear that this ability is part of the normal function of the language comprehension mechanism, since most listeners are able to evaluate the linguistic correctness of other people's speech. Presumably, in evaluating the linguistic correctness of an utterance, the criterion representations correspond to representations of linguistic knowledge which are normally used in the comprehension process. For instance, a phonetic error may be signalled because it produces a 'word' that is not fully matched by any of the lexical form representations in the mental lexicon. If phonetic (or phonological) representations are accessed first in comprehension, subsequently lexical meaning representations, and finally representations of syntactic and conceptual knowledge, then it can be expected that phonetic errors are detected faster than lexical errors, which are, in turn, detected faster than syntactic errors. Nooteboom's (1980) analysis of the spans of delay, i.e., the numbers of syllables

uttered between the onset of an error and the interruption of speech, in phonological and lexical errors supports this prediction.

Repairing

The appearance of a repair is dependent upon the original utterance. The erroneous elements should be replaced, whereas the acceptable elements are kept. In doing so, the speaker has to consider the interlocutor's problem of linking the repair to the original utterance, i.e., the listener's *continuation problem* (Levelt 1983, 1989). Perhaps the most transparent way of making a revision would be to restart from the beginning of the sentence. Levelt (1983) found, however, that speakers do not systematically do this. Rather, they seem to seek a balance between clarity and economy. Restarts are often made at the locus of the error, or a few words before it. Speakers apparently adhere to some highly systematic principles in coupling original utterances and repairs. If a restart begins with a word that is identical to a word in the original utterance, this word is the 'weld' between original utterance and repair (word identity principle). Alternatively, if there are no words in the original utterance identical to the first word of the repair, the first word is intended to replace a word in the original utterance with the same syntactic category (category identity principle).

5.1.3 EVALUATING AND REPAIRING IN CHILDREN: COORDINATION THEORY

An important theoretical point concerns the origin of children's internal representations used for evaluating in speech revision. Are these representations 'adult-based', i.e., derived from the target language, or are they 'child-based', i.e., reflective of the child's current level of competence? Clark (1982, Clark & Hecht 1983) suggests that the internal evaluation representations that children use are adult-based, and she embeds this hypothesis in a theory of speech revision in development which may be labelled *coordination theory*. This theory will be briefly explained in the following paragraphs, in order to illustrate that assumptions concerning the origin of evaluation criteria in children's revisions may have consequences for hypotheses concerning the function of speech repair in development.

Clark's theorizing sets out as a critique of the suggestion that the genesis of speech repair is closely related to the awareness of, and prevention of communicative failure. She asserts that, given the fact that children are generally perfectly able to communicate their needs, even with impoverished linguistic tools, there is no pressing need to repair speech. Rather, Clark claims, the function of repair in children is to match the speech they produce with the speech they -predominantly- perceive, i.e., speech which obeys adult standards. In summary, it could be simply stated that children's speech revisions are instances of 'comprehension teaching production', as Tunmer, Platt & Herriman (1984) put it. A similar account was proposed by Marshall & Morton (1978).

A first prediction that can be derived is that given the adult-based standard in evaluating, all speech repairs in children should be progressive, i.e., approximating the adult model. Clark acknowledges the fact that if adult-based representations are the child's internal standard in speech repair, repairing would be the rule rather than the exception, especially in

young children, whose speech is abundantly defective in comparison to adult standards. But, as a matter of fact, speech repair does not seem to occur with extreme frequency in children. Clark explains this by conjecturing that the child successively attends to different aspects of the adult linguistic model, in order to bring down the number of elements-to-be-repaired to a manageable amount. Thus, children would, for instance, start out by concentrating on phonological attributes. Later on, attention is shifted to morphology and still later to syntax. This is called the *spotlight hypothesis*. According to this hypothesis, a developmental shift in the focus of repair operations should occur. Repairs at different levels of linguistic description should peak at different times, rather than occur in proportionate numbers throughout the developmental period.

Clark's proposals run into some problems, empirical as well as theoretical. On the empirical side, it is not altogether clear whether the claims of the coordination theory apply to all types of speech revision. Speech revisions do not appear to be categorically progressive, as is witnessed by the rather inconsistent findings reported in the literature. Another and more principled objection against Clark's proposals is that 'progression' in repair cannot be used to decide between adult-based or child-based internal evaluation criteria. Progression could in reality be the result of approximating a child-based representation that is a simplified version of the adult model. Only revisions that transcend the child's current competence would provide decisive evidence in favour of an adult-based criterion. Revisions of this type have not been revealed by Clark. Neither do such 'really progressive' repairs appear to occur in replacements. The results of Braine and Bloom *et al.* seem to indicate that replacements are more complex, and possibly later acquired than the original utterances, but do not progress beyond the child's current level of competence. Weisenburger (1976) observed that build-ups produced by a 2-year-old girl did not exceed the complexity of other utterances which were not part of a build-up sequence. Rather, she noted that the original utterances in such sequences were clearly below the child's level of competence.

At a theoretical level, one wonders what Clark's 'adult-based' representations might embody. The conceptual representation underlying the output utterance can hardly be considered adult-based. Thus, 'adult-based' can be expected to refer to representations at intermediate levels of the comprehension process. This is perhaps conceivable in the case of word form representations. But what could be meant by adult-based representations at the level of morphology or syntax? Are these, say, 'echoic representations' of adults speech, or do they represent 'abstract' linguistic knowledge, derived from adult input speech. If representations that are employed in evaluating are echoic, it is a valid prediction that children would only be able to correct those utterances which they have actually heard before. Thus, a particular child would, for instance, be unable to repair an error in S-V agreement, unless she had actually overheard an utterance with this particular S and this particular V. Such an account amounts to a language development theory based on imitation. The alternative interpretation, viz. that morphological and syntactic representations incorporate 'adult' rules which have been distilled from language input, seems more promising. However, Clark's theory then amounts to proposing that 'tacit linguistic knowledge' which the child acquires via perceptual processing of input speech is not directly

accessible to the -developing- production system. This raises the question as to how, eventually, linguistic rules are 'built into' the production system.

Rather than assigning a 'teaching' function to revisions, it might be conjectured that revisions function to *maintain* the current (optimal) linguistic standard. That is: revisions occur only when performance clearly deviates from what the speaker is currently able to produce. This corresponds to the function of self-corrections in adults. It implies that even in the immature speaker, evaluation criteria are reflective of the current level of competence, rather than of a more advanced adult-based level. Clark seems to have forgotten that apart from adult speech, children normally hear themselves talk quite a lot. As a consequence, children may have stored representations based on their own output (Kuczaj 1983, Platt & MacWhinney 1983), which may be a necessary precondition for the proposal that children evaluate their speech against a what they are able to produce. On the other hand, some revisions may serve to explore or practise language. This seems particularly likely in the case of replacements. Nevertheless, the question remains whether practice or exploration is somehow oriented toward the adult model. In terms of the processing scheme, the question is how 'evaluating' can be associated with exploration and/or practice. In summary, the question that the present research seeks to answer is whether different types of speech revisions can have different functions and in what way the processing operations described above, particularly evaluating, support these functions.

5.2 METHOD

The database for this study consists of a corpus of utterances of two Dutch boys, T and N, that were transcribed from approximately 34 hours of tape recordings spanning about 9 months. T was recorded from 2;4 up to 3;0. N was 3;0 at the beginning of the recording period, and 3;10 at the end. Mean lengths of utterance (MLU, Brown 1973) were 1.9 for T and 2.3 for N at the beginning of the recording periods and 2.9 for T and 3.9 for N at the end. In general, T showed a fairly normally paced development of language abilities: first words appeared around 1;5 and first two-word utterances at approximately 2;2. In comparison, N was a slow starter, with first words appearing around 2;0 and first sentences at approximately 2;8. Most notably, N was delayed in phonological development, persisting in many of the processes that are typical of apprentice speakers, particularly fronting. In the course of the observation period, N's phonological abilities clearly matured, although the delay was not fully overcome until about 4;2.

The children's speech was recorded in everyday home situations, using ordinary (non-professional) cassette tape equipment. Approximately one hour of recording was collected per week. About seventeen hours of recordings for each child were independently transcribed by two phonetically trained transcribers. Definitive transcriptions were based on the transcribers' consensus. The original hand-written transcripts are now being converted into CHAT computer format and will be made available through CHILDES (MacWhinney & Snow 1985) shortly.

The present study analyzes self-corrections, replacements and clarifications. Self-corrections were extracted in the course of transcribing the recordings. As self-corrections were included instances of speech hesitancy which involved an apparent interruption of the ongoing utterance, and a restart which could be related to the original utterance, as well as an alteration. Only those instances on which the two transcribers had reached agreement were included for analysis.

As replacement sequences were considered those sequences of structurally related utterances which satisfied the following criteria:

- (1) the utterances should be produced within one turn.
- (2) there should not be any change in the situation that would be indicative of non-equivalence in meaning or pragmatic intent of the utterances.

Several types of replacements surfaced: Literal repetitions (examples 8 and 9); phonetic changes: the words and their order in the utterance remains the same, but the rendition of one or several of them is altered (ex. 10, 11); substitutions of words or phrases (ex. 12, 13); additions of words or phrases (ex. 14, 15); deletions of words or phrases (ex. 16, 17)

- (8) mag wel (*can do*)
mag wel [T022-11]
- (9) hij 's bijna op (*he's almost finished*)
hij 's bijna op [N071-244]
- (10) bimbap ['bɪmbɑp] (onomatopoeia)
bimbam ['bɪmbɑm] [T185-141]
- (11) papa kijken ['ceɪkə] (*daddy look*)
papa kijken ['keɪkə] [N023-032]
- (12) ik ga die pakken (*I'm going to grab that one*)
ik ga 't pakken (*I'm going to grab this*) [T241-093]
- (13) hier uit komt (*here out-of comes*)
bovenkant uit komt (*top-side out-of comes*) [N031-180]
- (14) jij doen (*you do*)
jij maar doen (*you just do*) [T251-080]
- (15) zo een stukje touw afknippen? (*such a piece of rope cut off*)
zo een stukje touw andere kant afknippen (*such a piece of rope other side cut off*)
[N091-209]
- (16) wat krijgen nou weer? (*what get now again*)
wat krijgen nou? (*what get now*) [T162-087]
- (17) doe dat nou hoogwerker? (*does that now high-worker*)
doe dat hoogwerker? (*does that high-worker*) [N151-115]

As clarifications were counted those utterances that were contingent upon non-specific requests of the interlocutor, e.g., 'huh?' or 'what did you say?'. Apart from literal repetitions and alterations analogous to those enumerated for replacement sequences, this category also included non-contingent utterances, i.e., utterances which appeared to be unrelated to those preceding the clarification request, and 'zero' responses.

5.3 RESULTS

5.3.1 SELF-CORRECTIONS

A total number of 164 self-corrections was found in corpus T, and 229 in corpus N. Counts incorporating only fully interpretable, complete and non-formulaic utterances yielded totals of 14,079 words in corpus T and 24,830 words in N. These figures yield an average rate of self-correction of 1 in every 86 (T) to 108 (N) words. The following paragraphs will describe the attributes of two phases in the self-corrections from the T and N corpora, viz. *interrupting* and *restarting*, in that order. Then, a section will be devoted to the description and comparison of repair operations -phonological, lexical, syntactic- in self-corrections and the two other types of speech revision: clarifications and replacements.

Interruptions

Figure 5.1 depicts the distribution of intervals between the locus at which the error occurred (i.e., the first erroneous syllable) and the locus of interruption. It appears that in over 70% of all cases in both corpora, interrupting occurs immediately, that is, directly after the first erroneous syllable, as in (18) and (19). In corpus T, 28% of all interruptions involve at least one syllable, in corpus N 22.7% (examples 20 and 21).

- (18) Roefje [ε] [//] eet ə pap (*Roefje [ε] [//] eats porridge*) [T044-028]
 (19) heef ik hier nou [ty] [//] nou 'slapen (*have I here now [ty] [//] slept*) [N082-287]
 (20) ik wil [nəR] drop [//] nog dropje (*I want [nəR] licorice [//] another licorice*) [T111-159]
 (21) hij blijs niet [//] hij blijf niet plakken (*he stayf not [//] he stays not stick*) [N072-237]

The average length of delay (in delayed interruptions) is 1.24 syllables in T ($s = 0.48$), and 1.19 syllables in N ($s = 0.39$). Approximately 15% of all self-corrections involve delays that extend beyond the boundary of the (first) erroneous word.

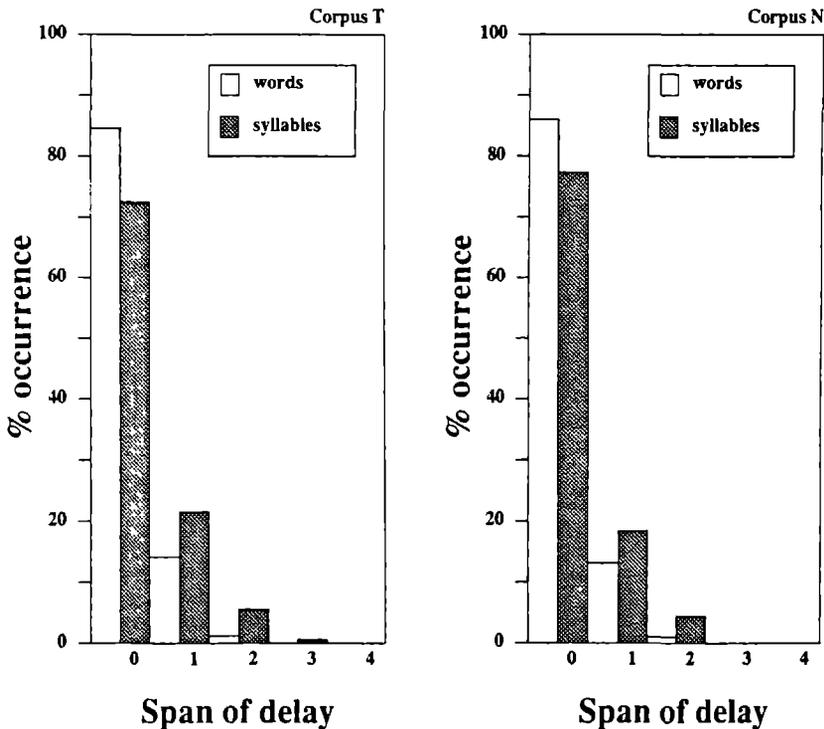
Table 5.1 presents data concerning the subjects' tendencies to interrupt within (ex. 22, 23) or after (ex. 24, 25) words.

- (22) me [//] ik wil meneer kijken (*mis [//] I want mister look to*) [T175-041]
 (23) hij [hoes] b [//] hij lus boterham niet (*he hikes s [//] he likes sandwich not*) [N222-518]
 (24) hij 's [//] eend is gepakt (*he 's [//] duck is caught*) [T111-295]
 (25) trein kan daar op deze [//] op ə stenen rijen (*train can there on this [//] on stones ride*) [N091-159]

Table 5.1. Immediate and delayed within-word and after-word interruptions in self-corrections in the corpora of T and N (separate and summed)

	Immediate		Total	Delayed		Total
	Within Word	After Word		Within Word	After Word	
T	61 (46.9%)	69 (53.1%)	130 (100%)	7 (28%)	18 (72%)	25 (100%)
N	63 (35%)	117 (65%)	180 (100%)	9 (28.1%)	23 (71.9%)	32 (100%)
Tot.	124 (40%)	186 (60%)	310 (100%)	16 (28.1%)	41 (71.9%)	57 (100%)

Figure 5.1. Spans of delay in numbers of words and syllables for the first and second halves of the two corpora.



Adults have been reported to avoid the interruption of non-erroneous words (Nooteboom 1980, Levelt 1983). In the present subjects, this tendency is not particularly clearcut. Within-word interruptions after a delay, e.g., (26) and (27), are slightly less frequent than immediate within-word interruptions, such as (28) and (29) ($\chi^2 = 2.42$, $df = 1$, $p > .10$).

(26) net a [//] met appel (*mith a [//] with apple*) [T032-011]

(27) dat kap i(k) [//] dat kan ik (*that cap I [//] that can I*) [N241-103]

(28) zi [//] wat zit erin (*si [//] what sits in it*) [T185-114]

(29) moet je van ə mensen doe(n) [//] zeggen (*must you of people d(o) [//] say*) [N221-445]

In order to check whether different errors are detected with different latencies, all errors (reparanda) were categorized as either phonological, lexical, or syntactic. The observed repair operation (see below) was employed to classify the error. Thus, for instance in cases where the repair involved a change of speech sounds, the error was categorized as phonological. If, on the other hand, a repair involved a change of sentence structure, for instance through the addition or reordering of words, the error was categorized as syntactic. Table 5.II shows the average lengths of delay between the first erroneous phoneme and the locus of interruption for the three types of error. It appears that the average delays do not significantly vary over error type in an analysis of variance (T: $F_{(2,143)} = .47$; N: $F_{(2,197)} = .45$).

Table 5.II. Mean lengths of delay (in syllables) after phonological, lexical and syntactic errors.

Error Type	Corpus T		Corpus N	
	M	SD	M	SD
phonological	0.41	0.62	0.22	0.48
lexical	0.29	0.67	0.3	0.56
syntactic	0.33	0.61	0.33	0.59

Restarting

After interrupting the original utterance, the speaker has to resume articulating in order to make the repair proper. The restart can be made at the locus of the reparandum, directly substituting a correct element for the erroneous one, or it may involve backtracking to a word which precedes the reparandum. The former restart is called *instant repairing* (examples 30 and 31), the latter *anticipatory retracing* (examples 32 and 33).

(30) wil jij dat [he] [//] halen (*will you ga [//] that get*) [N091-236]

(31) jij zit achter [tjoel] [//] stuur (*you sit behind [tjoel] [//] steering wheel*) [T254-004]

(32) Sinterklaas op de [kɪl] [//] Sinterklaas op de televisie (*Santa Claus on the kel [//] Santa Claus on television*) [T172-001]

(33) blijf daar maar [wəɑx] [//] maar deze auto staan (*stays there just [wəɑx] [//] just this car stand*) [N211-092].

Table 5.III shows that instant repairing occurs much more often than anticipatory retracing. There appears to be a relation between the locus of the reparandum in the original utterance and the manner of restarting, which is depicted in Figure 5.2. The two corpora were divided into a first and a second half. The first half of T's corpus covers age 2;3 through 2;7 (9 hours of tape), the second half 2;8 through 2;11 (8.5 hours of tape). In N's corpus, the first half covers the period between 3;0 and 3;5 (7.5 hours), the second half is between 3;6 and 3;10 (9 hours). Counting all cases (including single-word sentences) 60.9% in T and 53.7% in N of the restarts occur at sentence onsets. Sentence-initial reparanda are always instantaneously repaired. Errors that are located in (or start at) sentences' second words are followed by anticipatory retracing in roughly 50% of the cases. When errors occur in third and further words, the anticipatory retracing rate drops to an approximate 20%, and the majority of these retracings do not involve the beginning of the sentence.

If the subjects should randomly choose the locus of restarting, the probability of an instant repair upon an error in the *i*-th word of the sentence equals $1/i$ -given the 'impermeability' of the sentence boundary. Thus, in the trivial case when the reparandum is located in the first word, the a priori probability of instant repairing equals 1. When the reparandum occurs in the second word, instant repairing has a probability of 0.5. The observed proportions of instant repairs upon errors in second words are quite close to this estimation, and indeed, binomial tests indicate that in both corpora these values do not significantly deviate from chance expectation. For the set of corrections of reparanda in third and subsequent words, the ratio of the number of potential *instant repair* loci (which equals the the set-size) to the total number of *all* (instantaneous and anticipatory) restart locations (i.e., all words from the first in the sentence up to and including the reparandum) was taken as the estimation of the probability of instant repairing. For all sets of corrections of errors in third and subsequent words (i.e., T-1st half; T-2d half; N-1st half; N-2d half), binomial tests showed that instant repairs occurred significantly more often than expected.

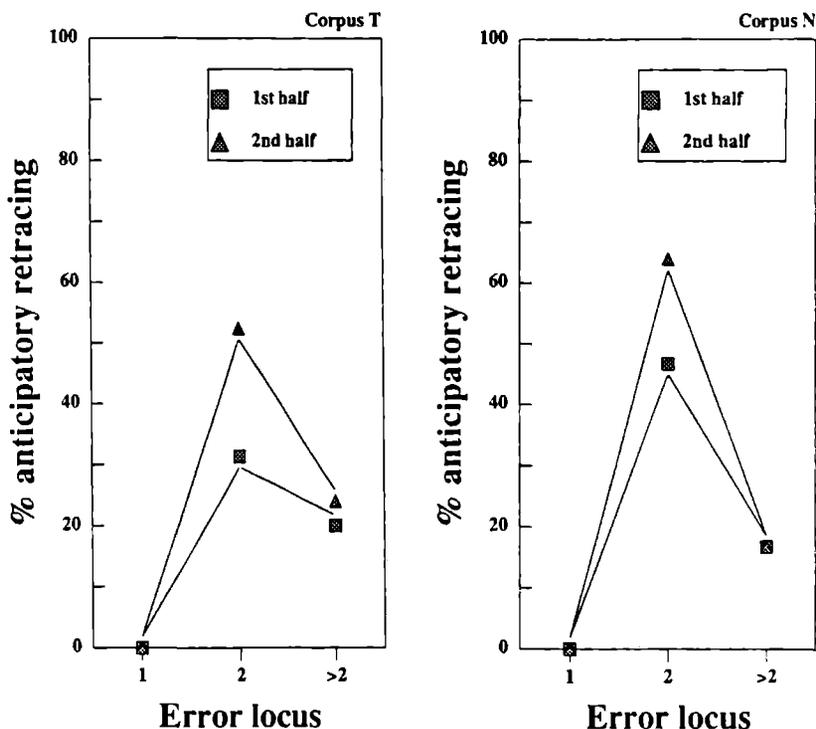
Figure 5.2 suggests that the tendency to retrace is somewhat higher in the second halves of both corpora than in the first halves. However, these differences do not reach significance in chi-squared tests.

Table 5.III. Restarting categories.

Corpus	Instant Repair	Anticipatory retracing	Total
T	135 (83.9%)	26 (16.1%)	161 (100%)*
N	184 (80.3%)	45 (18.7%)	229 (100%)
Total	319 (81.8%)	71 (18.2%)	390 (100%)

*3 cases could not be evaluated

Figure 5.2. Percentages of anticipatory retracing upon errors in words at first, second and later sentence positions, in the first and second halves of both corpora.



What circumstances, other than the location of the reparandum, might induce T and N to abandon their apparent 'instant repair strategy'? In the two ensuing analyses, restart tendencies will be related to two characteristics of the self-correction episode: the locus of the interruption with respect to the error and the nature of the error itself.

When the interruption is delayed, the location of the reparandum may be unclear, either to a listener, or to the speaker himself. Consequently, the speaker may tend to restart by anticipatory retracing. Table 5.IV shows the numbers of instantaneous repairs and retraced restarts upon errors that occur/start in words in second and higher positions in sentences, as a function of the type of interruption (errors in first positions cannot involve retracing). Although the numbers of delayed interruptions are too small to warrant any firm conclusions, N's data show a tendency in the expected direction: delayed interruptions are more often followed by a retraced restart than immediate interruptions ($\chi^2 = 3.35$, $df = 1$, $p = .067$). However, the expected proportion (cf., above) of anticipatory retracing in corrections with a delayed interruption in N is 0.65. A binomial test shows that the observed proportion does not significantly deviate from this value. In N's corrections involving immediate

interruptions, as well as in both sets in corpus T, the tendency to instantaneously repair exceeds chance values.

Phonological errors are 'self-betraying', in a sense, because they often result in non-word strings. Lexical errors, on the other hand, will have to be deduced from an analysis which relates words within the sentence. It is conceivable that the speaker's restart behavior reflects this difference. Table 5.V provides an overview of the restart tendencies in repairs of phonological and lexical errors at second and higher positions in the sentence. The pattern of restarting in T differs for the two types of error. Lexical errors lead to significantly higher proportions of anticipatory retracings than phonological errors ($\chi^2 = 4.86$, $df = 1$, $p < .03$). N, on the other hand, does not show this tendency ($\chi^2 = 0$, $df = 1$). Analogously to what was pointed out in the preceding paragraph, it appears that the proportion of instant repairs in T's corrections of lexical errors does not deviate from chance. In the other data sets, instant repairs are more frequent than would be expected.

Table 5.IV. The effect of locus of interruption on restart.

<i>Corpus T</i>		Restart Type		Total
Interruption:	Instant repair	Antic. Retracing		
Immediate	51 (68.9%)	23 (31.1%)	74 (100%)	
Delayed	5 (62.5%)	3 (37.5%)	8 (100%)	
Total	56 (68.3%)	26 (31.7%)	82 (100%)	

<i>Corpus N</i>		Restart Type		Total
Interruption:	Instant repair	Antic. Retracing		
Immediate	90 (70.9%)	37 (29.1%)	127 (100%)	
Delayed	6 (42.9%)	8 (57.1%)	14 (100%)	
Total	96 (68.1%)	45 (31.9%)	141 (100%)	

From the listener's point of view, it is not *a priori* clear whether a speaker retraces or not. The listener simply has to find a way to connect the speech after the interruption to the speech before the interruption in a meaningful way (the continuation problem). Would the *word-identity principle* and the *category-identity principle* be helpful in the case of 2-year old speakers? In order to check this, self-corrections were selected in which the material span between sentence onset and interruption encompassed more than one word. It is clear that if the original utterance (the speech before the interruption) contains only one word, the repair, i.e., the speech after the interruption, cancels this word. Thus, in such cases there would not be a continuation problem. It was ascertained whether words in the original utterances were identical to, or shared the syntactic category of the initial words in the associated repairs, and if so, whether 'welding' the original utterance and the repair at those

words would result in the correct continuation. In T, in 100 relevant cases, 30 involved a repair-initial word which was identical to one of the words in the original utterance. In 28 (93.3%) of these cases, the word-identity principle was respected.

Table 5.V. Effect of error type on restarting.

Corpus T Error Type:	Restart Type		Total
	Instant repair	Antic. Retracing	
Phonological	25 (83.3%)	5 (16.7%)	30 (100%)
Lexical	10 (50%)	10 (50%)	20 (100%)
Total	35 (70%)	15 (30%)	50 (100%)
<hr/>			
Corpus N Error Type	Restart Type		Total
	Instant repair	Antic. Retracing	
Phonological	31 (67.49%)	15 (32.6%)	46 (100%)
Lexical	33 (68.8%)	15 (31.3%)	48 (100%)
Total	64 (68.1%)	30 (31.9%)	94 (100%)

In the remaining 70 self-corrections, 11 cases were observed in which the first word of the repair shared its syntactic category with one of the words in the original utterance. In all of these cases the repair-initial word was intended to replace the matching word in the original utterance. In N, 155 relevant self-corrections were inspected. In 46 cases, the repair-initial word was identical to one of the words in the original utterance. In all 46 cases, the word-identity constraint was respected. In the remaining 109 self-corrections, 47 cases were found in which the repair-initial word's category matched that of one of the original words. In 42 (89.4%) of these cases, the repair-initial word was to replace the matching original. Examples of self-correction in which the word-identity principle is applicable (and respected) are (34) and (35). The category identity principle is applicable (and respected) in (36) and (37).

(34) ik wil nog ə keer [//] nog ə pap (*I want another time [//] another porridge*) [T023-036]

(35) op kom [//] op kop leggen (*on hear [//] on head lay*) [N023-137]

(36) en moet [//] gaat boven op de doos staan (*and must [//] goes on top of the box stand*) [T241-154]

(37) een zee [//] dat zee vind ik wel lekker (*a sea [//] that sea find I nice*) [N072-199]

In summary, it appears that even very young speakers respect these principles in a large majority of cases. However, in quite a large proportion of cases (59% in T; 40% in N) neither of the identity principles are applicable. In these cases, other cues may help to solve the continuation problem. In 25 of the 59 self-corrections in T in which neither of the

identity principles were applicable, the continuation problem could be solved because the error was phonological, resulting in a non-word. In N, this applied to 27 of the 62 cases (examples 38 and 39). Furthermore, 27 cases in T and 25 in N could be solved because the repair repeated parts of the original utterance which came *after* the error (examples 40 and 41).

(38) wel een [kadəb] [//] kaboutertje ("*truly*" a [kadəb] [//] dwarf) [T192-018]

(39) doe jij [hays] [//] huis bouwen? (*do you [hays] [//] house build*) [N171-514]

(40) hij 's [//] eend is gepakt (*he 's [//] duck is caught*) [T111-295]

(41) twee schoor [//] doen die twee schoorstenen nou? (*two chim [//] do those two chimneys now*) [N091-107]

5.3.2 REPAIR OPERATIONS

We will now focus on repairing itself, by comparing the preferred repair operations and their effects in self-corrections with those in the two other types of speech revision, clarifications and replacements. The ensuing analyses will concentrate on alterations at either phonological, lexical or syntactic levels of description. Consequently, some response categories were discarded, viz. literal repetitions (in clarifications and replacements), alterations at the prosodic level and non-contingent and zero responses (in clarifications). Table 5.VI presents an overview of the relevant data sets as well as the numbers of excluded responses.

Table 5.VI Valid and discarded repair operations in the three types of speech revision

<i>Corpus T</i>	Self-corrections	Clarifications	Replacements
Valid	148 (90.2%)	81 (34.9%)	415 (58.8%)
Non-interpr.	13 (7.9%)	80 (34.5%)	45 (6.4%)
Literal repetition/ Prosodic repair	3 (1.8%)	36 (15.5%)	246 (34.8%)
Non-contingent	-	35 (15.1%)	-
Total	164 (100%)	232 (100%)	706 (100%)
<i>Corpus N</i>	Self-corrections	Clarifications	Replacements
Valid	199 (86.92%)	73 (38%)	252 (61.5%)
Non-interpr.	23 (10%)	60 (31.3%)	46 (11.2%)
Literal repetition/ Prosodic repair	7 (3.1%)	19 (9.9%)	112 (27.3%)
Non-contingent	-	40 (20.8%)	-
Total	229 (100%)	192 (100%)	410 (100%)

As phonological repairs were classified additions, deletions and substitutions of speech sounds. All lexical repairs were word substitutions. Syntactic repairs included all alterations involving the sentential lay-out, i.e., word and phrase additions and -deletions, as well as combinations of these two.

Table 5.VII shows the numbers of phonological, lexical and syntactic repairs for each type of revision. The distribution of repair types differs significantly across the three types of revision in both children (T: $\chi^2 = 40.09$, $df = 4$, $p < .001$; N: $\chi^2 = 101.89$, $df = 4$, $p < .001$). In both children, the ratios of lexical repairs to phonological and syntactic repairs differed across revision types. Lexical repairs are relatively frequent in self-corrections as compared to replacements and clarifications.

Table 5.VIII shows that the various types of syntactic repair operations are differently distributed across the three types of speech revision (T: $\chi^2 = 42.42$, $df = 4$, $p < .01$; N: $\chi^2 = 44.59$, $df = 4$, $p < .001$). The difference between self-corrections and clarifications appears to contribute most to this difference. Over 90% of all self-corrections at the syntactic level involve word- or phrase- additions, against approximately 30% of the clarifications, which, on the other hand, incorporate a relatively high proportion of deletions of words and phrases. The proportions for the replacements appear to be intermediate between those of the other two categories.

Table 5.VII. Repair types in the three types of speech revision.

<i>Corpus T</i>	Phonological Repair		Lexical Repair		Syntactic Repair		Total	
Self-correct.	60	(40.5%)	32	(21.6%)	56	(37.9%)	148	(100%)
Clarification	37	(45.7%)	5	(6.2%)	39	(48.1%)	81	(100%)
Replacement	216	(52%)	20	(4.8%)	179	(43.2%)	415	(100%)

<i>Corpus N</i>	Phonological Repair		Lexical Repair		Syntactic Repair		Total	
Self-correct.	68	(34.2%)	80	(40.2%)	51	(25.6%)	199	(100%)
Clarification	13	(17.8%)	4	(6.2%)	56	(48.1%)	73	(100%)
Replacement	80	(31.7%)	25	(9.9%)	147	(58.3%)	415	(100%)

Table 5.VIII. Classes of syntactic repairs in the three types of speech revision.

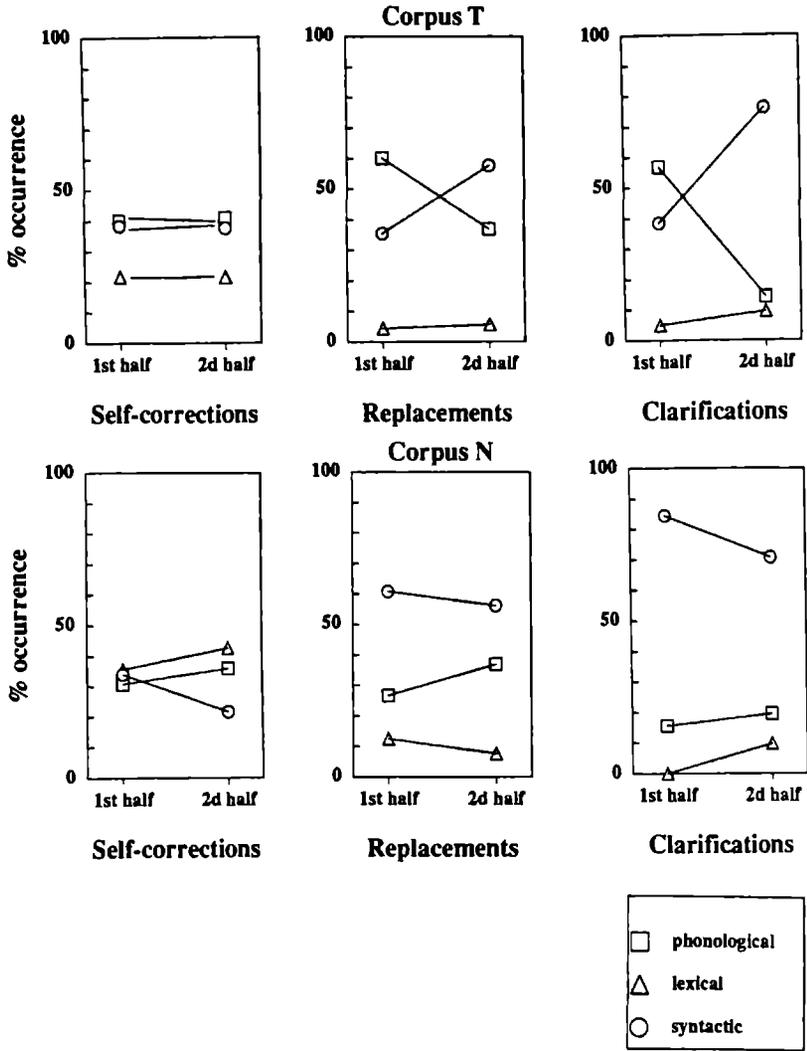
<i>Corpus T</i>	Word(s)		Word(s)		Combinations	Total	
	Additions		Deletions				
Self-correct.	52	(92.8%)	1	(1.8%)	3	(5.4%)	56 (100%)
Clarification	13	(33.3%)	18	(46.2%)	8	(20.5%)	39 (100%)
Replacement	99	(55.3%)	66	(36.9%)	14	(7.8%)	179 (100%)

<i>Corpus N</i>	Word(s)		Word(s)		Combinations	Total	
	Additions		Deletions				
Self-correct.	46	(90.2%)	2	(3.9%)	3	(5.9%)	51 (100%)
Clarification	16	(28.6%)	27	(48.2%)	13	(23.2%)	56 (100%)
Replacement	69	(46.9%)	57	(38.8%)	21	(14.3%)	147 (100%)

Figure 5.3 presents results which are pertinent to the question of whether the focus of attention in revision changes during development, as is predicted by Clark's spotlight hypothesis. The two corpora were split into two halves like before. The results are suggestive of some developmental shifts in the proportions of repairs at different levels of linguistic description. In T, a remarkable increase in the proportion of syntactic repairs, associated with a decline of phonological repairs is discernable in both clarifications and replacements. The difference in distribution of the three repair levels across the two periods which results from this shift is reflected by significant test results (replacements: $\chi^2 = 20.85$, $df = 2$, $p < .001$; clarifications: $\chi^2 = 11.26$, $df = 2$, $p < .004$). The self-corrections, however, do not reveal any shift ($\chi^2 = 0.014$, $df = 2$). In N, however, neither of the three distributional changes reaches significance.

In summary, these results indicate that the three types of speech revisions diverge considerably with regard to the proportions of repair types, and their fluctuation as a function of age.

Figure 5.3. Percentages of phonological, lexical and syntactic repairs in self-corrections, replacements and clarifications in the first and second halves of both corpora.



5.3.3 THE EFFECT OF SPEECH REVISIONS

Do speech revisions result in utterances that are more advanced than their predecessors? Two analyses were performed, one concentrating on phonological repairs, the other on

syntactic repairs. In both cases, the effect of the repair was evaluated from an adult point of view. Thus, in the case of phonological repair, an alteration would be qualified as an improvement if the resulting form was closer to the (average) adult template than its predecessor. In the case of syntactic repairs, a precisely circumscribed set of alterations was defined as improvements, viz.:

- (1) the addition of function words in obligatory contexts (determiners), or in cases where they would precisely specify a syntactic relation (prepositions),
- (2) adding a subject to a subjectless string (VX→SVX),
- (3) adding a verb to a verbless string (SX→SVX)

It should be noted that these criteria were chosen to *operationalize* the notion of syntactic improvement. It is not implied that there are not any other alterations which might count as improvements. However, these were not considered.

Table 5 IX Effects of phonological alterations in three types of speech revisions

<i>Corpus T</i>	Better	Worse	Neutral	Unclear	Total
Self-correct	55 (92.7%)	-	5 (8.3%)	-	60 (100%)
Clarification	20 (54.1%)	5 (13.5%)	12 (31.4%)	-	37 (100%)
Replacement	78 (36.1%)	60 (27.8%)	73 (33.8%)	5 (2.3%)	216 (100%)

<i>Corpus N</i>	Better	Worse	Neutral	Unclear	Total
Self correct	61 (89.7%)	-	7 (10.3%)	-	68 (100%)
Clarification	4 (30.8%)	3 (23.1%)	6 (46.2%)	-	13 (100%)
Replacement	26 (32.5%)	20 (25%)	31 (38.8%)	3 (3.8%)	80 (100%)

Table 5 IX shows the results of the evaluation of phonological repairs. It appears that approximately 90% of all self-corrections at the phonological level are improvements according to our criterion, against one third to at most 54% in replacement sequences and clarification requests. The ratios of improving to non-improving repairs differ significantly across revision types (T: $\chi^2 = 58.45$, $df = 2$, $p < .001$, N: $\chi^2 = 52.76$, $df = 2$, $p < .001$). Moreover, a non-negligible proportion (14-28%) of the phonological alterations in clarifications and replacements appear to be deteriorations.

The proportions of improving and non-improving syntactic repairs, according to the above criteria, are displayed in Table 5 X. Chi-squared tests indicate that the ratios of improving to non-improving repairs differ significantly across types of revision (T: $\chi^2 = 23.23$, $df = 2$, $p < .001$, N: $\chi^2 = 23.58$, $df = 2$, $p < .001$), which sustains the impression that self-corrections more often result in syntactically improved utterances than either clarifications or replacements.

Table 5.X Effects of syntactic alterations in three types of speech revision

<i>Corpus T</i>	Better	Worse	Neutral	Total
Self-correct	25 (44.6%)	2 (3.6%)	29 (51.8%)	56 (100%)
Clarification	3 (7.7%)	6 (15.4%)	30 (76.9%)	39 (100%)
Replacement	32 (17.9%)	27 (15.1%)	120 (67%)	179 (100%)

<i>Corpus N</i>	Better	Worse	Neutral	Total
Self-correct	24 (47.1%)	-	27 (52.9%)	51 (100%)
Clarification	6 (10.7%)	6 (10.7%)	44 (78.7%)	56 (100%)
Replacement	27 (18.4%)	21 (14.3%)	99 (67.3%)	147 (100%)

5.4 DISCUSSION

5.4.1 INTERRUPTING AND RESTARTING IN SELF-CORRECTIONS

Several differences between self-corrections of the present subjects and those of adult speakers can be noted. Let us first compare interruption patterns in the present subjects with those in adults. T and N evidently produce fewer delayed interruptions than adults do. In adults, Levelt (1983) found 30.2% interruptions that were delayed beyond word boundaries, against an approximate average of 15% in T and N. Moreover, it appears that if the present subjects delay, the material span between error and interruption is shorter than in adults, viz. approximately 1.2 syllables, against an average of 3.39 syllables in adults (derived from Levelt's [1983] data). What do these differences imply? At any rate, the fact that delays *do* occur in the present subjects seems to rule out the possibility that children's monitoring conforms to the production theory. Are children perhaps more efficient self-perceivers than adults? The present results do not support this conclusion. It should be recalled that the metric involved in the above findings (number of syllables) depends upon speaking rate, which is undoubtedly higher in adults than in children. Thus, the higher incidence of delayed interruptions and longer delay lengths in adults as compared to children may be ascribed to the fact that adults can output much more speech within the interval between error detection and interrupt generation than children. Whether children are more or less efficient monitors than adults, can only be answered with the aid of real time measures of interrupt intervals.

In contrast to Nooteboom's (1980) result, no evidence in the present data was found for a difference in detection speed for errors at different levels (phonological, lexical, syntactic) of linguistic description. This might of course imply that children's language processing lacks a

clear temporal-hierarchic order in accessing phonological and lexical information. On the other hand, the metric used to evaluate speed, viz. interruption delay in numbers of syllables, may be unreliable, particularly in children, due to not only a relatively slow, but also a rather variable speaking rate. The high standard deviations that accompany the mean interruption delays warrant the latter conclusion.

The present subjects appear to be more willing to interrupt non-erroneous words than adults. Levelt (1983) reports 22.1% delayed within-word interruptions. T and N produce on average 28.1% delayed within-word interruptions. This might imply that retaining the integrity of words in speech is less important for children than for adults. This seems to be corroborated by the results presented in Chapter 2, which indicate that interrupted words are not always restarted at the word beginning, but may also be restarted at the nearest syllable onset.

It is somewhat complicated to compare the present subjects' restart strategies with those of adults. The data on adults provided by Levelt (1983) contain not only the categories *instant repair* and *retraced restart*, but also a third category, viz., *fresh start*, which refers to a restart with new verbal material. Similar restarts did also occur in the present corpus, particularly in syntactic repairs, which often involved the insertion of words before the word that initiated the original utterance. However, in such cases the reparanda were considered to be virtual 'empty spots', i.e., forgotten words, and the associated restarts were classified as instantaneous. When Levelt's fresh starts are treated similarly, 65.5% of the repairs in his corpus are instantaneous, and 35.5% involve anticipatory retracing. T and N, on the other hand, produce anticipatory retracings in less than 20% of the self-corrections, on average. Thus, the present subjects appear to be less inclined to retrace anticipatorily than adults. To some extent, this might be related to the fact that many reparanda occur in sentence-initial positions, which precludes anticipatory retracing. However, even when anticipatory retracing is possible, instant repairs are preferred. This preference is somewhat less when a reparandum is located in the second word of a sentence, and in some idiosyncratic cases which will be discussed below. The frequency of anticipatory retracing seems to increase somewhat as a function of age. This may reflect a small step toward the adult pattern.

Do the present subjects show any awareness of the listener's task of interpreting repairs and their connection to the original utterance, as is clear adults do? Some rather idiosyncratic differences in restarting behavior as related to different aspects of self-corrections were observed. T produced more retraced restarts after lexical errors than after phonological errors. This may be related to the relative difficulty of identifying lexical errors as compared to phonological errors. N tended to produce more retraced restarts after delayed interruptions than after immediate interruptions. These patterns may reflect a budding 'listener-orientedness'. On the other hand, it is not impossible that T and N themselves experienced some problems in pinpointing the location of the reparandum in the cases in where they tended to retrace. As regards the listener's continuation problem, it appears that the subjects respect the two identity principles for the continuation of interrupted utterances -if applicable- almost as often as adults. However, in a considerable proportion of the cases,

neither of these two principles is applicable. In many of these cases, the listener cannot rely on 'on-line' continuation strategies.

The most conspicuous difference between children and adults concerns the distribution of error/repair types. In the present corpus, phonological and syntactic repairs contribute about 60 to 80%, whereas in adults lexical repairs are most prominent (Levelt 1983). This difference seems to make sense if it is recalled that in adult speakers syntactic and phonological planning operations are highly overlearned and automatized, whereas selecting words from a 'database' which may contain 50,000 items or more will always remain a somewhat effortful and error-prone task. In children, on the other hand, syntactic and phonological operations are not yet well-practised, and will therefore be relatively error-prone, which results in a larger proportion of phonological and syntactic repairs. This point will be further elaborated in the final section.

5.4.2 REPAIR PREFERENCES AND EFFECTS

The three types of speech revisions appear to differ with respect to the kinds of repair involved. Lexical repairs are relatively frequent in self-corrections, whereas phonological and syntactic repairs form the largest set in replacements and clarifications. Also, the types of repair within a certain level of description vary across revision types. Syntactic repairs in self-corrections are predominantly (>90%) expansions. In replacements, expansions (build ups) are less frequent than in self-corrections, but they still are in the majority, which would accord with the suggestions made by Braine (1973) and Bloom *et al* (1975). In the set of clarifications, deletions (break downs) were found to be the most frequent category, which is in accordance with Gallagher's (1977) results.

The evidence for developmental changes in repair preferences is not very consistent, neither between, nor within subjects. In T, rather dramatic differences were found between the first and second halves of the corpus, which indicated a shift of repair 'attention' from the phonological to the syntactic level. This shift agrees with Clark's (1982) findings. However, it did not surface in the self-corrections, only in replacements and clarifications. In N, some tendencies were observed, but these could not be statistically substantiated.

The effects of speech repairs appear to vary with their type. It was found that self-corrections, both at phonological and syntactic levels, predominantly result in improved renderings of the original utterance, at least from an adult point of view. This finding agrees with Clark's (1982) results. In replacements and clarifications, on the other hand, most repairs are, at best, neutral with regard to the quality of the utterance. With respect to replacements at the phonological level, these results are similar to those of Gallagher's (1977).

The main predictions of Clark's coordination theory can be summarized by the phrases *developmental shift* and *progression*. Although both developmental shift and progressive repairing were observed, these two characteristics do not co-occur in each type of revision. Progression seems to be a characteristic of self-corrections only. Developmental shift, on the other hand, was not observed in this type of revision. Rather, if it occurs at all, it seems to be

associated with the other two types of revision: replacing and clarifying. It might be objected that the sample in this study is small, the results idiosyncratic. The general pattern of results, however, does not appear to diverge very much from those of other investigations, with larger samples. Consequently, it does not seem unfair to conclude that the data are not altogether consistent with the coordination theory. In the following paragraphs, some preliminary speculations will be formulated with the aim of providing an alternative framework for the interpretation of the present data (and similar findings from related studies, for that matter).

The basic assumption of an alternative integrative account of speech revision behavior, and indeed of this study, is that, no matter what its form or function may be, speech revision relies on three operations: *self-perception*, *evaluating* and *repairing*. The difference between the three types of revision (self-correction, replacement and clarification) is related to a difference in the second operation: evaluating. The shortest way to put it would be to state that in self-correcting the evaluation process functions according to a *Match Principle*, whereas in replacing and clarifying it functions according to a *Draft Principle*. If we imagine that the speaker's evaluation process is an interrogation, the main question posed by the Match Principle is: 'Is this utterance a proper encoding of my message?'. The Draft Principle, on the other hand, poses the question: 'Can I express this message differently, perhaps better?'.

In the light of the above premises, the 'reparandum' in self-correction is an *error*, i.e., a discrepancy between a desired action and an actual action (cf. Laver 1980). The desired action, or: the evaluation criterion, encompasses the intended conceptual representation, as well as linguistic representations at intermediate levels. The impetus for repairing is a mismatch (or: not reaching a minimal degree of correspondence), between a certain element of the utterance and an internal representation. Because the speaker perceives the reparandum as an error, she attempts to correct it as fast as possible. Clear cases of mismatch restorations are lexical substitution repairs, which indicate that the child has misselected a word, i.e., that she has chosen a lexical item which does not capture her intention, and which is, therefore erroneous (to the child's own standard).

Phonological and syntactic self-corrections were observed to be progressive, i.e., approximations of the adult standard. Moreover, the subjects produced *more* phonological and syntactic self-corrections than adults, which might imply that they preferably repair those aspects of utterances which are notably defective in comparison to adult standards, as coordination theory holds. On the other hand, progressive repairing does not *prove* that children employ adult-based criteria in evaluating, as was argued in the Introduction. Furthermore, as to the high amount of phonological and syntactic repairs in comparison to adults, it is perfectly possible that these are not due to the child's striving toward adult competence via self-correcting, but rather, that they are induced because neither syntactic nor phonological production processes are particularly well-practised and, therefore, go awry quite often.

In replacements and clarifications, the Draft Principle prevails. It can be assumed that a young child, not yet being an experienced listener/interlocutor, cannot reliably estimate the

potential failure that has led to a request for clarification on the part of the adult. In other words, the child does not yet know what should be altered in order for the listener to understand a previously misunderstood utterance; there is no clearly delineated desired action. Moreover, it is conceivable that the level at which a repair is made is determined by the child's linguistic developmental stage. Thus, when a child is predominantly involved in mastering (aspects of) syntax, clarification repairs will predominantly be syntactic. In replacements, there is not a clear mismatch between intention and realization either. Consequently, the choice of a repair may also be determined by the developmental stage of the child. In Chapter 4, it was argued that T's development in the second half of the corpus is characterized by the emergence of a syntactic planning ability. The results of the present study show an increase of syntactic repairs in clarifications and replacements in the same period. This 'synchronicity' may support the above interpretation, but clearly, further investigations of the temporal relation of both variables are warranted. Children may use replacements to explore or practise the phonological or syntactic systems they are mastering. Replacing may thus be a form of 'language work' (Elbers 1989a, b).

Does the draft principle in speech revision die as language users reach maturity? Probably not. Levelt (1983) discovered that many self-corrections (30%) are so-called appropriateness repairs. In such cases, the reparandum does not violate linguistic standards, but seems less than optimal from a conceptual or pragmatic point of view. A word or phrase may be ambiguous, or inconsistent with the previous discourse, or not precise enough, as the following example illustrates.

(42) what I'm trying to do is to make a portrait [draw] [/] an impressionistic portrait of contemporary American society [F. Wiseman for NOS-television, 4-1-1990]

In such cases, as in the replacements and clarifications of the present corpus, there does not seem to be a clearly delineated criterion in the process of evaluating. Rather, the (adult) speaker gives the impression of being led by the question: "Can I express this message differently, perhaps better?". Interestingly, adults are apparently able to apply the Draft Principle in the same fast, 'on-line' way as the Match Principle (in error correction). Young children apparently are not able to do this. A post-hoc inventarisation of all self-corrections in N and T yielded just a few cases that could be counted as appropriateness repairs, 10 in T (6.1%), 19 in N (8%). The conjecture that can be derived from these observations is that as the language user matures, 'drafting' changes from a relatively slow, deliberate process, yielding non-interruptive revisions, into a fast 'on-line' mechanism, yielding revisions that are formally equivalent to those of 'matching'.

CHAPTER 5

6.1 INTRODUCTION

The problem which this dissertation addresses was formulated in Chapter 1 as the development of the speaker. More specifically, it is the architecture of the cognitive mechanism underlying the production of speech developmentally invariant or not. This is a complicated question, which will inevitably lead to a complicated answer. Some partial answers, based on empirical analyses, were given in the preceding chapters. In this concluding chapter, I will attempt to assemble these incomplete, partial answers into a somewhat more elaborate, although far from complete, model of the development of the speaker. This model can be likened to a patchwork quilt. Some of its patches are provided by the research reported in the previous chapters. Most patches, however, are traceable to various studies in the extended field of language development. The selection from the developmental psycholinguistic literature is not exhaustive. Of course, it would not have been possible to write even a marginally comprehensive review. More importantly, it would not have been compatible with the aim of this chapter, which is to provide (the preliminaries of) a model for the developing speaker which possesses a reasonable degree of internal consistency. Generally, developmental psycholinguistic studies are focused on the 'substance' of children's speech, i.e., the semantic, syntactic or phonological knowledge they possess. The reviews in this chapter, however, will predominantly illuminate the consequences of knowledge acquisition for the development of processing.

This chapter will proceed as follows. As a starting point, a brief outline will be given of the initial state of the speaking mechanism, labelled 'the beginning speaker', which will be compared to the 'mature speaker' presented in Chapter 1. As a working hypothesis, it will be assumed that many of the defining characteristics of the mature speaker are not yet realized in the beginning speaker. The main task for a model of the development of the speaking process, therefore, will be to show how the mature state is reached. This task will be divided into several parts, which loosely follow the succession of broadly defined phases in the development of language production: single word utterances, early word combinations and, finally, grammatical speech.

First, attention will be focused on the development of lexical representations and processes. This part in itself naturally subdivides into a discussion of the representation and

processing of 'form' and the representation and processing of 'meaning' Next, I will dwell on the development of representations and processes that enable children to move beyond the production of single word phrases It will be argued that the processing equipment which underlies early word combinations is not yet equivalent to the mature state Rather, the final changes of the speaker, leading to the mature state occur during the transition from the stage of early word combinations to the stage of 'grammatical speech'

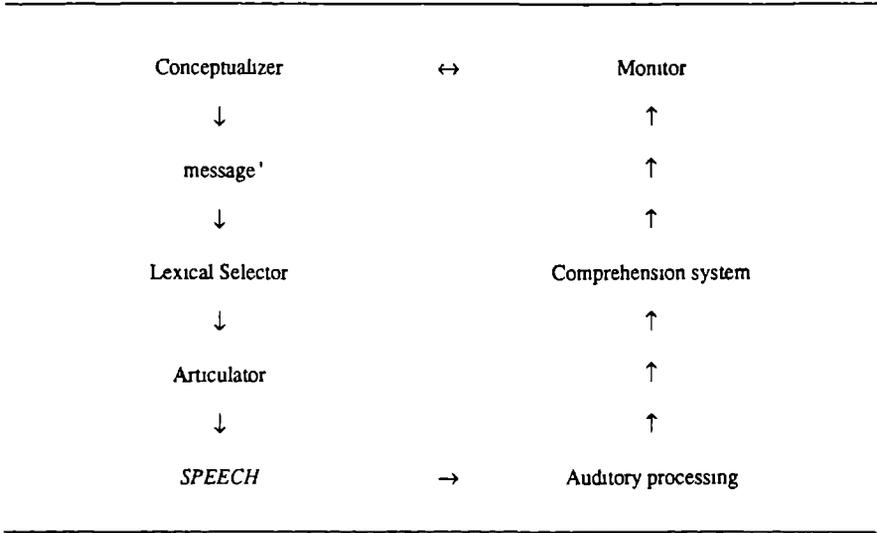
The reader should be warned that this chapter, as indeed this dissertation as a whole, only deals with production The development of language perception, as an autonomous skill, is systematically and deliberately left out of consideration The perception of speech and language are only discussed in the context of their presumed role in monitoring and controlling language production and its development

6 2 THE BEGINNING SPEAKER.

As the 'beginning speaker' I will consider the child that has just started using its first words In this connection, words are considered to be utterances with a relatively constant phonological form that are associated with a relatively consistent referential meaning Thus, the phase in which children babble or even produce so-called vocables or protowords, i e , situationally determined phonologically consistent forms (cf , A L Carter 1979), is left out of consideration There are no reasons for this restriction other than practical ones Including the first year or so of the development of speaking in which the foundations for, on the one hand, articulation, and on the other hand, concept formation are laid, would extend the scope of this chapter beyond my capacities, and would not be relevant to the argument to be developed

It is proposed that the beginning speaker is adequately modeled by the scheme depicted in Figure 6 1 The generation of an utterance, which at this stage of development consists of maximally one word, involves the construction of a particular conceptual representation, lexical selection, and the execution of an articulatory program Note that children's single word expressions may sound like sentences, as in ['obədədo r] (open the door) (Peters 1983) I will assume that such words are unanalyzed 'amalgams' of several morphemes More detailed presentations of the sorts of representations and processes involved, as well as their development, constitute a major portion of the following text Here, it will suffice to note that, in a sense, the beginning speaker can be considered a 'reduced version' of the mature speaker In particular, the pivotal component in the model of the adult speaker as presented in Chapter 1, the *formulator* is not yet present Instead, only *lexical selection*, i e , a precursor of the initial step in the formulating process of the mature speaker, constitutes the interface between conceptualizing and articulating

Figure 6.1 An outline of the beginning speaker



The initial speech production mechanism is not only a 'reduced' version of the mature mechanism, it is neither modular, nor strictly hierarchically organized. Levelt (1989) describes modules as 'relatively autonomous specialists'. It is clear that the conceptualizer is neither autonomous nor a specialist, not even in the mature speaker. The beginning articulator may be specialized as regards the resulting output, it certainly is not fully autonomous, in the sense of functioning independently of central processing resources. In section 6.3.3, some findings will be presented which suggest that there is no strict hierarchical order in the processing of word meanings and word forms. Finally, as long as the speaker produces only one word at a time, incremental functioning, the third characteristic of the mature system, is a vacuous notion.

In the ensuing descriptions of the changes that are involved in the development of the speaker, a developmental concept by the name of 'layering' will repeatedly surface. Layering refers to the process by which a new level of representation and/or processing (a new layer) is inserted, as it were, between two already functioning levels of representation or processing. It will be argued that the development of the lexicon consists of the insertion of three new representational layers: a semantic, a phonological, and a syntactic layer. The development of the formulator involves the insertion of levels of grammatical encoding and phonological encoding between the already existing layers of lexical selection and articulation. Thus the development of the speaker can be viewed as the transition of a two-layered processor into a multi-layered processor.

The presentation of the ontogenetical model in the following paragraphs will start with a discussion of the development of lexical processing. There are two reasons for this. First, in a superficial sense, the beginning speaker is just a *word generator*. Another, more profound

reason for giving priority to lexical processing is that lexical representations are the pivotal elements in speech production. It was noted in Chapter 1 that the mature Formulator is lexically driven. Analogously, it is felt that the development of speech production apparatus is in a sense 'lexically driven'. R. Berman provides a clear statement of this opinion:

Something like 'a word' clearly plays an important part in early acquisition: It contributes the basis for form-meaning connections; for phonological manipulations; and for subsequent grammatical combinations across items and modifications within items. (Berman 1988:52)

Restated in the terminology of speech production, it could be said that additions, reorganizations and differentiations of the representations and processes involved in the generation of utterances during development are rooted in additions, reorganizations, and differentiations in lexical information on either the semantic, syntactic or phonological level. For instance, the development of syntactic encoding is linked to the acquisition of syntactic attributes of words (syntactic (sub)categorization) (see section 6.5.1 ff.). Also, the development of phonological encoding as a separate processing component is related to the so-called 'phonemization' of lexemes (see section 6.3.1).

6.3 THE LEXICON

It is, perhaps, a paradoxical way to start a section on the development of lexical processing by stating that in fact the beginning speaker does not have a mental lexicon. Still, it is correct in the light of a conception of the mental lexicon as a highly specialized, autonomous (i.e., modular) mental organ, which is specifically dedicated to the storage and retrieval of semantic, syntactic, morphological and phonological attributes of words (Schreuder 1987). It is not the case that the beginning speaker does not have a lexicon because he has not yet acquired *all* of the semantic, syntactic, morphological and phonological knowledge of the mature speaker. This difference between the beginning speaker and the mature speaker relates to the amount of knowledge, and is therefore not very relevant. Rather, not having a lexicon refers to the fact that the representations which are used in the production of words are not part of an autonomous, 'modular' mental organ. Initial lexical meaning representations are parts of the 'general' conceptual knowledge. Initial lexical form representations are articulatory routines which are part of a general stock of articulatory motor programs. The lexicon comes into being, as it were, with, on the one hand, the emergence of phonological representations, i.e., representations of word forms built from segments, and, on the other hand, the development of semantic representations which are separate from general conceptual knowledge.

Section 6.3.1 addresses the development of phonological representations, the so-called *phonemization* of the lexicon. Next, in section 6.3.2, I will examine the assumption that initial lexical meaning representations are directly connected to 'general' conceptual representations, and that separate 'semantic' lexical representations emerge on the basis of these. In connection to this, some attention will be given to the question as to what

developmental processes might underlie these transitions. Finally, in section 6.3.3, I will consider the claim that the processing of word-meanings and of word-forms are highly interrelated ('non-autonomous') during the early stages of development.

6.3.1 THE PHONEMIZATION OF THE LEXICON

The model for the beginning speaker indicates that the level of word form representation coincides with the level of articulation. More specifically, it is suggested that early word forms simply are articulatory routines, which are pointed at by conceptual representations. These 'word routines' are built from the basic units of articulatory processing, viz. syllable-sized units of motor programming. In Chapter 2, it was argued that syllables are fundamental and 'developmentally basic' units in the execution of speech (see also Kent & Hodge 1989). It has become clear that at least in this respect, the speaker is developmentally invariant, since research in adults suggest that syllables remain the basic units in articulatory programming. Crompton (1982) has suggested that adult speakers possess a 'mental syllabicon' which contains all elementary articulatory routines needed to speak one's mother tongue. It seems plausible that the foundation for this syllabicon is laid during the babbling stage (Van Bekkum 1980, Locke 1986, Vihman 1989). The *phonemization* hypothesis suggests that phonological development in the first stages of language development consists of the emergence of abstract phonological structure 'on top', as it were, of the articulator, i.e., the syllabicon. In short, between the ages of 1;6 and 2;6 phonological (segmental) representations are acquired, which provide a fast and reliable system of addressing the syllabicon from an ever-expanding lexicon.

Support for the phonemization hypothesis can be derived from some recent developments in the study of 'child phonology', which will be reviewed below. Next, I will discuss some proposals that might account for the development of a layer of segmented phonological representation on top of the articulatory layer. Finally, I will briefly discuss phonological development from the perspective of recent phonological theory.

Child phonology

Traditionally, the subject matter of child phonology consists of children's initial, altered, simplified pronunciations of the words of their mother tongue. For years, the theory of Jakobson (1941/1968) has dominated this field of inquiry. Jakobson stated that the development of phonology did not start before the child had started to produce its first words. Babbling, he held, is a form of articulatory behavior irrelevant to the subsequent linguistic development. The acquisition of the sound system of a language should not be viewed as a gradual approximative process, but rather as succession of autonomous rule systems, constructed by the child on the basis of the available linguistic input. The pattern of phonological development is systematic and universal; it can be construed as the successive acquisition of pairs of phonemes which represent opposites on articulatory or acoustic dimensions captured by distinctive features. The order of acquisition corresponds to a universal markedness hierarchy. Thus, the oppositions that are acquired early are the ones

that occur in a great many languages, the oppositions that are acquired late are the ones that occur in a restricted set of languages.

The regular and highly invariant course of phonological development that is predicted by Jakobson's theory was not borne out by the data. Rather, a conspicuous characteristic of phonological development appeared to be the large inter-individual differences between children in terms of the order of acquisition of sounds and phonological rules. Furthermore, it was observed that early speech is full of processes that cannot be accounted for in terms of a theory that regards phonemes and phoneme oppositions as acquisitional primitives. Often, the use of certain segments appears to be restricted to particular words. Segments that are, from an adult point of view, identical are pronounced differently in different words. The acquisition of sounds may depend on position in the word, e.g. stops are acquired first in word-initial position, fricatives in word-final position (Menyuk, Menn & Silber 1986). Furthermore, the inclusion of words in the expanding lexicon appears to be influenced by 'preferences' for particular sound sequences. Also, children often appear to employ the same, or almost the same phonetic templates for words that are apparently quite dissimilar in the input language, which is sometimes labeled 'homonym strategy' (Vihmann 1981, Menn 1983).

In response to these findings, it was conjectured that children's early phonological development should be described in terms of larger structures: syllables and words. Among the first authors to argue in favour of this approach were Moskowitz (1970) and Waterson (1971). Moskowitz argued that before a phonological system in terms of phonemes and phoneme oppositions is constructed, the child needs to acquire a fairly sizable productive vocabulary, presumably approximately 50 words. Waterson (1971) analyzed the productive vocabulary of a child (age 1;6) acquiring English. She found that each word could be assigned to one of five 'structures', i.e., articulatory schemes defined in terms of prosodic attributes (length, stress-pattern) and articulatory features. Each of these five structures was shown to be characterized by different constraints on syllabic and phonic structure. Waterson furthermore noticed that the same set of articulatory features characterized the adult words from which the child's renditions were apparently derived. However, neither the combinations in which these features surfaced in the child's words, nor the places at which they occurred, fully reflected those of the adult models. For instance, the subject used a number of words which shared the following attributes: (1) oral stop at syllable onset; (2) voiced syllable ending; (3) disyllabic; (4) prominence of first syllable. Waterson calls this set of attributes the 'stop structure'. It appeared that not only the child's renditions, but also the adult models were characterized by this structure, e.g.: [be:be:] (=biscuit); [bæbu:] (=Bobby); [tʊtʊ] (=Kitty). Consequently, Waterson suggests that children perceive and represent words as bundles of prosodic and articulatory features, without a clear indication of their combination and sequence. Expansion of the lexicon may be achieved in two ways. The child may acquire new words by 'assimilating' them to one of the 'structures' available. Alternatively, structures may be slightly altered, or accommodated, in order to fit perceived words. It is clear that these two principles are 'special cases' of Piaget's principles of sensorimotor development.

Hypotheses regarding the nature of early phonological representations similar to Waterson's have subsequently been proposed by a number of authors (Ferguson & Farwell 1975, Menn 1983, Wode 1985). Menn (1983), in what she calls a 'psychological model of phonological development', provides a process-oriented account of child phonology that fits well in the present discussion. She starts from Waterson's conjecture that alterations and simplifications of phonological forms are primarily motivated by the beginning speaker's problems with the "planning and production of rapid changes of articulation in a short space of time" (Waterson 1971:30). Menn suggests that the beginning speaker constructs articulatory programs which yield sound shapes that to a sufficient degree agree with the adult model words they are intended to capture. The motor programs are largely invariant, but may contain a few variable, or free, parameters to which a small range of values can be assigned. The production of words in beginning speakers consists of retrieving an articulatory program, setting the 'free' parameters and running the program. Phonological development, according to this account, is captured by three complementary processes: (1) a gradual increase in the number of 'free' parameters per motor program; (2) an increase in the ranges of parameter values; (3) merging of short (monosyllabic) programs to form longer (polysyllabic) ones.

The conclusion that can be drawn from these and similar studies is that children's early word form representations do not contain phonemic segments. Rather, they seem to consist of a set of articulatory features, integrated in a prosodic 'carrier'. The primacy of prosodic information in early phonological representation is corroborated by several investigations of lexical development (Ingram 1978, Gleitman, Landau & Wanner 1988) and lexical error in children (Aitchison & Straf 1982, Chiat 1983). Mature speakers, however, appear to possess word form representations that involve units closely corresponding to phonemes, as is suggested by speech error evidence (e.g., Fromkin 1971). Consequently, we are faced with a 'discontinuity' in phonological development, and the associated process of 'reorganization'. Several authors have argued that approximately from the age of 2, that is, when children have acquired a productive lexicon of about 50 to 100 words, phonological processes in children are describable in terms of segments rather than in terms of words or 'canonical (articulatory) forms' (Macken 1979, Wode 1985). This would seem to imply that around this age, word form representations are segmented. Recent evidence from acoustic analyses of CVC syllables produced by children at various ages appears to support this hypothesis (Nittrouer, Studdert-Kennedy & McGowan 1989). This *phonemization of the lexicon* will in principle be reflected by the appearance of phonological speech errors based on misselections or misorderings of phoneme sized units in the course of speech planning (see Chapter 3). A crucial problem, of course, concerns the nature of the learning process underlying this 'reorganization'. This will be addressed in the next section.

Phonemization as a learning process

Locke (1988) has suggested an account of phonemization which runs as follows: After the child has acquired a productive lexicon of roughly 50 to 100 words, the size of the vocabulary starts to increase in an exponential fashion. Consequently, Locke argues, the

chance that the lexicon comes to contain pairs of words that are minimally different, i.e., in one segment, such as 'bed' and 'head', increases rapidly as well. Subsequently, the child 'discovers' these minimally differing pairs or, as Locke writes: "the child may perform contrastive analysis quite spontaneously and discover that two names can be different in just one part" (Locke 1988:17). Consequently, the child will segment this part and store it as an autonomous unit.

Locke's proposal seems to be an interesting first approximation to an account of the process of phonemization. However, I think it can count only as a descriptive account, rather than an explanation. Furthermore, I see some conceptual problems. The first of these concerns the apparent conscious, goal-oriented involvement of the child in the process of restructuring the phonological component of the lexicon. The child purportedly 'performs' analyses and 'discovers' similarities. It is not impossible that the child *is* actively involved in this process, but there is as of yet no clear behavioral evidence in favour of it (but see Ferguson & Macken 1982). A second objection that can be raised against Locke's scheme is that it is to be suspected of circularity. Locke refers to minimally contrasting word pairs as pairs differing in only one *segment*; the child discovers that word pairs may have segments in common. Thus, it seems as though the discovery of segments is based on segmented representations.

Another, non-circular account of the phonemization process is devised by Lindblom and his colleagues (Lindblom 1984; Lindblom, MacNeilage & Studdert-Kennedy 1984). The central idea in this proposal is that as the lexicon, i.e., the set of meaningful phonetic signals, increases, segment-oriented phonetic structure emerges 'automatically', through a self-organizing process. The first step in this self-organizing process is the selection of a restricted set of phonetic signals from a virtually unrestricted, continuous population. The selective process is guided by a number of a priori phonetic constraints. For instance, signals should be perceptually salient, and each pair should be optimally distinctive, both articulatorily and perceptually. In summary, the constraints yield 'sufficient perceptual benefits at acceptable articulatory costs'. In a simulation experiment, Lindblom *et al.* defined the population of phonetic signals as a set of 133 CV-syllables. An iterative selection procedure, bounded by a computational implementation of the phonetic constraints (saliency, distinctiveness), was run 133 times, each time with another initial syllable, to generate a lexicon. The eventual lexicon was defined as the set of 24 syllables that was chosen in all or most runs of the selection algorithm. It appeared that the starting point of the selection procedure did not exert a significant effect on the resulting selection: 20 of the 24 items in the lexicon were selected in all 133 runs. The important finding in this simulation was that the 24-item lexicon encompassed several minimal pairs, i.e., syllables which share the consonant part and differ in the vowel part, or vice versa, such as [bu], [du], [gu]. Lindblom (1984) concludes:

since by definition all syllables have distinct meanings we might conclude that according to standard procedures these minimal pairs contain distinct phonemes. The existence of [bu, du, gu] thus appears to suggest that in these derivations /b, d, g/ come out as separate phonemic segments. (Lindblom 1984:74).

The attractive side of Lindblom's proposal, as opposed to that of Locke, is its autonomous and 'mechanistic' character. However, Lindblom's proposal also has a few drawbacks. First, from a psychological perspective, it lacks an account of the cognitive mechanism by which the selection mechanism is implemented. Secondly, the resulting phonemic organization of speech remains *implicit*. Only a structural analysis of the selected lexicon would yield phonemic structure. In (real) adult speakers, however, we find evidence for explicit phonemization. Lindblom admits this shortcoming of the model. He writes:

It is clear that further processing of the selected articulatory gestures is necessary to arrive at explicitly coded phonemic units (Lindblom 1989:41).

In 'real' children, something like the initial selection of 'phonetic signals', i.e., syllabic articulatory routines, can be thought to occur during the stage of repetitive canonical babbling. The onset of repetitive babbling may very well be induced by a maturational process in the brain (MacNeilage & Davis 1989), but comparative studies of normally hearing and hearing-impaired children (Stoel-Gammon & Otomo 1986; Kent, Osberger, Netsell & Goldschmidt-Hustedde 1987) indicate that the development of an extended repertoire of articulatory routines is crucially dependent on auditory feedback. It is quite plausible that auditory feedback enables the babbling child to associate articulatory gestures with their acoustic consequences. These associations may be used to construct a set of articulatory routines that is both articulatory and acoustically optimally distinctive. Moreover, an internal 'map' relating acoustic patterns to articulatory behavior will enable the child to select an inventory of articulatory routines that matches the sound structures of the target language (Vihman 1989).

Phonemization can be interpreted as a kind of categorization: the child learns to treat patterns of relatively variable articulatory-acoustic events as instances of one abstract phonological class, which -by definition- determines meaning distinctions. Phonemization can thus be considered dependent upon the association between form and meaning, as Locke proposes. Moreover, since phonemization appears to be dependent upon the size of the productive lexicon (see preceding section), it seems that 'form' should be taken to include not only acoustic but also articulatory representations.

The child's growing ability to understand words reflects the emergence of associations between acoustic patterns and conceptual representations. Some time after the child has started to understand words, he will start to *use* words as well. Often, children appear to employ articulatory structures that they have acquired as a result of babbling, and that to some extent resemble the intended adult targets, as first approximations to words (Elbers & Ton 1985; Vihman, Macken, Miller, Simmons & Miller 1985). At that time, the three types of associations that seem to be necessary for phonemization are present: (1) associations between articulatory patterns and acoustic patterns, (2) associations between acoustic patterns and concepts; and (3) associations between concepts and articulatory patterns. The question now is, of course, by which mechanism these three sets of associations are interrelated to form phonemic categories. Presumably, a learning connectionist network could succeed. Connectionist networks have been shown to be able to categorize complex

input patterns in a so-called unsupervised way, that is, without explicit instruction. Apart from the fact that phonemization presumably should be envisioned to be implemented at an 'intermediate' level of representation, which is connected to articulatory, acoustic as well as conceptual levels of representation, it is as yet far from clear what kind of architecture and learning algorithms such a network should involve. This I am currently investigating.

Although the mutual interconnection of articulatory, acoustic and conceptual representations may be sufficient to explain phonemization, it seems possible that a fourth factor is involved, viz. morphological development. Several morphological processes, at least in Dutch, particularly inflection such as noun pluralization and verb conjugation are adjoined by resyllabification, e.g. hond (dog) → hon\$den¹; kruip (crawl) → krui\$pen. Resyllabification can only occur if sub-syllabic structure is represented. In other words, the productivity of morpho-phonological processes is crucially dependent upon computations at the level of segments. Thus, it makes sense to state that from a logical point of view, morphological productivity is dependent upon phonemization. From a chronological point of view, however, an alternative interaction between phonological and morphological development is conceivable. It may well be possible that the acquisition of morphological rules 'drives' the phonemization process. In other words, the acquisition of morpho-phonology may facilitate the analysis of 'holistic' word form representation into segment strings. Of course, the viability of this hypothesis should be evaluated in empirical studies of the (temporal) relation between phonological and morphological development.

Phonological development and autosegmental phonology

The 'classical' description of phonological development in terms of phonemes and phoneme contrasts is congenial to the 'classical' so-called 'linear' phonology. Recent phonological models, however, no longer assume that phonological representations are unidimensional, linear strings of segments and boundaries. Autosegmental phonology proposes that phonological representations consist of several autonomous levels of representations which are called *tiers*. Each tier is assumed to contain abstract representations of a certain aspect of phonological structure, for instance tone, rhythm, syllable structure, et cetera (van der Hulst & Smith 1982). Usually, it is assumed that all tiers are associated to a central tier that is built from abstract timing slots ('beats'). The pattern of the association lines that connect tiers to this so-called skeleton determines the relative timing of articulatory realization of phonological attributes. Autosegmental representations adequately deal with supra-segmental processes such as tone, intonation and stress, as well as with sub-segmental processes such as vowel- and consonant harmony. Hence, the formalism of autosegmental phonology seems to be felicitous for the description of child phonology (Menn 1978).

A somewhat eccentric variety of autosegmental phonology is *articulatory phonology*, developed by Browman & Goldstein (1989). In this theory, phonological representations of words are bundles of articulatory gestures. Gestures are represented as parameters of

¹ Additionally, the acquisition of morphologically related words, involving morpho-phonological patterns such as the [t]-[d] ([hɔnt]-[hɔndən]) alternation in this example, may enable the child to derive adequate underlying phonological representations of morphemes (cf. Mohanan 1986).

coordinated movements of groups of articulators. Three major groups of articulators are distinguished: the *laryngeal* system, the *velic* system and the *oral* system. The latter is further subdivided into the *tongue body* system, the *tongue tip* system, and the *lips*. The laryngeal system is responsible for the traditional distinction between voiced and unvoiced sounds (one parameter). The velic system determines nasality (one parameter), and the oral system determines the classical place and manner features (two parameters: place of constriction and amount of constriction).

Browman and Goldstein propose that the parameters for the laryngeal, velic and three oral systems correspond to autosegmental tiers. In this case, a tier can be likened to a line in a musical score. Thus phonological representations not only indicate the lay-out, and presence or absence of gestures, but also their temporal extension and overlap. Both of these factors contribute to phonological contrasts. Furthermore, Browman and Goldstein argue that various patterns of gestural overlap can account in a homogeneous manner for quite diverse phonological processes such as assimilation, deletion and insertion. In contrast to most autosegmental models, articulatory phonology neither encompasses a 'skeleton' of timing slots, nor association lines between tiers. Time is implicitly represented: all gestures have an intrinsic temporal extension and are temporally aligned with reference to a common, albeit implicit, time scale. Thus, articulatory phonology lacks a level of *segmental* (phonemic) organization. Consequently, it seems incompatible with most of the behavioral evidence for the segmental organization of speech in adult speakers.

On the other hand, the lack of a segmental tier (skeleton) renders the model particularly adequate for the description of phonological representations in beginning speakers. The 'phonological processes' in early child speech, such as substitution and assimilation, which reflect the discrepancy between adult word forms and children's renderings, might be construed as omissions of gestures, alterations and temporal shifts of gestural parameters or, perhaps, as results of particular constraints on gestural co-ordination, which may be a reflection of anatomical or motor immaturity. For instance, young children tend to voice consonants when they precede a vowel, e.g., *paper* → [be:bə] (Ingram 1986). Such behavior can be interpreted as an instance of increased overlap of laryngeal (voice) and oral (labial closure) gestures. Also, assimilations of apical consonants to neighbouring velar consonants, e.g., *duck* → [gʌk], can be interpreted as the perceptual result of overlap between tongue tip and tongue body gestures, such that the acoustic result of the tongue tip gesture is 'hidden' (cf., Browman & Goldstein 1989:12).

The phonemization of the lexicon might, in phonological terms, be seen as the 'addition' of a skeleton tier to the phonological representation. Such a transition would amount to the development of explicit rather than implicit coding of the temporal interrelationships of tier-representations. In connection to the discussion in the previous section, it might be conjectured that explicit time coding in phonological representations arises as a consequence of the detection of correlations between differences at the level of meaning and differences at the level of the temporal organization of speech signals.

6.3.2 DEVELOPMENT OF WORD MEANING REPRESENTATIONS

The child's early conceptualizations seem to be organized around its own actions with or upon entities in the world. Representations of actions or 'schemata' are the buds from which the eventual conceptual structure grows (cf., Piaget 1954). Nelson (1983) argues that in the first few years of life, the child's conceptualization of the world is broken down along the lines of 'events'. Events typically involve an action schema, one or several persons and/or objects with which or upon which the action is performed, as well as an indication of, for instance, the situation or context in which the action usually takes place. Consequently, objects and persons are, in the child's mind, characterized by the events in which they may figure. For instance, the concept 'ball' may be characterized by its privilege to figure in a ball playing scheme, which can be thought to typically involve, apart from the child himself; a particular adult, say the father; a typical action, e.g., rolling from one person to another, as well as typical situational context, say 'in-the-garden'. Thus, 'ball' is defined as the object, or one of the objects which functions in the described event. This model would be corroborated by observations to the effect that if the child is given a ball in the right circumstances, it will immediately signal its expectancy of the remaining parts of the scheme to be acted out. Such observations are indeed the rule rather than the exception in young children,

The child's first words are closely linked to these 'event' representations. Gopnik (1984) writes:

There are several common characteristics of the concepts encoded by these early words [such as *gone*, *more*, *no*, and spatial expressions, F.W.]. These concepts involve plans, they involve actions that are performed on objects in order to achieve goals. (Gopnik 1984: 173)

When applied to initial substantial word meanings, the above sketch of conceptual representation accords with what has been labeled the 'Functional Core Hypothesis' of semantic development (Nelson 1974), which states that early words are labels to elements in event representations. This is supported by observations that children in the first phase of language development tend to mix up words which refer to referents with identical or similar 'event privileges'. In the above example, one could expect the child to confuse the words 'ball' and 'car', if toy cars could also appear in the event representation sketched above. The intimate connection between words and events may also be exemplified by children's responses to words, as in the case of a girl who reacted to the word 'bath' by performing all of the actions that are typically associated with a bathing episode (Church 1961, cited in Nelson 1983).

Thus, it seems that in the beginning speaker word meaning representations, or semantic representations, are not yet differentiated from, say, the 'general knowledge store' (Smith 1988). In other words, lexico-semantic knowledge is not yet differentiated from 'encyclopedic' knowledge (Clark & Clark 1977). The question that has to be posed in the present context is, of course, which consequences for language production this might have. Moreover, one would like to know both when and how the transformation to the mature state

takes place and which effects on the production of language might be expected to be associated with this transformation

As long as word meaning representations are not differentiated from general conceptual representations, there cannot be something like a 'semantic network' in which word meaning representations are interconnected according to the similarities in semantic structure. Rather, if relations between word meanings exist at all, they are mediated by shared encyclopedic knowledge. Thus, we would expect the patterns of lexical errors in beginning speakers to differ in a qualitative way from those in mature speakers. Misselections in immature speakers would be expected to depend on the associations of the words with the same or related event representations, rather than on semantic relations. In Chapter 3 several of such 'episodic' errors were presented. It should be noted that episodically mediated lexical errors are not ruled out in mature speakers, we need only think of the so-called Freudian slips of the tongue. The point here is that given the hypothesis of 'event based conceptual representations, it is the only sort of lexical confusion that can be expected to occur in beginning speakers

It is, as of yet, a matter of debate *when* the transition to a more mature, semantically based word-meaning store takes place. Werner & Kaplan observed that

To be sure, this development from vocables as concrete names to vocables as words carrying a full *categorical significance* is only begun at the two-vocable level, it cannot be fully realized and consummated before true grammatical and syntactical formants and notions become available as concomitants of sentence structuring. The emergence of such categorical names (as one may call them) at the two-vocable level might well be considered as a preparatory stage, necessary for the full-fledged articulation of experience via 'words as constituents of sentences' (Werner & Kaplan 1963: 144, emphasis mine)

A phenomenon which may be thought to bear some relevance to this issue is the so-called paradigmatic shift in ontogenetical studies of word association, of which Petry's (1977) study is a fine example. Petry found that young children tend to produce response words in association tasks that can be thought to plausibly combine with the stimulus words in an utterance. Such reactions are called 'syntagmatic', e.g. fork → eat, bed → sleep. Petry pushed beyond this finding and analyzed the precise relations of the stimulus-response pairs. She observed that many of these were highly idiosyncratic, but that they shared the characteristic of 'highlighting' salient aspects of canonical events in everyday life. Petry interprets these findings as supportive of the notion of 'episodic' word meaning representations, which can be likened to Nelson's 'event representations'. The so-called paradigmatic shift in word association appears to occur around age 6. After this age, children's word associations rapidly acquire a mature flavour, which is characterized by so-called 'paradigmatic' stimulus-response relations, e.g. doctor → nurse, dog → cat.

This finding would indicate that semantic word representations are not attained until the age of 6, i.e. long after the child has reached the two-word stage. However, some other findings, reported by Bowerman (1978), are more in line with Werner & Kaplan's suggestions. Bowerman observed occasional lexical errors in her two daughters, who were between 2 and 4 years of age at the time of observation. These errors consisted of

substitutions of words which, from an adult point of view, were highly related, e.g., 'put' for 'make' and 'behind' for 'after'. The errors could not be due to sheer 'ignorance', since the words involved were known to have been used quite correctly for a certain amount of time, several weeks or months. Bowerman therefore argues that they should be likened to 'slips-of-the-tongue', i.e., errors of lexical retrieval, due to the simultaneous activation of several, related words. Such simultaneous activation could of course only occur if the involved words are represented in close connection to one another. Thus these errors bear witness to the fact that children as young as 2-4 may have started to construct semantic networks. In fact, Bowerman argues that the apparent increase of such substitution errors (although correct use always prevails) indicates that 2 to 4 year old children are in the middle of a process of organizing the mental lexicon in terms of semantic features. Also, studies of the development of metaphoric word use (Elbers 1988a) indicate that children may start producing lexical metaphors as young as 2½ years. Since, as is argued by Elbers, the metaphoric use of words is dependent on the availability of a de-contextualized, paradigmatic organization of lexical meaning (as well as on the ability to manipulate this organization), this observation would support Bowerman's conclusion.

The reason for the apparent disagreement between Bowerman's results and the results of Petry's and analogous studies should be sought in the manner in which the data were acquired. Bowerman's data refer to naturally occurring phenomena, which are observed during the child's normal application of his language skills. Petry's data, on the other hand, are the result of an experimental technique which requires a good deal of metalinguistic ability on the part of the child. It is generally assumed that metalinguistic abilities develop late (Schaerlaekens & Gillis 1987). Moreover, from an ontogenetical point of view, the relation between the development of primary linguistic knowledge and skills and metalinguistic skills is a precarious one. Karmiloff-Smith (1986) conjectured that knowledge that is acquired later within the framework of primary language skills, is also later available for conscious inspection or manipulation in the framework of metalinguistic processes. Thus, it could be that at a certain age, say 4 years, semantic representations are already operational at the level of primary production processes but cannot be intentionally inspected or manipulated at the level of metalinguistic processing which is involved in word association, or other experimental paradigms. Such a hypothesis would reconcile the paradoxical results.

A semantic representation in mature speakers encompasses the conditions that have to be met by the conceptual representation for a word to be selected. These conditions necessarily represent the set of characteristics that is shared by all conceptual representations to which a word may refer. Thus, the acquisition of semantic representations can be considered a form of categorization (see the Werner & Kaplan quotation above). It is not known how such a categorization proceeds. It is not implausible, though, that learning the meaning of words in terms of the meaning of other words may contribute to the loosening of the tight bonds between word meaning and world (encyclopedic) knowledge. It is clear that when a minimally sufficient set of words has been acquired, subsequent meanings can be learned by reference to these basic words. Thus, whereas initially word meanings are learned by

'experiencing' the perceptual and functional qualities of their referents, later acquisitions may be 'language-internal' (Van Bekkum & De Vries 1980; Van Loon-Vervoorn 1989). For instance, children may learn the meaning of 'dog' by seeing, feeling and manipulating the animal, whereas the word 'wolf' may be learned through someone explaining that it refers to an animal which resembles a dog but is wild and more dangerous. Van Loon-Vervoorn (1989) has demonstrated that a differentiation of words along the lines of these two types of meaning acquisition provides valid predictions with regard to word processing in normal adults as well as lexical loss and recovery in aphasics. It is not implausible that learning words in terms of other words facilitates categorization, which is a prerequisite for the development of autonomous semantic representations.

6.3.3 THE ONTOGENETICAL DISSOCIATION OF MEANING AND FORM

It has been suggested that in the young child acquiring her first words, names for things are features of these objects' representations in the child's mind. In other words, the beginning speaker seems to treat the name of a referent on a par with other, e.g., physical, attributes, rather than as an arbitrary label. Thus, to a child a 'chair' may be a four-legged contraption to sit on, which sounds as [tʃe:r] (cf., Werner & Kaplan 1963). From the perspective of language processing, this conjecture might be interpreted by stating that beginning conceptual representations and word form representations are closely connected, so that processing of conceptual information and processing of form information are highly interactive (i.e., non-autonomous). A strong connection between conceptual and formal levels of representation in children as compared to adults does not seem to be fully unexpected, given the absence of 'intermediate' semantic and phonological representations. Moreover, there appears to be some supportive evidence.

Hoff-Ginsberg (1983) reported on a number of sound-based errors in 1 to 2 year old children. She observed several instances of phonological blending (two word forms merging into one intermediate form) and homonym strategy (employing one articulatory pattern for several meanings). In contrast to other researchers who also observed these phenomena (e.g., Vihman 1981), Hoff-Ginsberg paid attention to the semantic side of these errors. She argued that these apparently pure phonological processes have corollaries in the conceptual sphere. As an example in point, Hoff-Ginsberg mentioned an episode in which a child who had been observed 'merging' the word forms for 'clock' and 'cat' was found pointing to a clock, uttering the onomatopoeic 'mew'. Furthermore, she observed conversations between children in which an apparent misidentification of a word led to an abrupt shift of the topic of conversation toward something related to the concept referred to by the intruding word, without apparent distress in either of the juvenile interlocutors. These findings suggest that in beginning speakers (and hearers, for that matter) similarity in form may imply similarity, or rather associatedness in meaning.

Another type of evidence is reported in a paper by Camarata & Leonard (1986). These authors studied the relation between conceptual complexity and phonological accuracy in the

production of utterances. They taught a group of 2-year-old children a set of 20 nonsense words, of which one half referred to objects, and the other half referred to actions. The sound structures of the experimental words were adapted to each child's phonetic abilities. It has been suggested that action words, by virtue of their being relational, are conceptually more complicated than words referring to objects (cf., Gentner 1978). Camarata and Leonard evaluated the phonological accuracy of renderings of these neologisms in a free recall task, by computing the mean ratio of correctly produced consonants to the total number of consonants. It was found that the average value of this accuracy metric was significantly lower in action words than in object words. This finding can be taken as an indication that during the programming of utterances in beginning speakers, the retrieval of conceptual representations and the activation of word form representations are tightly interconnected, if only from a temporal point of view. Thus, the high amount of processing capacity that has to be invested in the selection of an action word is detrimental for the unpacking of the related phonological form. Chapter 3 presented findings that point in the same direction. It appeared that in word substitutions that were diagnosed as 'conceptually' triggered, the words involved shared form characteristics of a prosodic nature to a degree that could not be expected by chance. Consequently, these errors can be thought to be constrained by form characteristics, which implies that the retrieval of conceptual representations and of form representations are closely interconnected.

It may be concluded that the developmentalists' conjecture summarized in the first paragraph of this section finds some support in analyses of language use and language processing in beginning speakers. Consequently, it is necessary to account for the process of separation' between conceptual representations and form representations. At present, I have no proposal for a solution to this problem. There are some indications, however, as to the age at which this separation may take place. A relevant study is Elbers' (1985) analysis of word finding problems in an almost three year old boy². Elbers argues persuasively that her subject during a particular episode possesses a word form without an associated meaning, viz., 'soldaatjes' (soldiers). At the same time, the subject embarks on repeated attempts to communicate on the subject matter of 'dolfijnen' (dolphins). In the course of these attempts, the child repeatedly produces the 'semantically empty' form 'soldaatjes', as well as some blends of this word with the intended form, i.e., 'soldeine', and shows several characteristics of being in a 'tip-of-the-tongue' state. These observations clearly indicate the autonomy of meaning and form of the words involved, i.e., the end state of the ontogenetical dissociation of word meaning and word form. Hence, I tend to speculate that most of the dissociative process takes place in the third year of life, as a consequence of the phonemization of form representations, and the semantic reorganization of meaning representations.

² This boy is the same as subject T, in the preceding chapters. The episode studied by Elbers was not included in the transcribed corpus used in this study. It occurred near the end of the period of observation that is covered by the analyses in the preceding chapters.

6.4 HOLOPHRASTIC LEXICALIZATION

I assume that the conceptual structures which underlie the beginning speaker's utterances are isomorphous to the child's 'general' conceptual structures; they represent events which evidently encompass more than one (referential) entity. The beginning speaker's utterances, however, contain only one word. Consequently, the child has to 'choose' which conceptual element to lexicalize. I will follow Braine's (1974) proposal for this selection process, which he called *holophrastic lexicalization*. Note that the assumption that the beginning speaker *selects* elements for lexicalization from a composite conceptual representation contrasts with the view that early single-word utterances capture the underlying concept in a 'holistic' manner. The selection hypothesis implies that the words in single-word utterances refer to entities (persons, actions, objects) as well as to their *roles* in the conceptual representation, such as agent, patient and the like (Greenfield & Smith 1976).

Braine suggests that children lexicalize those parts of conceptual representations that fulfill two conditions: (1) the particular part is salient, as compared to other parts; (2) an appropriate word has to be available. The notion of availability is clear enough: of course the child can only lexicalize an element that has been associated to an articulatory pattern. Parenthetically, availability of lexical items is also an influential factor in utterance generation in adult speakers. However, in adults availability does not refer to the absence or presence of words in the lexical store, but to their relative accessibility (Bock & Warren 1985, Bock 1987).

As regards the notion of saliency, Braine does not propose a further operationalization. In adults, it has been established that so called 'human interest' (Levelt 1989) qualities of conceptual entities exert a considerable influence on grammatical mapping, and thus, often, on serial ordering in sentence formulation (Sridhar 1988). These human interest qualities, for instance *humanness*, *change of state*, and *unexpectedness*, appear to be universal. It appears plausible that they, perhaps in collaboration with perceptual attributes, constitute saliency in holophrastic lexicalization.

6.5 TWO-WORD SENTENCES AND BEYOND

The aim of the present section is to propose a model for the developmental transformation of the language production mechanism underlying the transition from one word utterances to multi-word utterances and, eventually, to full-fledged syntactically regular sentences. Traditionally, this is called the 'development of syntax', and consequently my story will begin with a brief historic overview of this field (section 6.5.1). The main issue dividing the field in the past 25 years, and still a matter of hot debate concerns the characterization of early child grammars: are they semantic or syntactic? A problem that is unavoidably brought up in this connection is that of *continuity*. If it is assumed that early grammars are defined as operations on semantically defined categories, this should imply a discontinuity in development, for mature grammars involve rules on syntactically defined units.

Consequently, it should be shown how children derive a syntactically defined grammar from a semantically defined one, which implies the conversion of semantic categories into syntactic categories. If, on the other hand, it can be shown that early child grammars are of a formal syntactic nature, discontinuity is no longer a problem, and we need only to show how children *discover* to which categories words and phrases belong.

It will be argued in section 6.5.2 that from the point of view of the development of sentence production, the issue of semantic vs. syntactic speech need not be one of controversy. Rather, the development of syntactically mature speech is seen as an example of layering: A new, syntactic level of representation is *added* to the conceptual level. In section 6.5.3, it is argued that in connection to syntactic category acquisition, a grammatical encoder is added to the already functioning process of lexical selection. Furthermore, a tentative chronology of the development of the formulator will be provided.

Finally, in section 6.5.4, another issue that has regularly surfaced in studies of child language development, the developmental increase in utterance length, will be discussed from the point of view of the model for the development of the speaker.

6.5.1 EARLY WORD CATEGORIZATION: SEMANTIC OR SYNTACTIC?

The first attempts to formally describe the structure of early multi-word utterances are the well-known 'pivot-grammars', which were based on distributional analyses of two-word utterances. Braine (1963) was the first to notice that a small set of frequent words occurred in fixed positions in two-word utterances. Most of these words fulfilled predicate-like functions, e.g. 'that', 'more', 'allgone', etc. The remaining words were less frequent and did not occur in fixed sentence positions. Most items in this set fulfilled argument functions. Braine called the first type 'pivots', and the second type 'open class'. The majority of the utterances in his corpus could be described by two elementary phrase structure rules:

$$S \rightarrow P + O$$

$$S \rightarrow O + P$$

Several other researchers (e.g. Brown & Bellugi 1964) subsequently noticed comparable patterns in their corpora of early two-word utterances. On the basis of this apparent convergence, McNeill (1966) proclaimed pivot structures a universal of language development, and attempted to describe the gradual differentiation of pivot grammars into full-fledged transformational grammar.

The pivot approach soon proved to be inadequate. Brown (1973) showed, on the basis of the evidence then available, that in some cases pivot grammar specified *more* grammatical classes than was necessary (overdifferentiation), and in other cases specified too small a number of grammatical classes (underdifferentiation). In some cases, pivot grammars were even both overdifferentiated and underdifferentiated with respect to the same set of utterances. The most important criticism, put forth by, among others, Brown (1973), Schaeplaekens (1973) and Bowerman (1973), concerned the inability of pivot grammar to

differentiate between the various intentions that appeared to be expressed by superficially similar utterances

Consequently, alternative approaches to grammatical development were pursued in the early 1970's Bloom (1970) sketched a grammar for a corpus of child utterances in the transformational generative tradition. However, this attempt still incorporated some of the principles (e.g., distributionally defined categories), and, therefore, weaknesses of the pivot approach. Furthermore, it appeared necessary to posit various reduction rules to account for the child's underspecification at surface level of hypothesized underlying intricate syntactic structures, which is both unparsimonious and implausible. The other alternative to pivot grammar (as well as TG-oriented approaches) which received a good deal of attention, attempted to capture the underlying structure of children's early utterances in terms of semantic intentions, which appeared to be derivable from 'rich interpretation' of utterances, exploiting the social and physical context of speaking (Schaerlaekens 1973, Brown 1973). The structure of children's utterances was described in terms of semantic relations (agent, recipient, action, etc.) which are applied to semantically classified words (object-words, action-words, etc.)

The semantic approach dominated the field for quite some time until, recently the syntactic approach to child language was 'revitalized' as a result of developments in linguistic theorizing (Wexler 1982). An important issue regularly brought up by the modern day advocates of a syntactic approach to child grammar is that given the end-state of grammar, which is characterized by operations on syntactic categories, a semantic account of child grammar implies a discontinuity in the development of grammar. At some time during the development of grammar, semantic categories should be replaced by syntactic categories. This hypothesis is not only unparsimonious (it's much simpler to assume that syntactic categories are present from scratch), the 'syntacticians' say, it is also very difficult, if not impossible to account for the transformation of semantic categories into mature syntactic ones (cf., Frijn 1989).

The syntactic approach to child grammar assumes that the input language does not allow the child to learn the syntactic categories (this is one of the embodiments of the 'poverty of the stimulus' argument [see Chomsky 1986]). Rather, it is assumed that syntactic categories are part of universal grammar, and therefore part of the child's biological endowment. One of the proponents of this point of view is Steven Pinker (1984). Pinker's learning theory presupposes that syntactic categories are innate. The employment by children, however, of the 'prototypical' relations between certain semantic categories and certain syntactic categories is not denied. Pinker argues that children are pre-wired to use these relations in order to 'bootstrap' syntactic categorization. Thus the earliest syntactic classes will fully overlap with certain semantic classes, e.g., all nouns refer to objects, all verbs refer to actions, et cetera. The difference between a purely semantic approach and Pinker's assumption resides in the presupposition that, although the initial assignment of words to categories is semantically based, the categories are labeled in syntactic terms, which precludes a developmental discontinuity.

A recent theory of syntactic development proposed by Berman (1988) seems to take a looser stance with respect to the innateness of categories. Berman assumes that before the child begins to assign words to abstract categories, she has to have a vocabulary of some size (note the similarity to arguments in child phonology cited above). This implies that during the initial phases of language development, i.e., in the one-word phase and the early two-word phase, the child's speech is essentially agrammatical. Berman assumes that early sentences at best reflect the functional syntactic distinction between argument and predicate, presumably a universal ('primitive') in language. As in Pinker's proposal, initial assignment of words to abstract categories is dependent upon the words' semantic attributes. The first words to be categorized are those which represent the least marked, or most 'canonical' exemplars of a syntactic category. The 'refinement' of word class distinctions, however, is a lengthy process which involves several substages ('steps'). According to Berman, the child uses various sources of information to reach the eventual 'mature' classification: morpho-syntactic, distributional, lexico-semantic and discursive.

Most approaches to syntactic categorization assume that this process is based on analysis of adult input speech. Alternatively, it may be conjectured that the child uses his own utterances in this process. A hypothesis to this effect was proposed by Hill (1983), in the framework of a computational simulation study of utterance generation in the two-year-old. The essence of Hill's proposal is that abstract classification of words emerges from patterns of compatibility between words in the active lexicon and so-called sentence templates. Initially, (in)compatibility between a word and a template is conceptually mediated, e.g., the word 'fire' is compatible with the template 'show ____', but not with 'give ____'. As the set of words that is compatible with a certain (set of) templates increases, it will become more and more diverse. Eventually, when the set has reached a certain volume, the conceptually defined links between templates and words are replaced by an abstract categorization. An example of how the early phase of such a production-based classification might proceed in a 'real' child is provided by Elbers (1988b).

Irrespective of whether grammatical categories are bootstrapped or constructed by means of a learning procedure, it is clear that a distinction should be made between the major syntactic categories (N, V, A) and the minor syntactic categories (Det, Aux, Conj, etc.). In contrast to major category words, most of the minor words lack canonical relations to semantic classes which are crucial in Pinker's bootstrapping hypothesis, and important cues in learning proposals such as Berman's. In fact both authors seem to converge on the view that since minor category words are members of relatively small, closed sets which are organized along a restricted set of syntactic dimensions, they demand a special kind of acquisition procedure, presumably along the lines of Pinker's proposals for the acquisition of paradigms. At any rate, the distinction between major classes and minor classes is quite evident from the course of language development. Stage I speech (early multi-word utterances) does not seem to contain words that can be assigned to minor classes in the target grammar. These words typically appear after some time of producing multi-word utterances. Their emergence was considered by Brown (1973) as the mark of a new stage (Stage II) in language learning.

6.5.2 THE EMERGENCE OF SYNTAX

Even if early word categories are of a syntactic nature, there seems to be virtually no evidence for *syntactic structure* in early multi-word utterances. Braine (1988) summarizes the available evidence by stating that

At the time that the first word combinations begin to be acquired, the child has a small vocabulary and *no syntax*. (Braine 1988: 236, emphasis mine)

And according to Berman

Language production at the one-word phase and during the period of initial word combinations is largely *agrammatical*. (Berman 1988:51, emphasis mine).

Consequently, it may be concluded that conceptual factors are the primary determinants of sentence structure at this stage of development. At some later stage, the syntactic properties of words come to -additionally- determine the structure of sentences, and from that point in time onward purely syntactic grammars may be considered more successful in modelling the child's linguistic competence.

At what moment in development do the syntactic attributes of words come to be relevant to the process of sentence generation? My guess would be that this moment roughly coincides with the onset of stage II in Brown's (1973) scheme. According to this scheme the transition from stage I to stage II is marked by the appearance of the so-called grammatical morphemes. Brown, and other researchers after him (De Villiers 1978), found that roughly the first 14 grammatical morphemes appear in a reasonably fixed order in the speech of children acquiring English. Soon afterward, distributional evidence for several syntactic categories, including some minor categories is found (Valian 1986, Inhs & Leonard 1988). Moreover, there are suggestions that words that belong to one of the minor classes in the target language that were already present in the child's speech are re-categorized (see Chapter 4). Children's initial syntactic categories do not always fully correspond to those in adults. For instance, children acquiring Dutch initially seem to differentiate V and Aux, and have to collapse these two classes in order to attain the target grammar (De Haan 1986, 1987). Soon afterwards, productive morpho-syntax, hierarchical phrase structure and, eventually, recursivity emerge (Hill 1983).

It is important to note, however, that the emerging syntax, i.e., phrase structure, does not 'drive out' the semantic/conceptual influence on sentence structure. Rather, the emergence of syntax can be seen as an *addition*. A new *layer* is added to the system of representations that determine sentence structure.

6.5.3 THE DEVELOPMENT OF THE FORMULATOR

In view of the above suggestions, I will assume that the lay-out of early multi-word utterances fully depends upon (1) the content of conceptual representations, and (2) the characteristics of a process responsible for the lexicalization of certain entities in this conceptual representation. Just as in the case of single-word utterances, the conceptual

representations underlying early multi-word utterances are assumed to be 'event-representations' which were discussed above. Hence, the developmental transition from single-word utterances to multi-word utterances does not imply a change in the child's capacity to construct conceptual representations. The difference is that children start to lexicalize more than one part of the conceptual representation. This may be due to a relatively autonomous development in the ability to store and prepare several lexical units for output within a cohesive prosodic format, as the findings of Dore, Franklin, Miller and Ramer (1976) suggest. With Braine (1974) I assume, however, that the determinants of lexicalization are still the same as those in the single-word stage: availability and saliency.

The implication of the above proposal is that Stage I children do not use a grammar at all, not even a semantic relations grammar. The semantic relations that can be discerned in early multi-word utterances simply reflect the event structure of the underlying conceptual representation (cf., Elbers 1988b). For instance, if the child happens to lexicalize a part of an event representation which represents a person performing an action, as well as the part representing the action itself, an observer will note an 'agent-action' relation. Thus early multi-word utterances do not reflect any truly linguistic structure. This was already suggested by Schlesinger in 1971. Schlesinger, who calls conceptual representations that underlie utterances 'I-markers', writes

I-markers are determined by the innate cognitive capacity of the child. There is nothing specifically linguistic about this capacity [] It is just the way the child views the world, and will be the same whether he learns to speak, or fails to learn to speak due to some organic or environmental handicap (Schlesinger 1971: 70)

Golinkoff (1981) describes several experimental results which strongly indicate that one- and two-year old children 'view the world' in terms of action roles. Moreover, Golinkoff reviews evidence which underscores the similarity of 'semantic' relations such as *agent*, *location*, *possessor*, and *recurrence* in conceptualization, as well as in language production and comprehension. This supports the assumption that, indeed, the so-called semantic roles and relations in Stage I in fact reflect general cognitive categories.

Although there are no clear indications of the productivity of syntax during Stage I, I will assume that children are nevertheless involved in the process of either 'learning' or 'bootstrapping' syntactic categories, N and V in particular (Berman 1988). This implies that at some point in time most words in the child's vocabulary are assigned to a syntactic category. Now, according to an inductive learning proposal à la Pinker (1984) the child starts to employ this knowledge to synthesize phrase structure rules. In a semantic-distributional learning model à la Maratsos & Chalkley (1982), acquisition of phrase structure and syntactic category acquisition are almost synonymous, and in the parameter setting framework, it would seem reasonable that given the fact that phrase structure is an integral part of UG, as X-bar theory holds, children would automatically know the phrase structures associated with the syntactic categories (heads) that they acquire, given a sufficient amount of input to set the relevant parameters. At any rate, phrase structure rules become available upon the acquisition of syntactic categories.

For language production, this would imply that the process of sentence construction has to be enriched with 'subroutines' which construct phrases according to phrase structure syntax. These subroutines are the roots of the grammatical encoder. It is absolutely unclear how this process should be envisioned, but this is not important for the present argument. What is important is that a new component is added to the 'ontogenetically old' process of holophrastic lexicalization. Thus, it can be assumed that the first step in sentence generation still consists of the selection of words which refer to aspects of an intended concept that are salient, in some way or another. A new step (layer) is added to this process, however, viz., the construction of phrases on the basis of the newly acquired syntactic class information in lexical entries. Note that as soon as phrase building subroutines are added to the sentence construction process, many words belonging to the so-called minor classes are accessed and selected on the basis of syntactic specifications generated by phrase structure subroutines. Many of the minor class words that are 'prescribed' by phrase structure rules, or: phrase subroutines, e.g. determiners, may not yet be available in the child's lexicon. Consequently, their places may be filled with empty 'place holders', such as the frequently observed schwa. At the same time, the child may start to actively search for words in the input language that are appropriate candidates for these 'unfilled' classes. It has been established that if the input language does not provide such words, as seems to be the case in pidgins, children 'invent' their own closed-class vocabulary (and thus contribute to the process of creolization, see Bickerton 1984).

The relative timing of the acquisition of syntactic categories, and the consequent emergence of grammatical encoding routines, with respect to the other changes in the lexicon, i.e., the development of semantic representations and phonemization, as well as the emergence of phonological encoding, is not known. It may, however, be deduced to some extent. Phonemization was argued to start when the child's productive lexicon contains about 50-100 items. This size is reached somewhere between ages 1;6 and 2;0 (Griffiths 1986). The onset of the development of the phonological processor will, by necessity, occur at roughly the same time. As regards the development of (categorical) semantic representations, I will follow Werner & Kaplan's (1963) suggestion that this process starts in the two word stage, somewhere around age 2;0.

It may take a considerable amount of time before these developments are 'completed'. Nevertheless, it is not unrealistic to assume that with the emergence of syntactic categories and the emergence of grammatical encoding, which may be approximately placed at age 2;6, the formulating process approaches its ultimate lay-out. Conceptual structures determine the activation and selection of lemmata (lexical selection), which activate phrase building routines (grammatical encoding). Subsequently, word forms are connected to lemmata at the end nodes of syntactic representations, and surface structures are phonologically 'filled out' and adapted (phonological encoding). In summary, the grammatical encoder seems to be the last component in this mechanism to develop. This reorganization of the speech production mechanism and its overt consequences in the form of disfluencies was referred to in Chapter 4, although in a somewhat different terminology.

6 5 4 INCREASING UTTERANCE LENGTH

The problem of why children's utterances are so short has bothered quite a number of child language researchers. One of the proposed solutions to this problem is that children have limited central processing resources, such as 'attention' and 'working memory', and that the increase of sentence length should be ascribed to the gradual alleviation of this limitation. This solution is only partially satisfactory. Although it might be true that children's working memories are more limited than adults', it seems to presume that language generation processes in mature speakers are fully dependent upon central processing resources. This is -by and large- incorrect. The model presented in Chapter 1 assumes that language formulation and articulation are subserved by modular processors, which are largely independent from central processing resources.

The key word to what is probably a better solution to the problem of increasing utterance length is *automatization*. R. Clark wrote

Language () is a complex skill and in the young child, no single aspect of the skill is automatic. Levels of performance in any one aspect of the skill will be subject to decline under the stress of grappling with some other novel aspects of performance. (R. Clark 1982: 13)

In terms of the approach presented here, the processing components of the speech production mechanism are not yet automatized in the beginning/developing speaker. They are, to some extent, dependent on central processing resources, i.e., attention and working memory. For short, they are not yet *modular*.

Automatization of the components of the production system is a developmental process. Eventually, it enables *incremental* production, which amounts to doing several different things at the same time, and, in effect, without attending to it. It is clear that non-incremental, non-modular speech programming effectively limits the amount of information that can be processed at a time, given a limited amount of processing resources, which results in reduced utterance lengths. A modular, incremental mechanism, on the other hand, allows for the generation of utterances which fully capture all aspects of -even very complex- conceptual representations. Moreover, an incremental modular system guarantees fast and fluent speech delivery.

Presumably, in order to become modular, i.e., automatic and independent from attentive control, processors need practising. The relation between repeatedly using a particular sentence frame and the decline of disfluency described in Chapter 4 is a case in point. It has been suggested that stuttering, i.e., long-lasting or 'chronic' speech disfluency, is -at least partially- related to insufficient automatization of speech production processes. Arends, Povel & Kolk (1988) investigated the effects of the complexity of a speech task and distraction by a parallel non-speech task on the amount of disfluency in moderate and severe stutterers. One of their results was that as the speech task involved more complex cognitive operations (story telling as opposed to counting), the amount of disfluency increased. This tendency was greater in severe stutterers than in moderate stutterers. This finding suggests that the less fluent a speaker, the more susceptible his speech production processes are to the

interference of -attention-demanding- parallel (cognitive) operations, which supports the conjecture that speech production processes are insufficiently automatized in stutterers.

6.6 SELF-MONITORING

Indisputably, adequate speech production in adults relies on perceptual feedback. It seems plausible that the same holds for the developing speaker. The question is, however, whether perceptual feedback has a part in the *development* of speaking abilities. In the previous sections of this chapter, some developmental processes were described in which auditory feedback of speech was suggested to contribute to the development of the speech production system. The creation of a stock of articulatory routines from which, eventually, initial word-forms are taken, was a case in point. This process was assumed to take place during repetitive babbling, which has been shown to depend on auditory feedback. Also, phonemization may be dependent upon the association of articulatory gestures with the resulting acoustic patterns via auditory feedback. Finally, a hypothesis was presented to the effect that syntactic categorization is dependent upon the production of word combinations. It seems reasonable to assume that perception/comprehension of the self-produced utterances is a necessary step in such a learning scheme.

In the above examples, mere self-monitoring, i.e., perception and processing of the own speech output, appears to be the effective factor. By contrast, self-monitoring may often be only instrumental in a process by which speech output is compared to a particular standard (evaluation) and, if necessary, revised. Chapter 5 addressed the question of whether self-monitoring, in combination with evaluating, may function as an 'updating' process: a mechanism that generates new, more adult-like versions of the language system, by comparing the current output to an adult-based model. Unfortunately, the data were not unequivocal. It was suggested that self-corrections do not have an updating function. Two other types of monitoring-based speech revisions are not unlikely to have a developmental function. However, they seem to be primarily explorative, rather than straightforwardly heading toward the adult model.

It has been suggested that self-monitoring, evaluating and speech revision are the ontogenetic 'roots' of a more general class of 'metalinguistic' behavior (Karmiloff-Smith 1986). Levelt (1973) has argued that linguistic competence, as described by linguistic theories, can be viewed as theories of metalinguistic behavior. The primary data of the linguist, linguistic intuitions, are, according to Levelt, judgments of the possibility to utter particular sentences in certain situations, i.e., metalinguistic statements. Thus, competence might be seen as a 'state', i.e., a temporary condition that results from something like (covert) speech monitoring, rather than as a 'trait', i.e., a structural component of the mind. From this perspective, linguistic competence may be seen as an outcome of the development of speech production and comprehension, rather than as an underlying determinant (cf., Straight 1982).

6.7 FINAL REMARKS

In this chapter I argued that the beginning speaker differs from the mature speaker in a quantitative as well as in a qualitative way. As regards the quantitative difference: the beginning speaker can be considered as a 'subset' of the mature speaker. It was argued that in the course of development, this quantitative difference diminishes, as new levels of representation and processors are inserted 'in between' the conceptual and articulatory levels. This was called 'layering'. As regards the qualitative difference, I attempted to show that the beginning speaker lacks the properties modularity, hierarchy and incremental function. These are gradually attained in the course of development.

It will not have escaped the reader's notice that the treatment of the development of speech production in this chapter showed quite a few lacunae. Not a word was said about the production of speech prosody and its development. The development of morphology was only very scantily alluded to. Most importantly, the central developmental concept, layering, clearly needs further elaboration. In particular, the nature of the processes underlying the creation of new layers needs to be clarified.

Finally it is clear that whereas some of the hypotheses in the model are supported by (some) empirical evidence, others are largely speculative. The latter may be seen as rough working hypotheses for future research.

The general question that is addressed in this dissertation can be read like this: "do language production mechanisms change during the period in which language is acquired?". It is often assumed in developmental psycholinguistics that language development comprises the 'accumulation' of knowledge in a cognitive processing system that does not principally differ from the adult system. The research reported here can be seen as an attempt to investigate this *null-hypothesis*. On the basis of analyses of young children's speech delivery, accounts are proposed of various aspects of their language production mechanisms. These accounts are compared to what is known about the language production mechanisms in adults. It will not come as a surprise that the answer to the general question pointed out above is partially affirmative and partially negative. Some aspects of language production, e.g., articulation, seem to be developmentally invariant. However, in several respects, e.g., the planning of sentence structure and the processing of word forms, there appear to be qualitative differences between language production in young children and adults. As regards the latter cases, propositions on the nature of the developmental transitions are provided.

Chapter 1 presents a rough picture of the language production apparatus in adults. This picture is based on a 'classical', information-processing model of linguistic processing. The production of spoken language is assumed to comprise three discrete processors: the Conceptualizer, which generates (non-verbal) message representations, the Formulator, which builds sentence structures (grammatical encoding), and turns these into phonetic representations (phonological encoding), and the Articulator, which translates phonetic representations into motor commands for the articulatory apparatus. It is assumed that the system has a *modular* organization, that information flows -by and large- in one direction: from the *top down*, and that the processors work simultaneously, in an *incremental* fashion.

The chapters 2 up to and including 5 form the empirical core of this dissertation. Each chapter describes a study of a particular aspect of speech delivery. In general, the analyses focus on the moments where speech delivery breaks down: hesitations, self-corrections, speech errors and the like. Analyses of such phenomena in adults have proven to be very informative with regard to the underlying processes and representations. The subjects in these studies are two boys acquiring Dutch, T and N. The data are derived from transcribed longitudinal samples of their tape-recorded spontaneous speech. For each child, the observation period covered approximately 9 months. T was observed from age 2;4 up to and including 3;0. N was observed between 3;0 and 3;10. The boys' stage of language development may be indicated by their mean lengths of utterances (MLU). T's MLU was 1.9

at the beginning of the longitudinal sample, and 2.9 at the end. For N, the figures are 2.3 (beginning) and 3.9 (end).

Chapter 2 describes so-called *word fragmentations*. Words may be fragmented by either of two hesitatory processes: the repetition of a part, e.g. the initial consonant or first syllable, or the intrusion of a speech pause. In the analyses of these fragmentations, interruptions of speech delivery were distinguished from restarts. Interruptions occurred in monosyllabic as well as in polysyllabic words. In polysyllabic words, interruptions mostly preserved CV(C) units. In these cases, they were followed by *immediate* restarts, i.e., the continuation of speech delivery from the point of interruption onwards. In cases where interruptions distorted CV(C) structure, a high proportion of *retraced* restarts was found. Retraced restarts involved either the word beginning (full retracing) or an intervocalic consonant directly preceding the place of interruption (partial retracing). It is argued that these spontaneous hesitations primarily reflect the characteristics of the articulatory representation. Thus, the results support the hypothesis that syllables correspond to units of information processing in the articulator. In this respect, beginning speakers do not differ from adults. Presumably, the basic syllabic articulatory routines are formed during the stage of repetitive babbling. Supplementary results on the locations of speech interruptions are similar to results of *elicited* syllabification experiments. This seems to indicate that elicited syllabification primarily reflects the articulatory level of processing. The generally reported finding that the ability to fragment words into phonological segments develops later than the ability to syllabify can be explained by the fact that a phonological level of processing emerges later in development.

Chapter 3 deals with the incidental errors in the two speech corpora. Incidental errors are defined as relatively infrequent deviations from the child's current linguistic standard. They are assumed to reflect transitory failures in the process of language production, and may thus provide a window onto the representations and processes involved. The analyses focus on lexical errors and sound errors. Most frequent among the lexical errors are substitutions. In over 60% of these, the words involved are conceptually related. Two types of conceptual relations are found: semantic relations (predominantly co-ordination), and 'episodic' relations. In episodically related substitutions, the targets and the intruding words seem to be related through an association between the persons, objects or events they signify in conceptual representations. About 60% of all lexical substitutions affect function words. When content words are substituted, the intruding word and the substituted word strongly tend to correspond in length and stress-bearing vowel. This tendency is not affected by the presence or absence of a conceptual relation between the involved words. The findings suggest that (1) word meaning representations may to some extent be episodically organized; (2) the retrieval of word meaning and the retrieval of word form may be more closely intertwined in these children than in adults; (3) function words, as a category, are not yet fully differentiated from content words.

Among the sound errors, more than 40% involve substitutions of single *articulatory features*. It is argued that these errors represent failures of articulatory control, i.e., unintentional alterations of gestural parameters. Two other sound error categories, *slur* and

syllable deletion, are argued to arise at the articulatory level as well. Most of these articulatory errors are analogous to 'systematic' phonological processes in younger children. Hence, it is suggested that there is a continuity between simplifying phonological processes in early speech and incidental articulatory errors in somewhat older children. A small proportion (10-20%) of sound errors showed characteristics of misselections or misorderings of phonological segments. This finding is in agreement with the hypothesis that roughly after age 2, phonological segments emerge as constituents of word form representations. Anticipations of phonological segments appeared to be somewhat less frequent than in adults. On the other hand, they mainly involved syllable onsets, and targets and intrusions in contextually determined errors appeared to occur in similar phonological contexts. These findings are similar to those in adults.

Chapter 4 describes the changing pattern of disfluency, in particular: repetitions (of sounds, syllables, words and phrases), sentence interruptions and self-corrections in T as a function of age. The period of observation covers the early phase of the transition from 'pre-grammatical' to grammatical language. This transition is marked by the appearance of function words as a category, and the acquisition of productive morphology and morpho-syntax. The frequency of occurrence of disfluencies shows a significant increase and a subsequent decline, which appears to be a fairly general phenomenon among 2-3 year old children. A new finding, however, is that as the general frequency of disfluency increases, its distributional pattern changes as well. Whereas in the first half of the observation period the distribution of disfluencies over sentence positions is relatively random, they tend to concentrate in function words and sentence-initial words in the second half. It is argued that these findings reflect the emergence of a component in the speech production mechanism that is dedicated to the construction of morpho-syntactically organized sentence structures. Additional supportive evidence for this conjecture comes from the finding that in the second half of the corpus, the decline of disfluency rate is related to an abundant use of particular syntactic frames.

Chapter 5 focuses on three types of speech revisions: self-corrections, replacements and clarifications. Self-corrections are spontaneous revisions which involve an interruption of the ongoing utterance. Replacements are non-hesitatory alterations of preceding utterances and clarifications are revisions upon interlocutors' (non-specific) requests. It is assumed that each type of speech revision is based on three processing steps: *monitoring*, *evaluating* and *repairing*.

The chapter comprises two parts. The first part describes the patterns of *interrupting* and *restarting* in self-corrections. Interruptions are less often delayed than in adults, and if there is a delay, the amount of speech that is uttered between error and interruption is smaller. Moreover, T and N more often interrupt non-erroneous words than adults. As regards restarting, the subjects show a strong preference for instant repairing, i.e., restarting at the location of the reparandum (the error to be repaired). However, this pattern appears to be affected by the location of the reparandum in the sentence: a reparandum in the second word of a sentence is more often associated with an anticipatory retracing than a reparandum in later positions. Retracing cannot cross the sentence onset. Together, these findings do not

indicate that children differ principally from adults as regards monitoring and repairing in self-corrections

The second part of Chapter 5 focuses on *evaluating* in the three types of revision: is the speech that is monitored compared with some internal criterion, and if so, what is the nature of this criterion? The repair operations in each of the three classes of revisions were classified with respect to linguistic level of description (phonological, lexical or syntactic) and analyzed with respect to their effects (improvement vs. non-improvement of the linguistic quality) and developmental trends. In general, self-corrections are more often *progressive*, i.e., yielding utterances that are better from an adult point of view, than replacements and clarifications. On the other hand, in replacements and clarifications, there are some indications that the linguistic level to which repairs are predominantly oriented may shift as a function of age, viz., from phonology to syntax. It is argued that the *coordination theory*, which states that speech revisions are used to 'update' the linguistic system as to approximate adult standards, cannot fully account for these results. It is suggested that self-corrections are used to maintain an optimal level of speech, by matching output to criteria that reflect the child's current competence (matching). In clarifications and replacements, on the other hand, no clear evaluation criterion seems to be involved. Rather, these revisions can be seen as 'drafts'. They may serve to explore or practise language.

In the final chapter, an account of the development of language production mechanisms is proposed, which integrates the results of the four empirical studies as well as various findings in the developmental psycholinguistic literature. It is argued that the language production apparatus in the *beginning speaker* (the child that has just started to produce single-word utterances) is a 'subset' of that of the adult. It comprises three levels of processing: Conceptualizing, Lexical selection and Articulation. The mature system is approximated by the emergence of 'new' levels of processing in between the conceptual level at the top, and the articulatory level at the bottom. This is called *layering*. The emergence of processing structure is held to be dependent upon the growth of knowledge at the level of lexical items. Thus, for instance, phonological encoding arises in connection to the acquisition of word form representations that comprise segments, 'on top' of the level of articulatory routines. The development of grammatical encoding depends on the acquisition of syntactic categories. It is suggested that the language production apparatus in the beginning speaker is not yet *modular*, nor *hierarchical*, and incapable of parallel (incremental) functioning. These attributes are gradually attained in the course of development.

De algemene vraag die in dit proefschrift aan de orde wordt gesteld luidt als volgt: "veranderen taalproductiemechanismen gedurende de periode waarin de taal verworven wordt?". Er wordt in de ontwikkelingspsycholinguïstiek vaak verondersteld dat taalverwerving neerkomt op de accumulatie van kennis in een cognitief verwerkingssysteem dat zich niet principiëel onderscheidt van dat van volwassenen. Het onderzoek dat hier gerapporteerd wordt kan beschouwd worden als een poging om deze *nul-hypothese* te toetsen. Op grond van analyses van de spraak-uitvoer van jonge kinderen worden beschrijvingen van verschillende aspecten van hun taalproductiemechanismen voorgesteld. Deze beschrijvingen worden vergeleken met wat bekend is over taalproductiemechanismen bij volwassenen. Het is waarschijnlijk niet verrassend dat het antwoord op de hierboven gestelde vraag gedeeltelijk bevestigend, en gedeeltelijk ontkennend luidt. Bepaalde onderdelen van de taalproductie, bijvoorbeeld de articulatie, lijken invariant te zijn over de ontwikkeling. In andere opzichten echter, bijvoorbeeld de planning van zinsstructuur en de verwerking van woordvormen, lijken er kwalitatieve verschillen te zijn tussen taalproductie bij jonge kinderen en bij volwassenen. In de laatstgenoemde gevallen worden er voorstellen gedaan over de aard van de veranderingen tijdens de ontwikkeling.

Hoofdstuk 1 schetst een beeld van het taalproductie-apparaat van volwassenen. Dit beeld is gebaseerd op een 'klassiek' informatie-verwerkingsmodel van taalverwerking. Er wordt aangenomen dat de productie van gesproken taal berust op drie discrete processoren: de Conceptualizator, die (non-verbale) boodschappen genereert, de Formulator, die zinsstructuren bouwt (grammaticale encoding), en deze in fonetische representaties vertaalt (fonologische encoding), en de Articulator, die fonetische representaties omzet in motor-commando's voor de articulatoren. Er wordt verondersteld dat het systeem *modulair* georganiseerd is; dat de informatie in grote trekken in één richting verwerkt wordt, van 'boven' naar 'beneden'; en dat de processoren op een *incrementele* wijze functioneren.

De hoofdstukken 2 tot en met 5 vormen de empirische kern van dit proefschrift. Elk hoofdstuk beschrijft een onderzoek van een bepaald aspect van de spraak-uitvoer. Over het algemeen zijn de analyses gericht op momenten tijdens het spreken waar de uitvoer niet goed verloopt: aarzelingen, zelf-correcties, versprekingen en dergelijke. Analyses van zulke voorvallen bij volwassenen blijken buitengewoon informatief te zijn met betrekking tot onderliggende processen en representaties. De proefpersonen in deze onderzoeken zijn twee jongens die Nederlands leren spreken, T en N. De data zijn afgeleid uit getranscribeerde longitudinale samples van hun op band opgenomen spontane spraak. Bij elke kind omvat de

observatieperiode ongeveer 9 maanden. T werd geobserveerd tussen 2;4 (jaar;maand) en 3;0; N tussen 3;0 en 3;10. De taalontwikkelings-stadia kunnen worden aangegeven door middel van de gemiddelde uitingslengten in morfemen (mean lengths of utterances: MLU). T's MLU was 1.9 aan het begin van de longitudinale steekproef, en 2.9 aan het eind. Voor N zijn de waarden 2.3 (begin) en 3.9 (eind).

Hoofdstuk 2 gaat over zogenoemde *woordfragmentaties*. Woorden kunnen gefragmenteerd worden bij twee typen van aarzelingen: herhaling van een woorddeel, bijvoorbeeld de beginconsonant of de eerste syllabe, en intrusie van een spreekpauze. Bij de analyse van deze fragmentaties werd onderscheid gemaakt tussen interrupties en hernemingen (restarts). Interrupties kwamen zowel in monosyllabische als in polysyllabische woorden voor. Interrupties in polysyllabische woorden lieten CV(C) eenheden meestal intact. In deze gevallen werden ze gevolgd door *onmiddellijke* hernemingen, d.w.z. precies vanaf het punt van interruptie. In de gevallen waar interrupties de CV(C) structuur verstoorden werd een groot aantal terugkerende hernemingen (retraced restarts) aangetroffen. Zulke hernemingen gaan ofwel terug naar het woordbegin (full retracing), ofwel naar een intervocalische consonant die direct voorafgaat aan het punt van interruptie (partial retracing). Er wordt geargumenteed dat deze spontane aarzelingen primair de eigenschappen van de articulatorische uitvoer reflecteren. De resultaten kunnen derhalve beschouwd worden als steun voor de veronderstelling dat syllaben corresponderen met eenheden van informatieverwerking op het nivo van de articulator. In dit opzicht verschillen beginnende sprekers niet van volwassenen. Vermoedelijk worden elementaire syllabische articulatorische routines gevormd tijdens de het stadium van repetitief brabbelen. De overige resultaten met betrekking tot de locaties van interrupties komen overeen met resultaten van *uitgelokte* syllabificatie-experimenten. Dit lijkt er op te duiden dat uitgelokte syllabificatie voornamelijk het articulatorisch verwerkings-nivo weerspiegelt. De algemene bevinding dat het vermogen om woorden in fonologische segmenten te verdelen later tot ontwikkeling komt dan het vermogen tot syllabificatie kan verklaard worden door aan te nemen dat het fonologische verwerkingsnivo later in de ontwikkeling ontstaat.

Hoofdstuk 3 behandelt de incidentele fouten in de twee spraakcorpora. Incidentele fouten worden gedefinieerd als relatief infrequente afwijkingen van het courante taalgebruik van het kind. De veronderstelling is dat ze tijdelijke gebreken in het taalproductieproces weerspiegelen, en zo een venster op de betrokken representaties en processen bieden. De analyses zijn gericht op lexicale fouten en klankfouten. De meest frequente lexicale fout is de substitutie. In meer dan 60% van deze fouten zijn de betrokken woorden conceptueel verwant. Twee typen van conceptuele verwantschap zijn aangetroffen: semantische verwantschap (voornamelijk coördinatie), en 'episodische' verwantschap. Bij een episodische woordsubstitutie zijn het doelwoord en het binnendringende woord verwant door middel van een associatie tussen de personen, objecten of gebeurtenissen waarnaar ze verwijzen in een conceptuele representatie. Ongeveer 60% van alle lexicale substituties betreffen functiewoorden. Bij substituties van inhoudswoorden komen de lengte en de klemtoondragende vocaal van het binnendringende en het gesubstitueerde woord vaak overeen. Deze tendens wordt niet beïnvloed door de aan- of afwezigheid van een

conceptuele relatie tussen de betrokken woorden. De bevindingen leiden tot de volgende suggesties: (1) woordbetekenisrepresentaties zijn bij jonge sprekers in zekere mate episodisch georganiseerd; (2) het ophalen van woordbetekenissen en het ophalen van woordvormen is bij jonge sprekers sterker verweven dan bij volwassenen; (3) functiewoorden zijn als categorie nog niet volledig gedifferentieerd van inhoudswoorden.

Van de klankfouten kan meer dan 40% beschouwd worden als substituties van een enkelvoudig articulatorisch kenmerken. Waarschijnlijk vertegenwoordigen deze fouten het falen van articulatorische sturing: het zijn vermoedelijk onbedoelde veranderingen van stuurparameters van articulatorische gebaren. Twee andere categorieën klankfouten, *slur* en *syllabedeletie*, ontstaan eveneens op het articulatorisch verwerkingsnivo. De meeste van deze articulatorische fouten zijn analoog aan 'systematische' fonologische processen bij jongere kinderen. Er wordt daarom gesuggereerd dat er een continuïteit is tussen de simplificerende fonologische processen in de vroege spraak en de incidentele articulatorische fouten bij wat oudere kinderen. Een klein deel (10-20%) van de klankfouten vertoont eigenschappen van mis-selecties en/of mis-ordeningen van fonologische segmenten. Deze bevinding stemt overeen met de hypothese dat na de tweede verjaardag uit segmenten opgebouwde woordvormrepresentaties ontstaan. Bij deze segmentele fouten bleken anticipaties wat minder frequent op te treden dan bij volwassenen. Anderzijds betroffen deze fouten voornamelijk syllabe-onsets, en bleken de substituërende en gesubstituëerde elementen in contextuele fouten overeenkomende fonologische contexten te hebben. Dit komt overeen met bevindingen bij volwassen sprekers.

Hoofdstuk 4 beschrijft het veranderende patroon van niet-vloeiendheden, in het bijzonder repetities (van klanken, syllaben, woorden en frasen), zinsonderbrekingen en zelfcorrecties, bij T als functie van de leeftijd. De observatieperiode omvat de vroege fase van de overgang van 'pre-grammaticaal' naar 'grammaticaal' taalgebruik. Deze overgang wordt gemarkeerd door het verschijnen van functiewoorden, en de verwerving van produktieve morfologie en morfo-syntaxis. De frequentie waarmee niet-vloeiendheden optreden vertoont een significante toename, gevolgd door een afname, hetgeen een tamelijk algemeen verschijnsel is bij 2 tot 3 jaar oude kinderen. Een nieuwe bevinding is echter dat tezamen met de frequentietoename van de niet-vloeiendheden hun distributionele patroon verandert. In de eerste helft van de observatieperiode is de verdeling van niet-vloeiendheden over zinsposities betrekkelijk willekeurig. In de tweede helft daarentegen komen de niet-vloeiendheden voornamelijk voor bij functiewoorden en woorden aan het begin van zinnen. Er wordt betoogd dat dit resultaat wijst op de ontwikkeling van een component van het spraakproductiemechanisme die zorgt voor de vorming van morfo-syntactisch georganiseerde zins-"frames". Een bevinding die deze hypothese ondersteunt is dat de afname van niet-vloeiendheid in de tweede helft van het corpus verband houdt met een overvloedig gebruik van bepaalde zins-frames.

Hoofdstuk 5 richt zich op drie categorieën van spraak-herziening (speech revision): de *zelfcorrectie*, de *vervanging* (replacement) en de *verheldering* (clarification). Zelf-correcties zijn spontane revisies waarbij de lopende uiting geïnterrumpeerd wordt. Een vervanging is een herziening van een voorafgaande uiting zonder kenmerken van een aarzeling, en een

verheldering is een revisie na een verzoek daartoe van een gesprekspartner. Er wordt aangenomen dat elk van deze herzieningen tot stand komt op grond van een drietal verwerkingsstappen: *monitoring*, *evaluatie* en *reparatie*.

Het hoofdstuk bestaat uit twee delen. In het eerste deel worden interruptie- en hernemingspatronen bij zelfcorrecties beschreven. Interrupties blijken minder vaak vertraagd te zijn dan bij volwassenen, en als er een vertraging is, dan is de hoeveelheid spraak die tussen fout en interruptie geuit wordt, geringer. Bovendien blijken T en N vaker niet-foutieve woorden af te breken dan volwassenen. Met betrekking tot hernemen vertonen de proefpersonen een sterke voorkeur voor 'onmiddellijke reparaties' (hernemen op het interruptiepunt). Dit patroon blijkt echter beïnvloed te worden door de locatie van het reparandum (de te repareren fout) in de zin: een reparandum in het tweede woord van een zin is vaker gekoppeld aan een terugkerende herneming (anticipatory retracing) dan een reparandum op een latere positie. Bij herneming wordt de zinsgrens niet overschreden. Tezamen geven deze bevindingen niet de indruk dat monitoring en zelfcorrectie bij kinderen en volwassenen op principiële wijze verschillen.

Het tweede deel van hoofdstuk 5 stelt de *evaluatie* bij elk van de drie typen herzieningen centraal. Wordt de zelf-waargenomen spraak vergeleken met een intern criterium, en indien dit zo is, wat is de aard van dit criterium? De herstel-operaties bij de drie typen herzieningen werden geklassificeerd met betrekking tot linguïstisch nivo (fonologisch, lexicaal of syntactisch), en geanalyseerd met betrekking tot hun effect (verbetering of geen verbetering van de linguïstische kwaliteit) en ontwikkelingstendensen. Over het algemeen blijken zelfcorrecties vaker *progressief* te zijn, dan vervangingen en verhelderingen. Dat betekent dat de resulterende uitingen vanuit het gezichtspunt van de volwassene beter zijn dan de originelen. Anderzijds zijn er bij vervangingen en verhelderingen aanwijzingen dat het linguïstisch nivo waarop de meeste reparaties plaatsvinden verandert met het toenemen van de leeftijd, namelijk van fonologie naar syntaxis. De *coördinatie*theorie, die stelt dat spraakherzieningen primair gebruikt worden om het linguïstisch systeem dichter bij de volwassen standaard te brengen, kan deze resultaten niet volledig accommoderen. Het lijkt erop dat zelfcorrecties gebruikt worden om het taalgebruik op een optimaal nivo te houden, door de spraak te vergelijken met criteria die een weerspiegeling vormen van de competentie van het kind. Bij vervangingen en verhelderingen lijkt een evaluatiecriterium geen duidelijke rol te spelen. Dit type herzieningen kunnen beschouwd worden als 'voorlopige versies', die gebruikt worden bij de exploratie of het oefenen van de taal.

Het laatste hoofdstuk presenteert een theorie over de ontwikkeling van taalproductiemechanismen, waarin de voorafgaande empirische studies alsmede uiteenlopende bevindingen uit de literatuur geïntegreerd worden. Er wordt gesteld dat het taalproductie-apparaat van de *beginnende spreker* (het kind dat net één-woord-zinnetjes is gaan gebruiken) een 'deelverzameling' is van dat van de volwassene. Het omvat drie verwerkingsnivo's: conceptualiseren, lexicale selectie en articulatie. Het volwassen systeem komt geleidelijk tot stand door de ontwikkeling van 'nieuwe' verwerkingsnivo's tussen het conceptuele nivo en het articulatorische nivo. Dit wordt *layering* genoemd. Het ontstaan van de verwerkingsstructuur wordt verondersteld afhankelijk te zijn van de groei van kennis met

betrekking tot lexicale items. Fonologische encoding, bijvoorbeeld, komt tot ontwikkeling in samenhang met de verwerving van woordvormrepresentaties die uit fonologische segmenten zijn opgebouwd, 'bovenop' het nivo van articulatorische routines. De ontwikkeling van grammaticale encoding is afhankelijk van de verwerving van syntactische woordklassen. Waarschijnlijk is het taalproductie-apparaat van beginnende sprekers *modulair* noch *hierarchisch* georganiseerd, en werkt het nog niet op een parallelle (incrementele) manier. Deze eigenschappen komen geleidelijk tot stand in de loop van de ontwikkeling.

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CURRICULUM VITAE

Frank Wijnen werd op 23 mei 1958 te Rotterdam geboren. In 1976 behaalde hij te Hilversum het eindexamen Atheneum B. Vervolgens studeerde hij psychologie aan de Rijksuniversiteit te Utrecht. Het kandidaatsexamen behaalde hij in 1979, en het doctoraalexamen (cum laude) in 1984, met als hoofdrichting psychologische functieleer. Na enige assistentschappen bij de Katholieke Universiteit Nijmegen en het Max-Planck-Institut für Psycholinguistik werkte hij tussen 1985 en 1989 onder leiding van Dr. L.H. Elbers bij de vakgroep Psychonomie van de R U U. aan het NWO-onderzoeksproject "Ontwikkeling van spraakstoringen in verband met reorganisaties binnen het mentale lexicon" (560-263-010), op grond waarvan dit proefschrift tot stand kwam. Met een vervolg op zijn promotie-onderzoek, het NWO-project "Niet-vloeiendheden als resultaat van de ontwikkeling van formuleringsprocessen" (560-256-042), onder leiding van Prof. Dr. S.G. Nooteboom, is hij in 1989 begonnen bij het Onderzoeksinstituut voor Taal en Spraak van de R.U.U. Daarnaast is hij sinds februari 1990 in dienst van de Stichting Taalwetenschap als coordinator van het door deze stichting en de stichting PSYCHON gezamenlijk gesteunde Themaprogramma Primaire Taalvererving

1. De eerste woorden van het kind zijn op slechts twee nivo's in het cognitieve systeem gerepresenteerd: het conceptuele nivo en het articulatorische nivo. Semantische, fonologische en syntactische representaties van lexicale eenheden ontstaan in de loop van de ontwikkeling.

Dit proefschrift.

2. De veelvuldig waargenomen verslechtering van de spraakvloeiendheid bij kinderen rond drie jaar hangt samen met de ontwikkeling van de formuleringscomponent in het spraakproductiemechanisme.

Dit proefschrift.

3. Zelfcorrecties tijdens het spreken kunnen alleen optreden wanneer de spraakuitvoer, gegeven de competentie van de spreker, niet optimaal is.

Dit proefschrift.

4. Het is onwaarschijnlijk dat de genese van stotteren samenhangt met een spraakmotorisch defect.

5. De empirische argumenten die Y. Levi aanvoert tegen de door L. Gleitman voorgestelde discontinuïteitshypothese voor de grammaticale ontwikkeling zijn irrelevant.

L.R. Gleitman, Maturational determinants of language growth. Cognition 10(1981), 103-114.

Y. Levy, It's frogs all the way down. Cognition, 15(1983), 75-93.

6. De vooronderstelling die gedeeld wordt door het klassieke behaviorisme en het "klassieke" connectionisme, dat er geen beperkingen zijn op mogelijke associaties, is onjuist.

7. De wijd verbreide opvatting dat kinderen zonder enige inspanning hun moedertaal verwerven berust op vooringenomenheid.

L. Elbers & F. Wijnen, Effort, production skill and language learning. in: C.A. Ferguson, L. Menn & C. Stoel-Gammon (eds.), Phonological development: models, research, implications. Parkton (Md.): York Press, te verschijnen.

8. Wetenschappelijke arbeid is intrinsiek dynamisch en vernieuwend en heeft dus geen behoefte aan een dynamische, zich voortdurend vernieuwende universiteit.
9. Psycholinguïstisch onderzoek van stoornissen in de ontwikkeling van taal en spraak kan een belangrijke bijdrage leveren aan het begrip van de normale taal- en spraakontwikkeling.
10. Er bestaan ook werkende vaders
11. De beperking van het aantal letters in het laatste lemma van Van Dale's Groot Woordenboek der Nederlandse Taal, "zzzz", tot vier, moet als arbitrair beschouwd worden.

F.N.K. Wijnen,

On the development of language production mechanisms.

April 1990.

