The Relationship of Comprehension and Production

A Study of a Nonverbal Child

by

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ABSTRACT

This research examines whether a seven-year-old nonverbal boy's comprehension of syntax develops at an accelerated rate following the introduction of speech output through a portable speech synthesizer (VOIS 135). The study was motivated by (1) a general lack of agreement about the relationship of comprehension and production in language acquisition, (2) some child language investigators' claims that--at certain points during the development of language--production precedes and influences comprehension, and (3) the natural experimental condition provided by a nonverbal child who is suddenly given the ability to 'speak' with the help of a portable speech synthesizer.

At the beginning of the research period, the child's sentence comprehension was thoroughly assessed with standard and special purpose tests. His production was assessed through analysis of videotaped interactions. The child was then trained to use the synthetic speech device (VOIS 135) over an eight month period. At the end of this period testing of both comprehension and production was repeated to provide a measurement of language growth in each performance mode.

The child demonstrated comprehension of concatenated structures and clefts at the end of the research period; this represented a developmental leap from the beginning of the research period when he understood only much simpler structures. During the eight month study, development of comprehension on the lexical level came to an apparent halt. Production results indicated that the child experienced a definite expansion in productive vocabulary and length of utterance during the research period. Observations indicated that the child's pragmatic and discourse skills improved markedly with his use of the speech output device.

Factors which might account for developments (or lack of development as in the case of lexical comprehension) are discussed. Clinical implications of improvements in pragmatic and discourse skills through the use of the device are considered along with methodological suggestions for using this study as a pilot for larger research.

Conclusions are that: (1) use of the speech synthesizer led the child to listen to utterances as structural wholes; (2) the child became a more active and independent partner in the communication exchange; (3) synthetic speech garnered the child more attention and more opportunities for interaction; (4) synthetic speech gave the subject access to a greater range of communication partners. While the comprehension-production results are interesting, i.e. the child was able to understand structures at a level of unanticipated complexity after being trained to use the speech device, these results do not elucidate the nature of the comprehension-production relationship. Difficulties in interpreting the results of this study underline the need for a coherent theory relating comprehension and production in language development.

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Introduction

The relationship between comprehension and production in language acquisition has been a subject of speculation for some time. Recently, child language researchers have attempted to test out some of these speculations through experimental investigation. This thesis will further explore the relationship and re-examine some of the basic issues in light of research results. Specifically, I will present findings of a language acquisition experiment conducted with a nonverbal child, an experiment designed to examine the effect of alterations in speech production capacity and auditory feedback upon the acquisition of comprehension of syntactic structures and categories.

A nonverbal child is an experiment in nature where, due to unfortunate circumstances, language must develop in the absence of speech production. Introduction of a speech output mode for use by a nonverbal child would provide an excellent opportunity to observe and test the role of speech as a performance mode in language acquisition, and also provide a platform on which to examine current assumptions about the relationship of comprehension and production during language development. Such a facsimile of natural speech is available in the portable speech synthesizer.

In Chapter 1, discussion will focus on various theoretical positions and empirical studies concerning the relationship between comprehension and production, and the apparent priority of comprehension versus production in the acquisition process. In addition, the interaction between comprehension and production in language development will be explored.

The picture of comprehension and production in a nonverbal child (such as the subject of this research) is complicated by the issue of cognitive deficit which so often accompanies a nonverbal condition. A sample of the literature on the relationship of cognition and language is presented to support the claim of their mutual independence.

Chapter 2 consists of statement of hypotheses (in the null form) which were examined in the research.

Chapter 3 outlines the research method. Details are provided on the history of the child subject, tests and measures, and the synthetic speech device used.

Chapter 4 presents results of comprehension and production measures. Also provided are informal observations, and results of standard analysis procedures, for example, mean length of utterance and type-token ratio.

Results are summarized in Chapter 5 and discussed in light of other research presented in Chapter 1. Developments in the child's comprehension and production are explored with respect to possible contributing factors. Some conclusions are drawn about the nature of comprehension and production as evidenced in this study.

CHAPTER 1

COMPREHENSION AND PRODUCTION: A SURVEY OF THE LITERATURE

Defining Comprehension and Production

Over the past three decades, there has been extensive research into the process of language acquisition in children. Researchers have examined ways in which children produce or understand diverse aspects of language with the long range (although perhaps unattainable) goal of discovering more about the development of underlying knowledge or competence. Given that comprehension and production are such pervasive topics of inquiry in child language, it is striking that few investigators ever actually define what they mean when they use the terms "comprehension" and "production." In general, it seems that production is equated with speaking, and comprehension is more variably and vaguely equated with the behaviour required to demonstrate understanding in experimental or observational conditions. Variable definitions create misunderstandings and complicate the comparison of results across studies. The need for definitions becomes crucial when research purports to investigate an aspect of the nature of the comprehension-production relationship in language acquisition. Most of the authors of research reviewed in this chapter do not make their assumptions about comprehension and production explicit.

Bloom and Lahey (1978) allude to some of the problems involved in defining comprehension; they point out that "children's responses are multidetermined--what children do depends on many things in addition to what they hear" (p.237). Indeed, the problem of defining comprehension is enlarged by its complex nature. However, its complexity need not be intimidating. Chapman (1981) attempts to articulate a comprehensive description of comprehension and is successful in organizing the observations and musings of others (Bever, 1970; Clark, 1975; Simon, 1981; Wittgenstein, 1953), along with offering her own. She states, "comprehension is a process of problem solving, with multiple cues or inputs potentially available to a listener who has an extensive knowledge of the world and a variety of potential purposes in the interaction" (p.116). The problem solving involved in comprehension is carried out in the context of inferences which the listener must make. Chapman sets out these inferences as

> 1. What is the speaker assuming about me, about what I know, about what I want in this interaction?
>
> 2. What does the speaker believe or already know, what are his purposes in the interaction, and to what degree do we share knowledge of linguistic, social, and cultural conventions?
>
> 3. What's the topic of discourse, the discourse act being pursued by the speaker, and how does this utterance relate to each?
>
> 4. What new information is predicated about the referent?
>
> 5. What are the temporal, causal, or logical relations among the events being described, and when did they take place relative to the time of discourse? (p.117)

Cues from which these inferences are drawn are many and varied, e.g. context, preceding conversation, relative social position of speaker and listener (age, sex, authority, similarity, etc.), emotional tone of voice, etc.

In view of these complexities research into the nature of comprehension is faced with a dilemma that few researchers acknowledge. Karmiloff-Smith (1979)

described this as the "experimental dilemma" of comprehension research.

> On the one hand, we are all aware that if we design an experiment with all the extralinguistic and discourse clues available normally in language, then the child's understanding may be due to the accumulation of interacting clues and not of the linguistic category under study. Yet if we remove all these clues, we cannot be sure that we are not dealing with ad hoc, experiment-generated procedures, atypical of the child's everyday behaviour.(p.313)

In studying comprehension most researchers quite justifiably look for describable behaviour, i.e. some reaction which can be objectively observed and measured, and demonstrates understanding (which cannot be directly observed). This often leads to the assumption that what is observed is comprehension and, therefore, a definition of comprehension is superfluous. However, as Chapman's outline suggests, what may count as comprehension in one context may not apply to a different context. Karmiloff-Smith's point emphasizes that researchers must be clear about the context for which they are making comprehension claims, since each context will have definite effects on the inferences required by the listener. In any case, what is being observed is a behaviour taken to indicate comprehension, not comprehension per se.

At first glance, production seems to be easier to define. Children's speech can be recorded acoustically, written down, or described as something tangible. Speech lends itself to objective quantification and analysis. It is the principle modality that we describe to measure language development. It is, therefore, generally assumed that speech and production are one and the same. Problems arise when we try to examine the production of children using other modalities, e.g. the deaf or the nonverbal. A survey of the literature concerned with the comprehension-production relationship yields no comprehensive definition of production. The assumption that production is limited to speech ignores documented evidence to the contrary in studies of child language development.

For example, in the early stages of language acquisition children frequently pair utterances with gestures, extensively referred to as "sensorimotor morphemes" (Bates et al., 1975; Carter, 1979; Werner and Kaplan, 1963). Disregard for facts of this kind is largely due to the prevailing linguistic theory, which defines language terms very narrowly. Specification of a broader notion of production was required in this study of a nonverbal child, to include the variety of communication modes the child used (see Chapter 4). Since children's "production" often includes more than speech, general conclusions about the nature of production should be accompanied with a caveat about limitations of these conclusions.

The Relationship of Comprehension and Production

Throughout the inquiry into the relationship of comprehension and production in language development, the assumption of a gap between them has been a dominant theme. Most research is directed at revealing the nature of this gap and establishing a developmental order for comprehension and production. Description of the gap is best exemplified in the specific and general terms provided by Ingram (1973) and Bloom and Lahey (1978), respectively.

Ingram (1973) proposes a very specific account of this gap; he states that, "comprehension does precede production, and that it could never be any other way. That is, it is proposed that comprehension ahead of production is a linguistic universal of [language] acquisition"(author's emphasis)(p.313).

Bloom and Lahey (1978) propose a hypothesis about the relationship of comprehension and production which allows more flexibility. They state that

> the two represent mutually dependent but different underlying processes, with a resulting shifting of influence between them in the course of language development. [It is] suggested that the developmental gap between comprehension and speaking probably varies among different children and at different times, and that the gap may be more apparent than real.(p.238)

The two positions presented above illustrate different kinds of assumptions which may form the basis for experimental inquiry into the comprehension-production relationship. In addition, there are two ways in which researchers interpret this gap or precedence relation between comprehension and production. First, there are research conclusions based on observation of precedence of comprehension over production (or vice versa) which are usually stated in the form of a time table of general trends. Second, stronger claims may be made on the basis of these observed general trends, positing a necessary precedence, i.e. given developments in one performance mode must occur before corresponding developments in the other mode. Most of the research reviewed below arrived at strictly observational conclusions; only Lenneberg (1962) went so far as to claim a that comprehension necessarily precedes production.

In discussing the potential configuration of the relationship between comprehension and production, a thorny but central issue is generally overlooked: How are comprehension and production related to the child's underlying knowledge or competence? The definition of linguistic competence assumed here is that provided by Chomsky (1965). Understandably, with so much controversy over the status of competence in linguistics and psychology (see Greene, 1972; McNeill, 1975; Salzinger, 1975; Chomsky, 1965), it is far simpler to avoid the issue altogether. However, the issue becomes pivotal when we try to extrapolate our findings to wider and more comprehensive theories of linguistic and psychological development. Within potential models of the interrelationship of competence with

comprehension and production (see figures 1 and 2), there is the question of how this competence is organized. Two potential configurations are that

(1) Linguistic competence constitutes a central body of knowledge, undifferentiated in its contents with respect to comprehension or production

(2) Competence for comprehension and production is stored and organized separately (competence$_c$ versus competence$_p$).

In configuration (1), because competence is a central unified body of knowledge, any evidence of feedback or influence proposed between comprehension and production could only be due to performance effects and would not be suggestive of interactions at the basic level of knowledge. In configuration (2) the dichotomous organization of competence would mean that evidence of feedback or influence between comprehension and production may be related to processes occurring at either the surface (performance) or underlying (competence) levels.

Given these potential configurations of competence, what are the possible relationships between the performance modes of comprehension and production and the underlying knowledge? The literature supports three possible configurations of competence-performance interaction with respect to comprehension and production:

(a) Information flows only from competence to performance modes; there is no feedback from either performance mode.

(b) Information flows from competence to performance modes and competence receives feedback from comprehension performance only (no feedback from production performance).

(c) Information flows from competence to performance modes and both comprehension and production performance modes provide feedback to competence.

The intent here is not to explore these models in detail but simply to demonstrate that the relationship of comprehension and production is far more complex than the interaction of superficial performance modes and should be considered in formulating conclusions. Indeed, while this study will make no strong claims regarding the interworkings of competence with comprehension and production, some speculation will be presented for consideration and further investigation (see Chapter 5).

Figure 1

Schematization of Possible Relationships between Competence, Comprehension and Production: Competence as Single Unified Representation

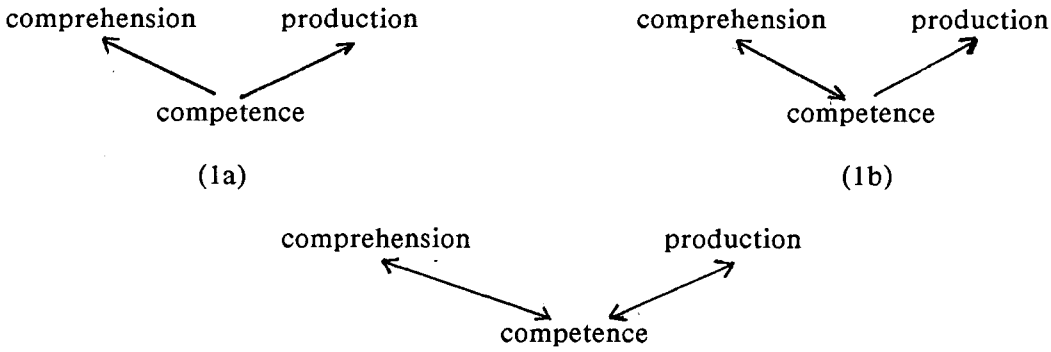
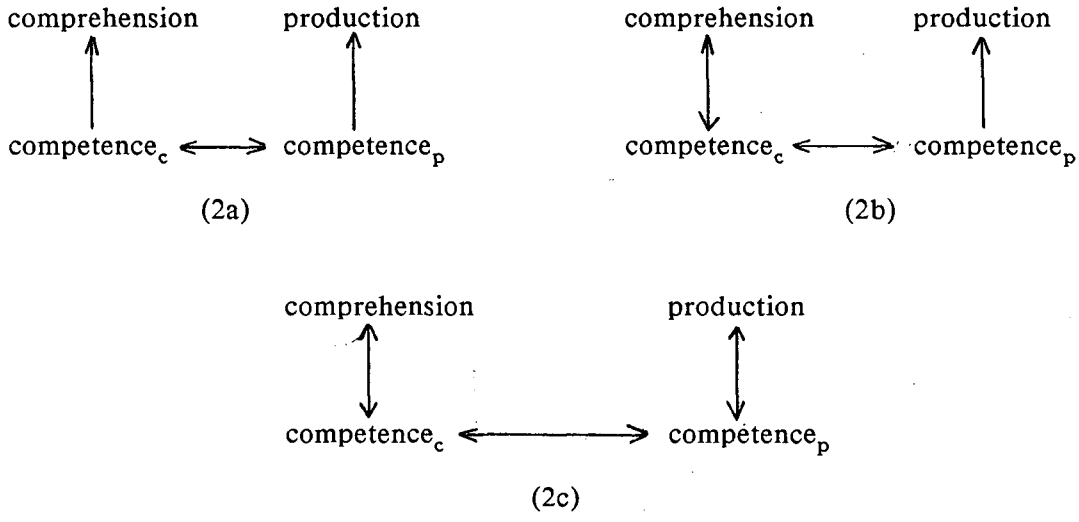


Figure 2

Schematization of Possible Relationships between Competence, Comprehension and production: Competence as Dichotomous Representation



A survey of relevant language development literature reveals that comprehension and production are generally related in three basic ways with respect to their precedence or priority over one another (as discussed above). These relations of precedence or priority can be represented using logical notation as:

(1) comprehension < production;

(2) comprehension = production;

(3) production < comprehension.

The research findings fall into two groups, with one group supporting relation (1) and the other presenting evidence in support of both (2) and (3). It is under this division that research will be reviewed.

Comprehension < Production

Observational support of the contention that comprehension precedes production in development comes from studies of 2-year-old children . Fletcher and Garman (1979) summarized the quantitative findings of Benedict (1979) for a group of eight children in the initial stages of language acquisition concluding that:

> (i) comprehension vocabulary exceeded production vocabulary roughly fivefold,
>
> (ii) at the 50 word level, comprehension vocabulary was around 5 months in advance of production vocabulary,
>
> (iii) comprehension vocabulary items were acquired at about the rate of 22 new words per month, and production vocabulary items at a rate of about 9 new words per month, between the 10 and 50 word levels. (Fletcher and Garman, 1979: 6)

Experimental results with older children using multiword structures appear to lend further weight to the argument of comprehension before production. Fraser, Brown, and Bellugi (1963) devised an imitation-comprehension-production (ICP) task involving the presentation of pairs of pictures displaying ten different grammatical relationships to 3-year-old children. The presentation arrays provided two contrasting representations of a relationship, e.g. (i) boy pushes girl and (ii) girl pushes boy. Such an array was accompanied with a related sentence such as, "The boy is pushing the girl." In the imitation task the children were asked to repeat sentences. The comprehension task was to match a picture from the presentation pair to a spoken sentence. In the production task, children were asked to provide a sentence for one of the pictures. From their results, Fraser et al. concluded that imitation precedes comprehension, which in turn precedes production in the course of language development. Lovell and Dixon (1967)

repeated these ICP tasks with 2-year-olds, and arrived at the same results and conclusions.

The conclusions that Fraser et al. drew from their research are strongly related to the time in which it was done. In the early 1960s there was a major movement in linguistics to unseat the dominant position of behaviourism, which maintained that imitation was the primary mechanism by which children acquired language (see Chomsky, 1959 and 1965; Skinner, 1957). The experiment designed by Fraser et al. had a principal goal of clarifying the role of imitation in language acquisition. Findings on the relationship of comprehension and production were secondary in focus and were used by the authors to support their case on imitation. However, it was not long before Fraser et al.'s results were being hailed as strong evidence of the precedence of comprehension over production in development. Indeed, the replication by Lovell and Dixon (1967) solidified this view. Fernald (1972) raised several valid methodological criticisms concerning the inequality of response possibilities between comprehension and production tasks in the Fraser et al. study. These criticisms are discussed in the next section in a review of Fernald's findings.

Evidence in support of the necessary priority of comprehension over production has been suggested through observation of language development in nonverbal children. Nonverbal is defined here as the inability to use speech as the primary modality for expressive communication. Lenneberg (1962) presents a case report of a nonverbal child's ability to understand language. The subject was an 8-year-old boy suffering from congenital anarthria of unknown etiology, with normal hearing, and no evidence of "organic" deficits (i.e. nothing which could be detected through standard medical assessments of the time). The child's comprehension was tested by having him respond to a series of questions and

commands. Lenneberg does not elaborate on the kinds of questions or commands presented nor on the criteria used to judge a response as evidence of comprehension. He found that the subject responded correctly to verbal instructions, even when they were delivered from a tape recorder. Lenneberg states that the finding of full comprehension was confirmed by neurologists, psychologists, speech-language pathologists and medical residents, although he provides no information about what determined these corroborations. He also observed that the child was able to respond appropriately to passive sentence constructions. This observation was put forward as evidence that the child was interpreting structure, not just word order, supporting a claim of well developed comprehension. Lenneberg concluded from his findings that, "understanding is definitely prior to and independent from speaking. However, there is no clear evidence that speaking is ever present in the absence of understanding"(p.232).[1]

Lenneberg presents this case study as compelling evidence of the necessary priority of comprehension over production in development and is cited as such by Ingram (1973), in support of his claim for the putative universal stated above. However, beyond obvious problems with this research in terms of a vague and unspecified methodology, there is another problem more crucial to this discussion; claims stemming from situations in which production is not possible do not serve to enlighten us as to the nature of interaction between comprehension and production. Still open to speculation is the possibility that production could precede or at least strongly mediate the development of comprehension in language acquisition, in conditions where both processes coexist.

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[1]This may no longer be true. See, for example, a case study reported by Cromer (1986).

Comprehension = Production, or Production < Comprehension

These two relations are grouped together since much of the research suggests that in some aspects, production may precede comprehension and that, in a wider scope, production and comprehension develop concurrently. With respect to the claim that comprehension precedes production in language development, Fernald (1972) challenged the conclusions of Fraser, Brown and Bellugi (1963) by claiming flaws in their methodology and interpretation. Fernald indicated that response possibilities were unequal between the comprehension and production tasks. The comprehension task required that the child choose one of two pictures in a presentation array to match with a sentence spoken by the researcher. Thus, the probability of a correct choice in the comprehension task was 50%. The production task had stricter requirements for a correct response, i.e. responses which were irrelevant to the task were counted as errors. Fernald claimed that by counting irrelevant responses on the production task as errors, Fraser et al. tipped the probability of a correct response unfairly in favour of comprehension (but see Chapman and Miller (1975: 363) for a critique of Fernald's treatment). When Fernald repeated the experiment, only the correct or incorrect responses were counted for both comprehension and production, thus equating the response probabilities. Using this method of scoring, Fernald concluded that responses for comprehension and production were essentially the same, suggestive of their equality in the temporal scheme of language development.

Shipley, Smith and Gleitman (1969) undertook an experiment with young children in the single word (holophrastic) to telegraphic stages of language acquisition. They set out to investigate whether the factors which limit young children's utterances (production) are different from those involved in children's processing of linguistic auditory input (comprehension). They presented children

with commands to act on an object and observed their responses. Commands were of three different varieties: (1) well-formed (e.g. "Throw me the ball!"), (2) telegraphic (e.g. "Throw ball!"), and (3) holophrastic (e.g. "Ball!"). The commands were delivered by the children's respective mothers, who had been trained for the task. The well-formed commands were assumed to be the form caretakers generally use, while telegraphic and holophrastic commands were thought to be representative of forms that children might use to express the same notion. Subjects at two levels of development participated: (1) children whose spontaneous speech was at the single word level (holophrastic) and (2) children whose speech was telegraphic. The focus of the experiment was the child's discrimination of structure. Touching, handling or other appropriate actions with the object were taken as evidence of comprehension. Findings indicated that "those [children] who appear to be at the single-word, or holophrastic, stage in production prefer to respond to speech at or just above their own productive limit" (p.331). That is, they showed more correct responses to structures such as "Throw ball!" or "Ball!" Results from children at the telegraphic stage of speech production indicated that they preferred to respond to well-formed commands over telegraphic or holophrastic commands. The results overall indicate that in the early stages of language acquisition children's production and comprehension abilities are at about the same level, but as production develops to the telegraphic level comprehension abilities surpass production abilities.

There have been several criticisms of this experiment in the literature, most notably by Bloom (1973) and, Petretic and Tweney (1977). Bloom claims that Shipley et al.'s results with the older set of children "cannot be taken as evidence that comprehension exceeds production if the well-formed commands manifested the same structure represented in the children's own telegraphic (i.e.

reduced utterances" (p.292). She bases this criticism on a claim that early telegraphic utterances are often reductions of more complete underlying structures (Bloom, 1970). For example, the utterance "Mommy sock" may have a variety of underlying structures, e.g. "This is Mommy's sock" or "Mommy put my sock on," etc. Thus, the older children may have had an underlying production ability equal to their comprehension ability. While speculation on this possibility may interesting from a theoretical point of view, Bloom suggests no way in which this claim could be tested. Indeed, the criticism is based on an unverifiable notion of underlying structure. Bloom's criticism is a prime example of the problems involved in the examination of comprehension and production, i.e. the need to clarify definitions. Bloom's notion of production ability seems to encompass underlying structure. Shipley et al.'s procedure and discussion treat production as tangible, observable and quantifiable. Bloom's criticism has been stated much too strongly and would have been better phrased as a speculation and is, therefore, dismissed.

Petretic and Tweney (1977) claimed to replicate Shipley et al's experiment. They examined the comprehension ability of 36 children at three stages of telegraphic speech (mean length of utterance [MLU] 1.45, 2.03, and 2.76 morphemes) by assessing their behavioural responses to declarative and imperative sentences. They claimed to have used the same comprehension procedure as Shipley et al., but included several revisions which were to address shortcomings in the original procedure. Specifically, Petretic and Tweney stated that the problems with Shipley et al.'s procedure involved (1) scoring criteria did not allow for accurate determination of comprehension (i.e. any interaction with the toy), (2) their analysis did not reveal the fact that, in individual children, there was no consistent pattern of responding (e.g. of the four subjects at the single word

stage, two responded to well-formed utterances with equal or greater frequency than to the telegraphic or holophrastic utterances), and (3) since each child's mother was employed to deliver the stimuli, "the responses may have been confounded by differences in the stimuli actually presented and may also have reflected differences in familiarity of particular stimulus forms" Petretic and Tweney (p.202). To surmount these problems Petretic and Tweney (1) determined comprehension through complex categorization of behavioural and verbal responses (i.e. (i) behavioural responses: appropriate action, inappropriate actions, touching the toy, orienting responses, and visual responses; (ii) verbal responses: replies, questions, total repetitions, and partial repetitions; versus Shipley et al.'s "relevant response," i.e. any interaction with the toy), (2) examined individual results for consistency of response and, (3) used a single researcher to deliver all stimuli.

Petretic and Tweney concluded that

> consistent with Shipley et al.'s results for late telegraphic speakers, telegraphic speakers in [our] study indicated a marked preference for adult utterance type [in comprehension tasks]. However, unlike Shipley et al.'s findings of a preference for child forms by early telegraphic speakers [our subjects at this level] in the present investigation responded as did linguistically mature subjects.(p.207)

Thus the authors concluded that comprehension precedes production throughout early language development.

Gleitman, Shipley and Smith (1978) came to the defense of their original experiment and findings with a scathing rebuttal of Petretic and Tweney. Gleitman et al. claim outright that Petretic and Tweney (P&T) did not replicate their experiment but in fact conducted a different experiment, with a different subject population and different judgement criteria. In examining the two experiments it is evident that comparison is considerably confounded by modifications enacted by

P&T. Most prominent is the claim that comprehension precedes production even in the earliest stages of language acquisition, a claim based on comparing noncomparable populations. This discrepancy arose from the different ways each group of investigators defined developmental levels of production performance in their subjects; Shipley et al. used median length of utterance whereas P&T used mean length of utterance. P&T treated these as equivalent in their design and Gleitman et al. claim that the youngest group was older and linguistically more advanced in P&T's "replication" than in the original experiment. They argue convincingly that this discrepancy negates the counterfindings of P&T with respect to the early and continued precedence of comprehension over production in acquisition. It is pertinent to previous discussion of definitional problems arising in the comparison of research that Gleitman et al. admit "no doubt, confusion in interpreting our work arose in part from our own rather loose use of the term COMPREHENSION in contexts where, in retrospect, it was bound to be misconstrued"(authors' emphasis)(p.518).

Ruder, Smith and Murai (1980) conducted a study which attempted to extend and further test the generality of Shipley et al.'s findings, but they are careful to point out that their study is not a replication. They used 14 children between the ages of 1;4 (one year, four months) and 2;7 as their subjects. Eight of the children were acquiring English and the other six Spanish. Each of these two language groups were divided into subgroups on the basis of MLU, i.e. holophrastic versus telegraphic. Stimuli fell into five varieties of construction: (1) well-formed command (e.g. "Give me the spoon!"), (2) stylistic variant of well-formed command (e.g. "Give the spoon to me!"), (3) telegraphic command (e.g. "Give spoon!"), (4) lengthened telegraphic command (e.g. "Please [name] give spoon!") and (5) holophrastic (e.g. "Spoon!"). A response was counted as correct

only if a designated object was acted upon in a designated fashion.

Ruder et al. concluded that "the major finding of this inquiry was that the command-following behaviour of the holophrastic groups (English and Spanish) did not significantly differ from that of the telegraphic groups" (p.201). This finding runs counter to the conclusions of Shipley et al. and would appear to support the findings of Petretic and Tweney. Ruder et al. do admit that certain factors contributed to the difference in results from Shipley et al., specifically, (1) their method of presenting stimuli in a portable version of a Wisconsin General Test Apparatus (WGTA) ("a box with an opening at the back through which the stimulus items could be viewed and arranged by the experimenter while remaining hidden from the subject's view" (p.200)), (2) use of probes to keep the child on task and elicit desired action-oriented responses, (3) use of noncontingent reinforcement to insure that the subject was attending (e.g. verbal praise for attending, working hard, etc.), and (4) inclusion of additional stimulus constructions.

Leonard, Newhoff and Fey (1980) presented a paper which dealt with children's use of words whose referents were unknown to them. To do this they used 12 girls ranging in age from 1;6 to 1;9 with MLU's ranging from 1.0 to 1.26 morphemes. Twelve nonsense words were matched with 12 objects unfamiliar to the children (e.g. a toast remover, a shower head). During sessions with the child the investigator provided the nonsense word for each object 22 times in random order, in the form of sentences such as "Here's the gik, I'm gonna get the cheen." On two occasions during each session the objects were placed in front of the child at random and the child was asked "Where's the -- or Give me the --." Comprehension of the nonsense word was considered demonstrated "only when [the subject] responded correctly without any incorrect responses on that item on

subsequent task presentations" (p.190). This statement is the extent of their description of the criterion for judgement of comprehension; there is no indication of what kind of response was required (e.g. pointing, touching, looking) or how situational integrity was preserved (e.g. were the objects arrayed at random in a basket, on a table, on the floor, etc., and whether compliance was rewarded).

Throughout their paper the authors allude to the possibility that subjects used some of the nonsense words productively without demonstrating comprehension of these words. However, all of their presented examples can be very easily attributed to imitation or delayed imitation. The title of this paper, Some instances of word usage in the absence of comprehension, is hence misleading. The authors seem to be aware of some problem with their findings as they never discuss the implication of their results for the comprehension-production issue and instead settle for a conclusion that more research is needed (which is true).

Further data on production in the absence of comprehension comes from R. Clark (1973) in a study of her son, Adam. She submitted that Adam was able to produce structures beyond his level of comprehension through the use of "well-practiced routines, of which no part is substitutable. Only after considerable practice with a sequence could the child begin to modify it in a limited way" (p.9). The author suggested that the application and observation of structures through production is required in the acquisition of some aspects of linguistic knowledge.

Keeney and Wolf (1972) examined the imitation, comprehension and production of subject-verb agreement in English sentences by 46, 3- and 4-year-old children. They used visual stimulus arrays of paired pictures of birds, e.g. a picture of a single bird singing versus a picture of two birds singing. In the

imitation task the children were required to repeat a sentence verbatim to match with a single picture presented. Sentences in the imitation task were either grammatical or ungrammatical, e.g. "The bird is singing. *The bird are singing." The comprehension task involved three different conditions: (1) a singular or plural verb was presented along with a picture and the child was required to say the subject-noun that agreed in number, (2) a full sentence was orally presented by the investigator and the child pointed to the picture which matched it, and (3) a spoken verb was presented and the child indicated the corresponding picture. The production data on subject-verb agreement was obtained through samples of spontaneous speech.

Imitation findings indicated that in 93% of the ungrammatical sentences which were not repeated verbatim, the subjects corrected the noun-verb inflection. This observation provided evidence that they knew the productive rule of subject-verb agreement. The results for comprehension were mixed, with children performing well for complete sentences but poorly for the verb alone. The production data indicated that all the children could use subject-verb agreement in their speech (although with varying degrees of proficiency). From their results Keeney and Wolf concluded that production does precede comprehension with reference to inflection for verb number.

The crux of this finding is the children's poor responses for comprehension of singular/plural for an isolated verb. However, neither children, nor adults for that matter, use the isolated form of the inflected verb in regular speech. When asked "What is he doing?" most children, if they use an isolated verb form, respond with the progressive or uninflected form, i.e. "walking" or "walk." Rare is the child who will respond with "walks." The point is that the task required of the child in comprehending an isolated verb for inflection is actually a

metalinguistic task of identifying the role of an appended -s to a verb, as signaling a singular subject in the absence of any other linguistic context. It is hardly surprising that 3 and 4-year-old children found this task difficult and it raises serious doubts about the validity of Keeney and Wolf's findings with respect to comprehension and production.

Chapman and Miller (1975) examined the comprehension and production of subject-object order in semantically reversible sentences in an object-manipulation paradigm with children at the two and three-word utterance stage. They speculated that "children whose productions give evidence of an underlying subject-verb-object basis should be able, at the same or earlier time, to comprehend sentences in which word order is the only signal to deep structure subject and object relationships" (p.355). Three groups of five children each, with MLU's of 1.8, 2.4 and 2.9 morphemes, participated in the study. Twenty-four sentences were used in the comprehension and production tasks. There were four basic sentence types with each type presented in an original and reversed construction: (1) +animate, +animate ("The boy is hitting the girl. The girl is hitting the boy."), (2) +animate, -animate ("The dog is chasing the car. The car is chasing the dog."), (3) -animate, +animate ("The boat is hitting the girl. The girl is hitting the boat.") and, (4) -animate, -animate ("The truck is pulling the boat. The boat is pulling the truck."). Children were pretested to ensure that they knew the lexical items. In the comprehension task six toys corresponding to the sentences were arranged before the child and a sentence presented with the instruction "do what I say." The task was preceded by an initial set of practice sentences with unspecified feedback, to insure that the task was understood. A response was scored correct only if the action was appropriately demonstrated with the appropriate subject-object assignments. In the production task the child

watched the investigator perform an action with two of the toys and then was asked to describe the action in a sentence using the probes "What's happening? What's going on? What am I doing?" The task was preceded by sample sentences in which the investigator modeled the child's response, if necessary. Production responses were scored correct only if the subject (S) and object (O) were in the appropriate order with respect to (1) the verb (V), (2) each other or (3) individually with respect to the verb (i.e. S-V-O, S-V, V-O or, S-O).

When responses were analyzed the authors found that there was a significant proportion of unscorable responses. They conducted a correction of the analysis based on the methods of Fernald (1972) but rejected this correction in the belief that it might seriously distort inferences from the data. In defense of this decision they observed that "most children spent much time off task, often earning an unscorable response simply through responding to distracting stimuli, rather than through inability to respond to the sentence" Chapman and Miller (1975: 363).

Chapman and Miller concluded from their results that

> the competence to be attributed to the child on the basis of comprehension is less advanced and different from the competency to be attributed on the basis of production for the ordering of subject and object. (p.367)

This conclusion is adequately supported through the authors' application of statistical measures applied to their results and appears to be good evidence of precedence of production over comprehension in the area of acquisition of word order.

Summary of the Arguments

In support of the relation Comprehension < Production are the findings of Benedict (1979) with children in the initial stages of language acquisition (first 50 words). Fraser, Brown and Bellugi (1963) produce results which at first seem to support the temporal precedence of comprehension over production (Lovell and Dixon's (1967) findings support this finding); however, when the results are reanalyzed in the light of Fernald's (1972) criticism the argument is weakened considerably. Lenneberg's (1962) case report provides evidence that comprehension can develop in the absence of production; however, this finding contributes little to our knowledge of the nature of interaction between comprehension and production when the potential for both processes coexists.

In support of the relation Comprehension = Production are the findings of Fernald (1972), which suggested that when response possibilities were equated, 3-year-old children demonstrated equal abilities in comprehending and producing simple sentences.

The results of Shipley, Smith and Gleitman (1969) suggest that in the single-word stage of language development the relation Production < Comprehension may apply. This claim is disputed by Petretic and Tweney (1977) who claim that there were several serious methodological problems with the Shipley et al. study. Their results suggest that, on the contrary, comprehension consistently precedes production in acquisition. Shipley et al. rebut this criticism by showing that Petretic and Tweney used a noncomparable population and, thus, did not replicate the experiment -- invalidating their claims. Ruder, Smith and Murai (1980) conducted an experiment similar to Shipley et al.'s in English and Spanish using a comparable population. Their results indicated that comprehension consistently precedes production in development for the age groups they studied.

Leonard, Newhoff and Fey (1980) examined instances of word usage in the absence of comprehension but they remained equivocal about the relationship of comprehension and production and concluded with a call for more research. Keeney and Wolf (1972) studied imitation, comprehension and production of inflection for subject-verb agreement in English. Their findings led them to conclude that production precedes comprehension with reference to inflection for verb number; however, methodological problems cast doubt on the validity of this conclusion. R. Clark (1973) concludes from a study of her son that practice in production of sentence structures may be required before their comprehension. Chapman and Miller (1975) present a convincing argument that competency for production of word order precedes comprehension of same in development.

In sum, and criticisms aside, the following researchers claim that

1. Comprehension < Production: Benedict (1979), Fraser, Brown and Bellugi (1963), Lovell and Dixon (1967), Lenneberg (1962), Petretic and Tweney (1977), Ruder, Smith and Murai (1980);

2. Comprehension = Production, or Production < Comprehension: Fernald (1972), Shipley, Smith and Gleitman (1969), Keeney and Wolf (1972), Clark (1973), Chapman and Miller (1975).

Regardless of the direction of their conclusions, most of the authors above make only observational claims yielding a speculative time table of development. Only Lenneberg makes a claim that one performance mode must necessarily precede the other (i.e. comprehension must precede production).

Many of the differences in conclusions arrived at in these studies are related to methodological problems; however, it is important to bear in mind the points of Chapman (1981), regarding the complex range of inferences and cues applied by the listener in comprehension. With respect to the research presented above, it is

evident that stimuli and contexts varied (sometimes widely) between experiments; differences in the cues and inferences required in comprehension under these varied conditions may have resulted in the application of dissimilar comprehension strategies. Different comprehension strategies may have been of varying effectiveness depending on the situation, leading to different results and conclusions on the part of the researchers.

In addition to the complex nature of comprehension strategies is the issue of "experimental dilemma" raised by Karmiloff-Smith (1979) (see above). To what degree do the tasks and stimuli chosen by the investigators reflect actual comprehension abilities in real situations? Differences in results (and subsequent conclusions) may be related to how well the experiments allowed subjects to use comprehension strategies reflective of real-life abilities, as well as how insightful the investigators were about their subjects and data.

Motivation for this Study

The present research was undertaken to examine the effect--if any--of auditory feedback from speech (production) on the development of comprehension. The evidence discussed above is complicated and frequently contradictory. One fact that emerges from it all is that production and comprehension are assumed to be related; the nature of this relationship has been a source of interest to researchers for over two decades. Beyond the evidence presented above on whether production precedes comprehension or vice versa, there are theory based speculations on the possible nature of this relationship. Bloom and Lahey (1978) propose a hypothesis that comprehension and production "represent mutually dependent but different underlying processes, with a resulting shift in influence between them in the course of language development" (p.238).

Children's language play provides a valuable opportunity to probe the nature of these "underlying processes," particularly with respect to the role of production in language acquisition. Investigators have long noted children's propensity to experiment with language, widening and narrowing classes of sound, meaning and structure with changing idiolinguistic hypotheses. Kuczaj (1982), in his extensive review of the literature to date on the subject of language play and from his own experiments, concluded that "such play may assist children in their analysis and organization of linguistic knowledge, and thereby directly facilitate the acquisition of such knowledge" (p.227). Is it not possible that feedback from production in language play could directly affect the development of competency for comprehension? Indeed, it would seem that one of the major purposes behind language play is to test linguistic hypotheses. The child, by hearing his own production, comparing it to the productions of others and observing the reactions of others to his production, may be using production as a heuristic tool in the development of grammar. Ervin-Tripp (1964) pointed out that,

> in language, unlike other intellectual processes, the child monitors his own output through the same channel by which he receives the speech of others. If he can make discriminations and remember models, he can compare his own speech to that of others. (pp.404-5)

This implies the presence of a feedback loop operating between production and comprehension, perhaps directly or through the mediation of competence (see figures 1 and 2). Ervin-Tripp further suggested that "perhaps comprehension requires some ability to anticipate and hence, at a covert level involves some of the same behaviour that occurs in speech production" (p.405).

Bloom and Lahey (1978) elaborate further on the notion that production may contribute to the development of comprehension competency in their speculation that "as with lexical items, using a linguistic form may be a means of learning

it... Such learning may reflect a certain integrity of the linguistic system as children are learning it" (p.246).

It was the integrity of the developing linguistic system which was investigated in the present research.

Preliminary Considerations in Studying Comprehension-Production in a Nonverbal Child

In setting out this experiment there are some special considerations required in the study of a nonverbal child.

1. The nature of production performance is varied; it can range from verbalizations to any number of symbolic codes. In examining the relationship between comprehension and production, it is pertinent to define the methods and parameters by which they will be measured. Such a relationship is very complex occurring on several linguistic levels (phonological, syntactic, morphological, semantic, and discourse) and manifesting itself in a variety of modalities (responsive action, gesture, spoken language, sign language, symbolic codes).

2. Experimental variation of the modality of spoken language suggests the alternating imposition of nonverbal and verbal conditions on a developing child, a situation which would be neither practically nor ethically tenable with a verbal child. The nonverbal child, however, is an experiment in nature. Giving such a child a way of speaking would permit the investigator to observe the effect of speaking on language development and, hence, on understanding. While it is not usually possible to give natural speech to nonverbal children, technology provides a facsimile: the portable speech synthesizer. While neither as fast nor as intelligible as natural speech, synthetic speech has significant advantages over other nonverbal expressive communication systems, particularly in terms of

feedback. Synthetic speech provides for linguistic auditory feedback which approximates the linguistic output of others and also provides output which is more widely and naturally intelligible than gestural or graphic symbolic systems, the typical alternatives for nonverbal children.

3. The production variable provided by a speech synthesizer can be related to observations of change in rate or quality of language acquisition as measured by changes in comprehension abilities. Exceptional developments in comprehension (e.g. acquisition of structures markedly beyond the subject's pre-research language level), following the introduction of synthetic speech, may provide evidence of auditory feedback from production to comprehension (see figures 1c and 2c). Results may be suggestive of similar aspects of production-comprehension interaction in effect during the language acquisition process for normal verbal children.

At the time research was being considered, the subject, Ryan (a pseudonym), was at an early stage of syntactic development. The possibility of Ryan's selecting words or symbols for combination and then hearing them as a spoken unity (through synthetic speech) provided a rare opportunity to study in relative isolation the effect (if any) of feedback from speech production on the acquisition of language (specifically, in this case, comprehension.) In addition, the symbol/word selection limitations of Ryan's communication boards would comparably maintained on the display of the device used in this research (VOIS 135).

As discussed above, production may play an active role as a heuristic tool in the acquisition of language and thus may contribute to the development of comprehension and language in general. Nonverbal children consistently display a delay in their language development when compared with their verbal peers. A

premise considered for investigation was that, in a nonverbal child, we could expect a different or accelerated path of language development if the child were provided with a means of expression which more closely approximated the production of others (namely speech). This provision presents an opportunity to examine the validity of performance feedback models (i.e. linguistic auditory feedback) on the development of comprehension competence (see figures 1c and 2c). Upon establishing a baseline through comprehension tasks, we could examine the role of speech output in producing a measurable change in comprehension performance (this premise is stated in formal hypotheses in Chapter 2).

4. In using a nonverbal child as the subject of language acquisition research there remains a potential complication which must be considered. Nonverbal children often experience a cognitive delay or deficit which may be construed as an impediment to their ability to acquire language. (Indeed the subject of Lenneberg's (1962) study was described as educable mentally retarded.) In an experiment where the goal is to examine changes in comprehension-production abilities, any claims or findings may be contaminated by effects of the subject's cognitive status. However, the literature to be presented here supports the contention of the separate nature of language and cognition and will hopefully preclude the necessity of defense of the findings on the grounds of cognitive contamination.

Cognition and Language Acquisition

Nonverbal children generally score more poorly on psychometric intelligence tests than verbal children, indicating intellectual retardation as well as communicative retardation. (Indeed, the subject of the inquiry scored an average of two years below his same chronological age verbal peers on cognitive testing

conducted during the experiment. See Chapter 3, Cognitive Testing.) The question then is whether mental subnormality is likely to cause a delay in language development. The position taken in this research is that cognition and language are mutually independent; without going into an exhaustive review of this area, I will support my position with some examples.

Ryan (1975) presents a detailed survey of the literature on mental subnormality and language development. She cites Lackner's (1968) study of five children of subnormal intelligence in which no evidence was found that these children had grammatical abilities different from those of normal children. For example, transformational rules were consistently found to be a subset of an adult grammatical model. The five children were unable to repeat sentences they could not understand and spontaneously corrected incomplete sentences within their comprehension, consistent with linguistic behaviour observed in normal children. Ryan also cites Bartel's (1970) paper describing a training experiment that demonstrated that subnormal children could generalize what they had learned about morphology to new items. From her survey of the literature, Ryan concluded that there is "no essential difference in the organization of grammatical and semantic knowledge between [mentally] subnormal and normal children" (p.273).

Lyle (1961) conducted extensive tests of single word vocabulary using both recognition and naming with the Peabody Picture Vocabulary Test on 25 children of subnormal intelligence. He found that the subnormal children scored equal to or better than normals of a similar language age. He concluded that it is unlikely that language development is especially vulnerable to low intelligence.

A corollary of the issue discussed above is that a language deficit may affect the development of thinking, and thus impair the application of intellect to

the language acquisition process. Furth and Youniss (1975) in their landmark study probed this very question. Through experimental investigation of the development of logical structures (using a Piagetian model) in congenitally deaf children at a variety of ages, the authors found that the absence of spoken language was no absolute barrier to the ability to manipulate and use logical structures. In a comparison of studies dealing with the logical concepts of affirmation, negation, conjunction and disjunction, deaf children were behind normal urban hearing children but obtained similar scores as hearing children from a rural environment.

The authors concluded with a general hypothesis that linked the slightly retarded production level of deaf children to a general deficiency in experience rather than to the specific lack of language. It appeared to them that the absence of a linguistic medium in the developing child did not in itself lead to serious intellectual shortcomings.

Further evidence of the independence of language and the development of thinking is provided by a case study of a "hyper-linguistic" retarded adolescent (Yamada,1981). After thoroughly testing and examining all possible aspects of Marta's linguistic and cognitive behaviour, Yamada establishes her subject to be superior to the expected linguistic level, given the subject's cognitive level of functioning. While asserting that these results do not discount a relationship between language and cognition, Yamada states that "they [do] show that aspects of language, specifically syntactic and morphological aspects, can emerge independently of putatively prerequisite or commonly-governed cognitive behaviours" (p.155).

The literature presented above supports the notion of the independence of language and cognition. The present study has been conducted under this premise of independence.

CHAPTER 2

STATEMENT OF HYPOTHESES

Two hypotheses were examined during the course of this research:

1. Change in Ryan's comprehension of syntactic structures from the beginning to the end of the experimental period will not exceed gains expected from maturational development alone.

2. Change in Ryan's comprehension of syntactic structures from the beginning to the end of the experimental period will not differ in quality (i.e. the kinds of rules applied in comprehension) from development expected from maturation alone.

CHAPTER 3

METHOD

The Subject

Ryan, born to his mother in her late twenties, is the oldest son in a family of three children. Ryan's birth and infancy were unremarkable until he was twelve months old, when chronic vomiting began, followed by dehydration and dramatic weight loss. He was hospitalized for a period of four months and, during his stay, contracted red measles and pneumonia with high fever. An initial CT scan conducted following the stabilization of his condition revealed enlarged ventricles; however, two subsequent CT scans revealed normal ventricle configurations. The parents reported that, following his return home after hospitalization at age sixteen months, Ryan was "like a newborn." He had to be taught to sit up, roll over, chew, swallow, etc. The family was given guidance and support by a community infant development team.

At age 2;6, Ryan was assessed by a speech-language pathologist (SLP) in a local health unit. At this point, Ryan was completely nonverbal. His few gestures and frequent tantrums were a source of much frustration to both himself and his parents. After several months of intensive therapy, Ryan's comprehension improved but productive abilities remained unchanged. At this point, American Sign Language was introduced. Ryan quickly learned about twenty signs, which eased

some of his frustration. It soon became apparent, however, that sign had a limited potential, particularly for a hearing child in a hearing environment, where sign was not well known to people communicating with him.

At age 3;0, Ryan became very ill again and was hospitalized for several months. The diagnosis was cyclical vomiting, cause unknown. At age 4;6, Ryan was introduced to Blissymbolics, an idiographic symbol system designed originally by K.C. Bliss and adapted for augmentative communication purposes. He received intensive training with these symbols from the SLP and his mother. The use of Bliss symbols allowed Ryan access to a wider range of communication partners. He subsequently moved from the special needs daycare, which he attended on weekdays, to an integrated daycare. Exposure to typical peer models helped Ryan develop social skills and behaviour. His comprehension improved through day-to-day interaction with the other children. With Ryan's expanding vocabulary, the Bliss Symbol board soon became impractical to carry around, particularly for Ryan, who was fully ambulatory with many well-developed gross and fine motor skills.

When Ryan entered the school system, there was an attempt to place him in a class for special needs mentally handicapped children. The parents, feeling that Ryan's abilities were being underestimated, protested vigorously and were successful in having him moved to the more normal and integrated setting of a language development classroom.

I first met Ryan in October, 1984, at Sunny Hill Hospital. Over the following months I observed developments which posed interesting questions for theories of language acquisition. When research began Ryan was 7;4. He was in a grade 1-2 language development class and had nearly completed the grade 1 reading series. He had a large Bliss symbol communication board with approximately 300 symbols. His mother and the attending SLP estimated that he had knowledge of approximately 200 signs.

In his interactions with me, I noted that he used a variety of modalities to communicate: sign language, Bliss symbols, vocal intonation, mime, gesture and pointing to or use of relevant objects in the environment. Eye contact was frequent but usually fleeting. Ryan was cooperative in therapy tasks and would attend on good days for up to 45 minutes. He would generally pull away when casually touched but enjoyed giving hugs on his own initiative and wanted to be held when upset.

An oral peripheral examination conducted in March 1985 revealed that Ryan was unable to pucker his lips or protrude his tongue. Lateral and vertical tongue mobility was observed to be reduced in range and speed but with adequate strength, suggestive of problems of control and coordination. When I observed Ryan at the dinner table, he chewed and swallowed without problem; however, the coordination of the lips to pull food off of a fork or spoon presented difficulty. Ryan usually accomplished this task by using his teeth.

Ryan's vocal abilities were essentially intact with a full range of pitch and loudness. Ryan frequently "spoke" using [m] in combination with a neutral open vowel, imposing a variety of intonation patterns over his utterances. Question, statement and imperative intonations as well as emotional states were observable in Ryan's vocalizations. During the research period Ryan was heard to utter variants of the following clearly distinguishable words: no, mom, bad, okay, ah huh (yes).

The mother and the SLP reported that during the year preceding the research period Ryan had begun to combine signs, symbols and words into two "word" combinations with occasional three and four "word" combinations. ("Word" here refers to signs, symbols and words.) Ryan was also being assessed at the

time to determine his potential for using an encoded system to access an electronic augmentative communication device.

As I became familiar with Ryan it occurred to me that his condition presented a rare and unique experiment in nature. Here was a child, nonverbal and fully ambulatory, who demonstrated an ability to communicate in a variety of modalities. He was at the threshold of syntactic development and literacy. He was also being considered for an electronic augmentative communication device with synthetic speech output. Given that speech is the primary mode of production and is pervasive as a means of input and feedback in human communication, this was a unique opportunity to pose some relevant questions about the relationship between comprehension and production in language acquisition.

Given the conditions described for Ryan, a possible premise for research was that, in a nonverbal child, we could expect a different or accelerated path of language development if he were provided with a means of expression which more closely approximated the output of others (namely speech). Upon establishing a baseline of comprehension, we could examine the role of speech output in producing a measurable change in his level of comprehension.

As mentioned, at the time research was being considered, Ryan was at an early stage of syntactic development. Thus the possibility of Ryan's selecting words or symbols for combination and then hearing them as a spoken unity (through synthetic speech) provided a rare opportunity to study, in relative isolation, the effect (if any) of feedback from speech on the acquisition of language. In addition, the symbol/word selection limitations of Ryan's communication boards would be comparably maintained on the display of the device used in this research (VOIS 135).

History Compilation

The above information was obtained about the subject's language and communication abilities from sources who knew or had worked with him, e.g. the parents, who were asked a number of questions concerning Ryan's medical and overall developmental history. In addition, the parents were asked (1) to try to recall when Ryan had first begun to combine two or three symbols or signs into simple expressive phrases and (2) to identify possible situations in which their child was more likely to combine symbols or signs.

The teacher who had worked with Ryan over the preceding 1.5 years was consulted regarding his academic progress in language skills, reading, participation in classroom communication and asked to provide her subjective observations from communicating with him. Speech-language pathologists who had worked with Ryan in various settings e.g. the school, Sunny Hill Hospital and the local Provincial Health Unit, were consulted regarding therapy activities undertaken with him, observed progress, milestones and estimates of his communication abilities. The information compiled provided a relative idea of Ryan's language and communication development, particularly over the year preceding the research period.

Design

Pre-Design Considerations

This experiment was designed to provide measurable results of the interaction between comprehension and production within the following restrictions:

1. The syntactic level would be the focus of observation.

2. The experiment would be conducted (including pre- and post testing) within an eight month time frame. This decision was pragmatically motivated by deadlines associated with the loan of the device and use of facilities.

3. A commercially available synthetic speech augmentative communication device (the VOIS 135) would be available for the duration of the experiment.

The general design incorporated the following:

1. Extensive history of the subject

2. Thorough testing and sampling of comprehension and production abilities at the end points of the study.

3. Introduction and training with the device

4. Analysis of developments in comprehension and production during the experimental period.

The research project posed a choice of focus: whether to assess the change in comprehension (1) for a few specific syntactic structures, or (2) for a wide range of structures. The second alternative was chosen based on the following reasoning. The experiment was primarily directed at observing the effect of speech output on the development of comprehension. Ryan would require intensive training with the device if he was to use it with reasonable facility as a means of communication. Narrowing the scope of structures examined would increase the possibility of confounding effects from introduction and training with the device and reduce the researcher's ability to detect the subtle developments which could occur over such a short time period. A wide sample of structures would make overall changes in syntactic comprehension more evident, and possible training effects would be minimized.

To sample a wide range of structures, a comprehensive inventory was required. Curtiss, Kempler,and Yamada (1981) presented a list of structures which

they compiled for use in research on language acquisition. This list was adapted for use in research with Ryan. (See Appendix 1 for details of the list of Receptive Language Structures and Categories used in this research.)

Assessments of Comprehension

The object of assessment was to provide at least three different presentations of each category or structure. This was assumed to be the minimum sample size required to provide results of reasonable reliability, reducing the chance factor to 33% for the smallest arrays (three pictures per array X three arrays presented -- see Chapter 4 for details of statistical calculation). When all possible tests and materials had been considered and adapted, the number of arrays for each structure or category ranged from one to twelve. (See Chapter 4, table 3.) There were a small number of structures for which the number of arrays fell below the minimum level of three; these were auxiliary-Be (singular/plural), possessive morpheme, reflexive pronouns, third person verb form (singular/plural), past tense (regular) and future modal -will. The reduced number for these structures was related to a paucity of picture arrays for presentation. They were still sampled for as many presentations as possible, but the results bore only incidental weight in the final analysis.

No single available test provided at least three presentations of each and every structure to be assessed. Therefore, a variety of tests were used and adapted to maximize test presentations. Since some tests were biased to oversampling of particular structures or grammatical concepts (or simply not appropriate to the research requirements) their picture presentation arrays were used in the presentation of different structures from those sampled in the original test. For example, the Assessment of Children's Language Comprehension (ACLC)

Foster, Gidden and Stark (1973), samples children's ability to comprehend increasing numbers of salient elements in phrases and sentences. The presentations accompanying the picture arrays of the ACLC were not compatible with the structures selected for this research. However, some of the ACLC picture arrays, when paired with appropriate presentation structures (e.g. clefts, complex negation), provided the appropriate foils for sampling these structures. The original presentation structures used in the standard tests were preserved as much as possible. Test presentation structures were altered or replaced only when the original did not conform with the structures to be assessed in the research.

The test materials used for sampling comprehension included:

1. the Assessment of Children's Language Comprehension (ACLC), Foster, Gidden and Stark (1973),
2. subtest I of the Clinical Evaluations of Language Functions (CELF), Semel-Mintz and Wiig (1980),
3. the Test for Auditory Comprehension of Language (TACL),Carrow (1973),
4. and approximately thirty specially constructed picture plates[2].

In addition to pictured stimuli some categories (e.g. prepositions, conjunctions, etc.) were tested using objects (e.g. toys, common household objects) which Ryan was requested to manipulate in response to a phrase containing the target structure. For example, locative prepositions were tested by asking Ryan to move an object into a particular positional relationship, e.g. "Put the man in the house" or "Put the man under the bus." Other structures, such as before/after constructions, were tested by having Ryan execute a requested action, e.g. "Before you touch your nose, touch your foot."

[2]Originally created by Marnie Blenner-Hassett

The Peabody Picture Vocabulary Test (PPVT) (Form L) Dunn and Dunn (1981), was used at both test points to assess the development of comprehension. Nominative presentations of the PPVT were ideally free of grammatical structure or category and, thus, provided a separate measure of lexical comprehension. The PPVT also provided a relative level of vocabulary for guidance in presentation selection for the structure/category test portion.

Assessments of Production

Production was assessed using videotaped language samples and informal observation. Ryan was videotaped under two conditions at both beginning and end of the research period. The conditions were:

1. The investigator read the child a story from a children's book and then asked him to retell the story. Then Ryan was free to select a book from two or three books specially chosen by the investigator and encouraged to tell the story. Ryan was prompted to communicate about the stories with appropriate Wh-questions.

2. Ryan and his mother interacted in a play situation with toys and at some point the investigator would join the play. Interaction centered around the manipulation of objects such as puppets, dolls, toy figures, cars and a toy house. The interaction was accompanied by a narration of the action. Ryan was prompted with Wh-questions when spontaneous output was not forthcoming.

These two conditions provided both structured and unstructured communication situations with sufficient variety to provide ample opportunity for production. Each videotaped sample ranged from 45 to 60 minutes in duration. The samples were transcribed and analyzed for the structural variety of

utterances and their frequency of occurrence. (Full details of the analysis may be found in Chapter 4.)

Children's story books used in sampling were chosen for their clear, clean pictures in which an action or event was easily identified. That is, stories which were simply a concatenation of descriptions were unsuitable. Stories chosen had (a) a linear development with some identifiable climax, outcome or resolution and, (b) content of sufficient interest to Ryan such that he could be expected to comment on the situations represented from his own experience.

The books used were:

Cressey and Cole, Fourteen Rats and a Rat Catcher. 1976a.

Munsch R.N., Murmel Murmel Murmel. 1982.

Goodall J.S., Adventures of Paddy Pork. 1968.

Goodall J.S., Shrewbettina's Birthday. 1970.

Omerod J., Sunshine. 1981.

Rice E., Benny Bakes a Cake. 1981.

Winter P., The Bear and the Fly. 1976.

Zion G., Harry the Dirty Dog. 1976.

Cognitive Assessment

A measure of cognitive ability, the Leiter International Performance Scale: Arthur Adaptation, Leiter and Arthur (1955), was administered at the midpoint of the research period to provide an estimate of Ryan's cognitive level. Cognitive information was gathered to compare with language development observed and to provide another perspective of Ryan's overall development. This test was chosen because it is relatively independent of linguistic ability; a nonverbal child is unfairly disadvantaged in a heavily language-based test of cognition.

Procedure

Test Methods

Test methods were designed to provide maximal consistency of conditions and setting. Ryan was tested at Sunny Hill Hospital in a quiet room, in the same position with respect to the physical position of walls, furniture and examiner. Testing was conducted between approximately 1:00 and 2:30 P.M. He was occasionally resistant to testing; time out or diversionary activities were used at such points. Ryan's selections were acknowledged with a neutral comment such as, "fine," "good for you," "good pointing," etc.

Tests were organized and adapted as needed, prior to each session. In as much as it was possible, tests were administered in their entirety (including any revisions for research purposes) in a single session, given the child's limited attention and tolerance. For presentations using picture arrays, each structure was spoken once, with the option of a single repetition. If no response was given after a repetition, the array was noted and presented again at a later date, mixed randomly with other picture presentation arrays. Structures corresponding to picture arrays were presented randomly with respect to each other to prevent organization on the basis of difficulty or complexity. Thus, problems of increasing frustration and subsequent decreases in motivation were avoided. Randomization has been shown to decrease learning, an important consideration since the test battery was re-administered for the post-test.

Training with the Device

An electronic augmentative communication device with synthetic voice output, the Phonic Ear VOIS 135, was used in the project. (A full description of this device may be found in Appendix 2.)

Ryan was given instruction in the use of the VOIS 135, i.e. how to (1) how to turn on the device, (2) select levels, (3) make selections, (4) clear the temporary memory, (5) compile phrases, (6) repeat selections already made, (7) control the volume and, (8) he was made familiar with general points on care of the device and its preprogrammed memory. Instruction was on-going throughout the research period to ensure that Ryan was comfortable using the device and aware of situations where it would be useful. Training in device-user skills was combined with exposure to a variety of syntactic structures as well as integrated with language therapy continued from the pre-research conditions (e.g. on-going language intervention). Training was provided in two 1.5 hour sessions per week which, during the initial weeks, were conducted at Sunny Hill Hospital only, although the child was allowed to keep and use the device at home from the outset of the training period.

During training sessions Ryan was exposed to a number of syntactic structures in the context of an object manipulation game in which the use of the structure was required to assist a puppet or doll in completing an action. I initially introduced the structure in a demonstration context, i.e. I showed how its use could resolve a problem in a play situation. For example, a puppet boy might be looking for his dog but unable to see him. I would use the synthetic speech device, selecting the appropriate combination of words, to tell the puppet where the dog was, e.g.: "dog in house," "dog under car," or "dog on house." After

modeling the situation Ryan and I would take turns positioning the animal/object and giving the response--a method consistent with previous language therapy.

The criteria for choosing structures for use in the exposure sessions were (1) ability to be represented with objects and pictures, (2) simplicity, (3) applicability to probable communication situations for Ryan and (4) early appearance in normal language acquisition (Macrae, 1979; Garman, 1979; Miller and Ervin, 1964; Brown, Cazden and Bellugi, 1968). The structures used in the exposure sessions appear in table 1.

Table 1

Structures[a] Used in Exposure/Training Sessions with the VOIS 135

I see N	N allgone
I see a N	N prep N (in,on,under)
N + possessive morpheme 's	I have N
I want N	I have a N
N + V (combinations)	I like it (or N)
Don't V	I don't like it (or N)
Have to V	Give N please
You have to V	Where N?
I like V + ing	Where is N?
I don't like V + ing	He/she is V + ing
V + ing	

[a]Abbreviations used here are: N noun, V verb.

Overlays and Displays

Up to four individually programmed levels, with a phrase in each of the 118 cells can be programmed into the VOIS 135 (118 cells X 4 levels provides 472 programmable cells; see Appendix 2 for more detail on the VOIS 135). Initially, Ryan used only a portion of one level with vocabulary taken from his Bliss symbol communication board and arranged in a similar manner with respect to categories and their colour coding. As Ryan became more familiar with the device, the initial level (labeled the "home" level) was filled and revised to accommodate a larger vocabulary. A second level was implemented when vocabulary surpassed the 118 selections available on a single level. In order to represent additions on the second level without requiring Ryan to flip between two overlays, cells were divided in half with the original cell word (stored in level 5) represented in the lower half of the cell in black ink, and the new addition (stored in level 4) in the upper half in red ink.

When Ryan began using the device at school, a second overlay with appropriate vocabulary for the school environment was introduced. The school overlay was expanded as required in a manner analogous to the original overlay, and occupied levels 2 and 3. Ryan, his parents, and teacher all provided input on vocabulary selection.

CHAPTER 4

RESULTS

Results for measures of comprehension, production, and cognition are presented here as they relate to the two hypotheses motivating this research.

1. Change in Ryan's comprehension of syntactic structures from the beginning to the end of the experimental period will not exceed gains expected from maturational development alone.
2. Change in Ryan's comprehension of syntactic structures from the beginning to the end of the experimental period will not differ in quality (i.e. the kinds of rules applied in comprehension) from development expected from maturation alone.

Comprehension Results

Comprehension Research Measures

Table 3 presents the results of comprehension testing conducted on Ryan, using the methods described in Chapter 3. The first column opposite each structure or category is "sample size," representing the number of different presentations of that particular structure. For example, Active Voice Word Order was sampled through presentation of five different examples of the structure together with five respectively different stimulus arrays. The number of

presentations for which Ryan correctly chose the corresponding picture is listed for each structure under "Time 1" and "Time 2" (corresponding to the two test periods of April and September respectively). For a detailed list of the structures and categories with explanations and examples, see Appendix 1.

The presentation arrays for each material set varied from three to five pictures or options of choice, (ACLC arrays of five, CELF arrays of four, TACL arrays of three,special purpose pictures arrays of four, commands for Locative Prepositions I and II with a choice of at least four possible positions.) Chance response was generously taken at 1/3 to correspond with the smallest array. Given that for one presentation the probability of a correct response by chance alone is 33%, 11% for two presentations, 3% for three presentations, 1% for four presentations, etc., where the probability is calculated as $\{(1/3)^n\}$ and (n) is the number of different presentations of a single structure or category.

A correct response on three separate presentations of a single structure or category (probability of 3%) was taken as evidence of acquisition of that structure or category in the Ryan's comprehension. It may be argued that four correct presentation selections (probability of 1%) would provide a more statistically appropriate boundary for deciding that a given structure or category was acquired; however, it must be stated that presentation arrays of three accounted for only 52 out of a total of 202 presentations and in no instance accounted for all sampling of any one structure. Therefore, the chance level for three presentations at 3% is conservatively high and is better represented by the expression (probability < 3%). Thus, the level of three correct per structure is taken as a best estimate within a reasonable probability, of evidence of comprehension.

Five states of acquisition were formulated based upon Ryan's change in performance from Time 1 to Time 2. (See table 2.)

I. Structures or categories acquired previous to the experimental period.

II. Structures or categories acquired during the experimental period.

III. Structures or categories emerging at the outset of the experiment.

IV. Structures or categories emerging during the experiment.

V. Structures or categories not yet acquired.

These states were defined as:

I. Structures or categories acquired previous to the experimental period. This category includes structures or categories for which Ryan scored at least 3 correct at Time 1, and 3 or more correct at Time 2. Thus, performance remained at or above the level established to demonstrate comprehension.

II. Structures or categories acquired during the experimental period. This category includes structures or categories for which Ryan scored less than 3 correct at Time 1, and 3 or more correct at Time 2. In addition the shift in comprehension performance had to be at least an increase of 2 or more correct between the Time 1 and Time 2 scores. This minimum requirement provided for a reasonable margin of confidence with a 10% probability of a chance change of 2 more correct.

III. Structures or categories emerging at the outset of the experiment (but not acquired during the experimental period). This category includes structures for which Ryan scored two correct at Time 1 and 1, 2 or 3 correct at Time 2 (change of +/-1 or 0), or for the event that Ryan scored 3 correct at Time 1 and only 2 correct at Time 2. Both conditions suggest instability or ongoing development of comprehension of the structure. Neither condition allows a claim of "acquisition" as defined here, by (a) having a level of change below the reasonable margin of confidence of 2 or (b) by having a Time 2 score below the agreed acquisition level of three.

IV. Structures or categories emerging during the experiment. This category includes structures for which Ryan scored 0 or 1 correct at Time 1 and, 2 correct at Time 2. This performance suggested that Ryan had developed some comprehension of the structure during the period but had not reached a level of performance stable enough to indicate acquisition.

V. Structures or categories not yet acquired. This category includes structures for which Time 1 scores were 0 or 1 and Time 2 scores were also 0 or 1.

Table 2

Formulas for Judgment of States of Acquisition

State	Time 1	Time 2	Change required
	Number correct		
I	3 or more	3 or more	not applicable
II	<3	3 or more	at least +2
III	2	1, 2 or 3	0 or +/-1 only
or	3	2	-1
IV	0 or 1	2	not applicable
V	0 or 1	0 or 1	not applicable

Table 3

Receptive Structure/Category Test Results

Structure/category	Sample size[a]	Number correct			State[b]
		Time 1	Time 2	Change	
Active Voice Word Order	5	3	2	-1	III
Attributive/Stative	3	3	2	-1	III
Aux-Be Singular/Plural	2*	1	0	-1	V
Clefting	6	2	4	+2	II
Comparative Marker	5	5	4	-1	I
Complex Modification	7	2	5	+3	II
Complex Negation	4	0	0	0	V
Disjunction	6	1	2	+1	IV
Noun Singular/Plural	12	4	8	+4	I
Double Function Relative Pronouns (what, where)	5	1	2	+1	IV
Object Pronouns	4	3	2	-1	IV
Object Relative Clause	3	1	0	-1	V
Possessive Adjectives	3	1	2	+1	IV
Possessive Morpheme	2*	0	2	+2	IV
Reflexive Pronouns	1*	0	0	0	V
Declaratives	4	4	4	0	I
Simple Modification	8	3	5	+2	I
Simple Negation	6	3	2	-1	III
Subject Pronouns	4	2	3	+1	III
Subject Relative Clauses	6	0	1	+1	V
Subject Relative Clauses (N+V)	4	1	0	-1	V

Table 3 continued

Structure/category	Sample size[a]	Number correct			State[b]
		Time 1	Time 2	Change	
Verb 3rd Person Sing./Plural	2*	0	0	0	V
Who vs. What	3	0	2	+2	IV
Wh-Question of Object	3	0	1	+1	V
Wh-Question of Subject	6	3	5	+2	I
Before/After I	4	2	2	0	III
Before/After II	4	2	2	0	III
Passive Voice Word Order	5	0	2	+2	IV
Tense and Aspect Markers					
Present	5	5	4	-1	I
Present perfect	3	2	1	-1	III
Past	2*	0	1	+1	V
Future	2*	0	1	+1	V
Conjunctions					
and	3	0	3	+3	II
but	1*	0	0	0	V
Locative Prepositions					
(I) -in relation to self					
in	4	4	3	-1	I
on	4	4	4	0	I
under	4	3	3	0	I
in back of	4	2	2	0	III
in front of (&)	4	0	3	+3	II

Table 3 continued

Structure/category	Sample size[a]	Number correct			State[b]
		Time 1	Time 2	Change	
(II) -in relation to object with intrinsic front					
in	4	3	4	+1	I
on	4	4	4	0	I
under	4	3	4	+1	I
in back of	4	3	3	0	I
in front of	4	0	0	0	V
behind	4	1	3	+2	II
(III) -in pictures with objects with intrinsic front					
in	3	2	1	-1	III
on	6	4	3	-1	I
under	4	0	3	+3	II
in front of	1*	1	1	0	V
behind	3	2	2	0	III

*These samples fell below the 3 presentation minimum and are presented here as incidental findings only.

[a]Sample size represents the number of separate presentations and accompanying arrays for each structure/category.

[b]States are
I... acquired previous to the experimental period
II... acquired during the experimental period
III... emerging at the outset of the experiment
IV... emerging during the experiment
V... not yet acquired

Table 4 presents a breakdown of the structures and categories as they fall into the various states of acquisition with the age of mastery by normal children, based on the normative sample taken by Curtiss, Kempler, Yamada (1981), who used successful performance by 80% of the age group as their criterion for mastery.

Table 4

States of Acquisition for Ryan's Receptive Structures/Categories and Age of Mastery in Normals[a]

Structure	Age of mastery by normal children (in years)
I. Acquired previous to the experimental period	
Comparative Marker	4
Simple Declarative	2
Simple Modification	2 - 3
Wh-Question of Subject	4
Present Tense	5
Locative Prepositions	
I. in, on, under	--
II. in, on, under, in back of	--
III. on	--
II. Acquired during the experimental period	
Clefting	--
Complex Modification	--
Conjunction "and"	--

Table 4 continued

Structure	Age of mastery by normal children (in years)
III. Emerging at the outset of the experiment	
Active Voice Word Order	4
Attributive/Stative	--
Object Pronouns	--
Simple Negation	--
Subject Pronouns	6
Before/After I	5
Before/After II	5
Present Perfect	--
Locative Prepositions	
I. in back of	5
II. in, behind	--
IV. Emerging during the experiment	
Disjunction	4
Double Function Relative Pronouns (what, where)	--
Possessive Adjectives	--
Possessive Morpheme	--
Who vs. What	8
Passive Voice Word Order	5

Table 4 continued

Structure	Age of mastery by normal children (in years)
	V. Not yet acquired
Aux-Be Singular/Plural	--
Complex Negation	4
Object Relative Clauses	8
Reflexive Pronouns	--
Subject Relative Clauses	4
Subject Relative Clauses (N + V)	7
Verb 3rd Person Sing./Plural	5 - 8
Wh-Question of Object	5
Past Tense (-ed)	6
Future Tense (will)	7
Locative Prepositions:	
II. in front of	--
III. in front of	--

[a]Based on the normative sample taken by Curtiss, Kempler, Yamada (1983), who used successful performance by 80% of the age group as their criteria for mastery.

The results presented in tables 3 and 4 indicate that prior to the experiment, Ryan demonstrated comprehension of grammatical structures and categories usually associated with acquisition below the age of 5 years in normal populations. The structures/categories of State I are minimal in their application of transformational rules[3] and thus syntactically simple.

[3]Assuming Chomsky's (1965) transformational grammar.

In State II the development of comprehension of more complex structures is evident. Most significant is the development of comprehension of concatenated structures using complex modification and conjunctions. Improvement in understanding these structures could be attributed an improved ability to parse sentences and their constituents. In a standard theory transformational framework, the comprehension of complex modification and conjoined structures implies an ability to handle more complex phrase structure than is required for simple modification and simple unconjoined sentences, respectively.

The most striking change shown in State I is the comprehension of clefts; this is the only example of comprehension of embedded structures either before or after the experimental period. Lempert and Kinsbourne (1980) present research data which suggests that comprehension of clefts is not usually acquired in normal children until 6 or 7 years of age (see discussion for details of their study). In decoding the sentence,

(1)"It's the girl that the dress is sewing"[4]

and matching it to a correct picture from a choice of four pictures presenting a girl and a dress in various permutations, an appeal to left-to-right decoding will not hold, nor does matching a sentence to a picture based on logical or real life experience. In a transformational analysis, clefting requires the application of embedding rules to be understood, rules which were not being applied by Ryan in State I. The acquisition of comprehension of clefts suggests that some form of embedding rule was added to the grammar between the beginning and end of the experiment. Claims of transformational grammar aside, it is necessary to put the constituents into their intended semantic relationship in order to

[4]This structure was paired with an absurd but visually clear picture of a dress putting stitches into a girl.

understand the structure and it appears that Ryan acquired the ability to do so during the course of the experiment.

Compared with States I and II, the emerging structures listed in States III and IV are, for the most part, correlated with a later age of mastery in the normal population (4 to 8 years). Morphological aspects appear predominant in these stages for Ryan, e.g. simple negation, subject pronouns, possessive adjectives, possessive morpheme. Interesting parallels can be seen between States II and IV in the sense that although comprehension of the conjunction "and" was acquired, the disjunction "or" only began to emerge during the experimental period. Similarly "Clefting" was acquired, yet a very similar structure in terms of its word order, i.e. "Passive Voice Word Order" only began to emerge.

Structures not yet acquired, State V, were predominantly those requiring embedding and/or of greater structural complexity, e.g. Subject Relative Clauses, Object Relative Clauses, Complex Negation, Reflexive Pronouns. In addition, the results for past and future tense suggest that they were not acquired. (This observation, however, is of incidental weight only, since the sample size for these structures fell below the three presentation minimum.) The age of mastery in normals for the structures of State V ranged from 4 to 8 years with most structures falling at 5 years or above.

Overall, structures which emerged during the experimental period have a different quality from structures previously acquired. There was an expansion in the number of transformations available for application in comprehension. Indeed, for the first time we see transformations involving phrase movement (clefting), deletion and concatenation (conjoining and complex modification.) The acquisition of comprehension of Simple Negation and Active Voice Word Order would have been more consistent with the structures already understood and normally

expected to be understood by 4 years of age. (See table 5.) It is proposed that acquisition observed during the experimental period was different in quality to the acquisition level established at the outset.

Standard Comprehension Test Results

Two standard measures of aspects of language acquisition were administered at both Time 1 and Time 2. (See table 5.)

The Peabody Picture Vocabulary Test (PPVT) was conducted to provide a measure of word comprehension, to guide choice of vocabulary for presentation structures in the assessment of comprehension, as well as to assess development from start to end points. Results indicated no measurable difference in vocabulary over the duration of the experiment (a difference of 4 points in the raw score is negligible) and the subject's performance for both administrations of the PPVT remained below the first percentile for the standardized results for children of his chronological age. Indeed, these results suggest no growth in comprehension vocabulary during the experimental period.

The Test of Auditory Comprehension of Language (TACL) was chosen because it is one of the few standardized tests which assess comprehension of a variety of structures within Ryan's estimated language age. Results suggest a development of 4 months in age equivalency during the experimental period. This finding hinges precariously on a difference in the raw score of a mere 3 points and is therefore suspect in its significance. The results do indicate a receptive language level corresponding to approximately 4;0 with respect to a normal population, and are useful in corroborating other comprehension measures. In addition to the standardized results provided by the TACL information was also extracted from it to form part of the corpus of comprehension structure/category results.

Table 5

Results from Standard Receptive Language Tests

Time	Raw Score	Age Equivalent	Comment
		Peabody Picture Vocabulary Test	
1	51	4;6	Difference is insignificant as scores remained below the 1st percentile for Ryan's chronological age.
2	47	4;3	
		Test for Auditory Comprehension of Language	
1	64	3;10	Difference is of questionable significance due to change of only 3 in the raw score.
2	67	4;1	

Production Results

Data on Ryan's productive language was derived from language samples gathered at two points in the experimental period--at the outset (Time 1 -April) and at the end (Time 2 -October)--as well as through informal observation. Audio and video equipment were used to record the sessions for subsequent analysis, following the methods described in Chapter 2. Transcription and coding of recordings provided description of the situation (e.g. actions, toys, books) and the speakers (i.e. who was saying what and in what context). Since Ryan used a variety of modalities in his productive language (sign, mime, gesture, Bliss symbols, activation of the VOIS 135 and some spoken words), each expressive unit was coded for its mode. (These distinctions were contrasted on the transcription through use of various combinations of ink colour and upper and lower case letters.)

The output of a nonverbal child does not lend itself to evaluation under the classical notion of "utterance." Ryan could produce very few spoken words and the bulk of his output was through the many other expressive modalities at his disposal. In this analysis, the notion of utterance was expanded to accommodate Ryan's multimodal production. (For simplicity's sake, the constituents of Ryan's utterances are henceforth referred to as "words.") Boundaries for initiation and termination of an utterance provided the criteria for defining an utterance. These criteria were:

1. Utterance Initiation

This involved deliberate initiation of productive communication through the use of signs (related to American Sign Language), idiosyncratic signs (discrete gestures which were used consistently and repeatedly), Bliss symbols, the VOIS 135 and spoken words.

2. Utterance Termination

Termination was determined by Ryan regaining eye contact with the listener or divergence into another activity, e.g. play, manipulation of objects, movement from the communication situation.

A single utterance was deemed to be in process if Ryan seemed intent upon finding or selecting symbols or words on his wordboard or VOIS 135. He also maintained continuity of a single utterance by linking signs, discrete gestures, symbols or words with mime (perhaps to compensate for words lacking in his expressive vocabulary). Once the criteria for utterances were established, samples were then analyzed for mean length of utterance (MLU), word types and tokens, and utterance types and tokens.

Mean Length of Utterance

A core of 50 utterances from the middle of each sample was used in calculation of MLU in words, as defined above. Considered as utterance units in calculation were: signs, idiosyncratic signs, Bliss symbols, VOIS 135 activation and spoken words. A breakdown of the data used for calculating Ryan's MLU is presented in table 6. The results indicate a shift in MLU from 1.74 at Time 1 to 2.14 at Time 2. When Ryan's MLU results are matched with the predicted age of MLU for normal children (Miller & Chapman 1979), we see a shift in the corresponding predicted median age scores suggestive of productive development of about 3 months. (See table 7.)

Table 6

Data for Calculation of Mean Length of Utterance

Length of utterance in words	Number of utterances	Total words
	Time 1	
1	27	27
2	19	38
3	4	12
total	50[a]	87
	Time 2	
1	13	13
2	22	44
3	10	30
4	5	20
total	50[a]	107

[a]A core of 50 utterances was taken for analysis from the middle of each sample.

Table 7

Ryan's Mean Length of Utterance and Predicted Age from Miller & Chapman (1979)[a]

	Time 1	Time 2
MLU (in words)[b]	1.74	2.14
Median Age (in months)	24.6	27.7
Age Range in Months (+/- 1 SD)	20.1 to 25.1	22.3 to 33.1

[a]Predicted age is presented here only as a guideline and is not definitive. Miller & Chapman produced their data from speech samples of 123 children, 17 to 59 months of age in Madison, Wisconsin. No reliability or validity information was provided in their analysis.

[b]Calculated by total words (tw) divided by total utterances (tu) for each sample, {tw/tu = MLU }.

Word Types and Tokens

The same core of 50 utterances employed in the calculation of MLU was used in calculating a measure of vocabulary diversity or "type-token ratio" (TTR) (Templin, 1957: 160). Ryan's "words" were defined using the same criteria as for calculation of MLU. TTR is calculated by dividing the types of different words by the total words for a chosen sample. Table 8 presents the age and TTR correspondences found by Templin. In Templin's study, the change in mean TTR between 6 month age intervals range from 0 to +0.02. The change in Ryan's TTR over the same period was +0.07, indicating a notable expansion in productive vocabulary. Templin's results for children 3;0 yield a mean TTR of 0.45, close to Ryan's score of 0.44; however, Templin's three-year-olds achieved this ratio with a group mean for MLU of 4.1 versus Ryan's MLU at Time 2 of 2.14. This contrast

reflects the nature of Ryan's production at Time 2: essentially telegraphic and high in communicative content. The low redundancy and high content nature of Ryan's production may have skewed the TTR ratio higher than it should be. The high content/low redundancy factor also affects comparability, as we would expect Templin's ratios to be higher if only content words were counted. Despite these problems of comparison, Ryan's TTR results still indicate that there was a definite expansion in productive vocabulary.

Table 8

Templin's Calculation of Vocabulary Diversity[a]

	Different Words		Total Words		Type-Token Ratio
Age	Mean	SD	Mean	SD	(different words/total words)
3;0	92.5	26.1	204.9	61.3	0.45
3;6	104.8	20.4	232.9	50.8	0.45
4;0	120.4	27.6	268.8	72.6	0.45
4;6	127.0	23.9	270.7	65.3	0.47
5;0	132.4	27.2	286.2	75.5	0.46

[a]Adapted from Templin (1957) (using 480 subjects).

Table 9

Type-Token Ratios for Ryan

Age	Different Words	Total Words	Type-Token Ratio[a]
7;4	31	87	0.37
7;11	47	107	0.44

[a]Calculated by {different words/total words}.

Utterance Types and Tokens

The utterances produced in the two samples were analyzed for their structural type and their frequency of occurrence in the sample. Table 10 displays the results of this analysis. An increase in length and structural variety is evident between the two samples. While two word noun and verb combinations remain the dominant structural type, we can see a significant advance in structural length and variety with the appearance of four word combinations at Time 2. The grammatical categories of noun, verb, adjective and pronoun were identified for each word as appropriate.

Table 10

Utterance Types and Tokens

Utterance type[a]	Tokens	
	Time 1	Time 2
2 Word		
N+V	8	7
V+N	1	6
N+N	5	--
V+V	--	1
N+adj	3	1
adj+N	1	6
prep+N	1	--
Pro+V	--	1

Table 10 continued

Utterance type[a]	Tokens	
	Time 1	Time 2
3 Word		
N+N+N	1	1
N+N+V	2	--
N+V+N	--	2
V+N+V	--	1
N+N+adj	1	--
adj+N+N	--	3
N+adj+N	--	1
V+adj+N	--	1
N+V+adj	--	1
4 Word		
N+V+N+V	--	1
adj+N+N+V	--	1
adj+N+N+adj	--	1
V+N+V+prep	--	1
V+N+prep+adj	--	1

[a]The abbreviations are: N noun, V verb, adj adjective, Pro pronoun, prep preposition.

Cognition Results

The Leiter International Performance Scale: Arthur Adaptation (LIPS), was administered to Ryan to provide a measure of relative nonverbal cognitive level. This measure was done at the midpoint of the research period. Results indicated that Ryan was functioning cognitively at about the five year level with respect to norms provided by the LIPS.

CHAPTER 5

DISCUSSION

Summary of Results

Comprehension

Results indicate that Ryan acquired comprehension of complex modification and the conjunction 'and', during the experimental period. These findings may be stated with reasonable certainty, as both structures underwent an improvement of +3 in raw score, correlated with a probability of 3%. Clefts were also acquired with reference to criterion (see table 2), although this finding was not supported with the same degree of statistical certainty as the acquisition of complex modification and the conjunction 'and'. (Clefts underwent an improvement of +2 in raw score, with a probability of 10%.) Test performance at Time 2 indicated that Ryan was able to decode clefts even with reversed logical word order. Structures acquired prior to the experiment were generally compared with an age range for mastery in normal children of two to five years, whereas structures acquired during the experiment fell in the five to six years range for normal children (Curtiss, Kempler and Yamada, 1981). (See table 4.) Results from the Peabody Picture Vocabulary Test (PPVT), indicated no growth in comprehension vocabulary during the research period. (See table 5.)

Production

Production results indicated a change in mean length of utterance (MLU) from 1.74 to 2.14 words, comparing with a normal developmental period of approximately three months (see table 7). Analysis of type-token ratios (TTR) for words used in the language samples suggested an expansion in the variety of lexical items used in productive vocabulary from Time 1 to Time 2 (see table 9). Analysis of structures used in production indicated word combinations of greater length and variety for Time 2 (see table 10).

Cognition

Cognitive assessment using the Leiter International Performance Scale: Arthur Adaptation, indicated that Ryan was functioning at about the five year level when compared with the normal population. Age level findings were generated for other results and are displayed in table 11.

Summary

Age level results displayed in table 11 suggest selective and uneven development in language abilities. From beginning to end of the experiment MLU increased, reflecting an improved ability to combine words into longer structures. TTR for words increased noticeably, suggesting a larger productive vocabulary. Interestingly, this observation is juxtaposed with an apparent halt in the development of comprehension vocabulary. The picture is one of an expanding productive vocabulary and a seeming quiescence in the development of comprehension vocabulary. One could speculate that Ryan was focussing on the most salient aspect of his vocabulary at the time, i.e. production, perhaps to the neglect of other aspects of his vocabulary, i.e. comprehension.

Table 11

Age Correlations for Ryan

Measure	Age in Years		
	Time 1	Time 2	Change
Cognition[a]	(5;0)		--
Mean Length of Utterance[b]	2;1	2;4	+0;3
Comprehension Vocabulary[c]	4;6	4;3	-0;3
Test for the Auditory Comprehension of Language[d]	3;10	4;1	+0;3

[a]Based on results from the Leiter International Performance Scales: Arthur Adaptation, Leiter and Arthur (1955).

[b]Based on data from Chapman and Miller (1979). See table 7.

[c]Based on results from the Peabody Picture Vocabulary Test, Dunn and Dunn (1981). See table 5.

[d]Carrow (1973). See table 5.

Comprehension results for structures suggest that Ryan acquired the ability to apply rules for comprehension of concatenated and embedded structures during the experiment. The acquisition of this comprehension ability implies the addition of processes to Ryan's grammar which were not available to him at the outset of the experiment. Comprehension of clefts indicates an ability to use syntactic structure to overcome contradictory surface word order. For example, Ryan responded by choosing the correct picture at Time 2 but not Time 1, from arrays of four pictures presented with the sentences:

(1) "It's the girl that the dress is sewing."

(2) "It's the girl that the dress is shaking."

Both sentences were paired with absurd but visually clear pictures depicting the actions described. The comprehension of embedded structures suggests that Ryan was applying grammatical strategies of a different quality than those used at the outset of the experiment.

Discussion

The emergence of comprehension of clefts is the most striking aspect of Ryan's development during this study. Information relevant to the discussion of clefts is contained in a study conducted by Lempert and Kinsbourne (1980). They examined the development of preschool children's sentence comprehension strategies with respect to word order, specifically for reversible passive and inverted cleft sentences. They suggested that

> in decoding irreversible and improbable sentences such as 'The baby feeds the mother,' young children may disregard word-order information and instead so assign the agent role that the sentence is taken to refer to a relatively probable event. (p.371)

They noted that 'probable event' strategy would not be reliable for the child when applied to sentences in which either noun could be agent; their study attempted to shed some light on strategies children used in decoding these sentences.

Fifty-two preschool children between the ages of 2;5 and 6;3 were used as subjects. In a summary of their procedure Lempert and Kinsbourne stated that "the children were required to act out the meaning of reversible passive and inverted cleft sentences. Active and cleft sentences were standard order controls intended to focus the child's attention on sentence structure" (p.372). Pertinent to our discussion are the sentences that were used: (a) cleft, e.g. "It's the cow that bumps the horse" and (b) inverted cleft, e.g. "It's the truck that the wagon

bumps." Children acted out the sentences using appropriate toys.

Lempert and Kinsbourne applied a two-tailed binomial test to their results which indicated that (within each age group) inverted clefts were significantly easier than passives for the younger group of children (2;5 to 4;5), but more difficult than passives for the older group (4;6 to 6;3). They suggested that this result was due to the application of an agent+action strategy (agent role assigned to the noun immediately preceding the verb), which decreased in use with maturity. Lempert and Kinsbourne concluded that,

> by using whatever strategies are available to them, young children bypass the need for intensive structural analysis... Major syntactic changes between ages five and seven may be one outcome of a generally more adaptive problem-solving approach emerging in this period. (p.378)

With respect to the data and conclusions of Lempert and Kinsbourne (L&K), Ryan's comprehension of the cleft constructions in examples (1) and (2) could be attributed to the application of an agent+action decoding strategy. This would also account for Ryan's poorer performance on comprehension of passive constructions. However, unlike the subjects of L&K, Ryan was also confronted with the task of deciphering an absurd relationship in which a strategy of 'probable event' could never apply. Comprehension of these absurd relationships may reflect the application of a more adaptive problem-solving approach in line with L&K's speculations on the abilities of older children (5 to 7 years old). Chapman (1981), defined comprehension as a process of problem-solving through the use of multiple cues, inputs and inferences. It could be construed that Ryan's ability to draw inferences improved from Time 1 to Time 2 with the result that he was able (1) to identify what was required of him in the comprehension task (i.e. choose the matching picture no matter how ridiculous it may seem) or, (2) to favour thematic strategy over 'probable event' strategy.

Table 11 reveals that production abilities at Time 2 were in the range of 2;4, comprehension abilities for vocabulary were in approximately the range of 4;3, and cognitive abilities were in the range of 5;0. The null hypotheses tested in this research proposed that the development of comprehension of syntactic structure would be consistent with gains expected from maturational development alone. Normative data for the comprehension of clefts is not available in the literature. However, group data from Lempert and Kinsbourne (1980) suggests that comprehension of clefts (standard and inverted versions) is not demonstrated with any consistency until age five. Given that Ryan's other language abilities fall in the 2 to 4 year age range for normal children, the development of comprehension of a structure associated with a 5 year level (or perhaps older with respect to comprehension of absurd semantic relations in addition to complex word order) suggests an extraordinary jump in syntactic development, one which would not be anticipated from observing Ryan's rate of development prior to the study. Therefore, I conclude that (1) the change in Ryan's comprehension of syntax, from Time 1 to Time 2, is not consistent with gains expected from maturational development alone, and leads to rejection of Hypothesis 1. In addition, the ability to comprehend structures with reversed logical word order suggests the application of rules distinctly different from those available to Ryan at Time 1, and indicates a different quality of acquisition than would be anticipated from gradual maturational development alone. Therefore, I also conclude that (2) the qualitative difference in comprehension of syntactic structures from one test period to the next (i.e. the kinds of rules he knows at each time of testing) does not proceed in the step-by-step fashion expected from maturational development alone and leads to the rejection of Hypothesis 2.

The experiment was conducted as a means of examining the interaction of comprehension and production. The conclusion that comprehension of clefts was not an anticipated next step in syntactic development at this level of development leads to the question: "What was responsible for this development?" Which factors could account for the significant expansion of production vocabulary and MLU with a simultaneous halt in the development of comprehension vocabulary? Potential answers to these questions will be considered under (1) training and exposure, (2) added modality, (3) auditory feedback, and (4) improved communication experience.

Training and Exposure

The methods for training Ryan in the use of the VOIS 135 are described in Chapter 3. Practice with the device usually involved a play situation in which a particular structure was employed to resolve a problem. The exact nature of these sessions is presented in detail in Chapter 3. The structures used for exposure/training are listed in table 1. It would seem plausible to conclude that use of the exposure structures in training sessions contributed to an increase in MLU; however, the case is not quite so clear. The language sample taken at Time 2 contains only two examples of structures similar to those used in exposure/training sessions, they are:

(3) "cereal allgone" (N allgone)

(4) "Where boy?" (Where N?)

(N + V combinations were used in the exposure/training sessions but they are discounted due to their frequent appearance in the language sample for Time 1, indicating a prior ability to use this structure. See table 10.) Use of structures through the training sessions may have stimulated Ryan to consider ways that

words could be combined but there is no rationale to support the notion that exposure/training sessions contributed directly to his increased length of utterance. Since none of the structures used in the exposure/training sessions were either embedded or concatenated, we cannot attribute acquisition of comprehension of clefts, complex modification or the conjunction 'and' to direct influence from these sessions.

Added Modality

The nature of Ryan's communication is multimodal: sign, mime, gesture, Bliss symbols, and a few spoken words. The introduction of the VOIS 135 provided another modality for expression. It is possible that use of the VOIS 135 allowed for a greater choice of words for production and, thus, contributed to the increase observed for MLU and TTR. About 20 new words were added to the VOIS 135 display over the course of the experiment. In the Time 2 language sample only two of these new words ("scared," "allgone") appear in the portion of the sample used in the calculation of MLU and TTR. Elimination of these two words from the calculation of TTR has little effect, changing the TTR from 0.44 to 0.43 for Time 2. Therefore, a greater choice of words for production is not directly responsible for improvements seen for MLU and TTR. On the contrary, evidence suggests that Ryan became more adept at using his original vocabulary.

One striking subjective observation between the language samples of Time 1 versus Time 2 is that Ryan seemed to be able to switch modalities with greater ease at Time 2. During the sample taken for Time 2, Ryan was more explicitly active in directing the listener's attention either to himself for signs or gestures, to his Bliss communication board, or to the VOIS 135. This behaviour suggests that Ryan improved his discourse skills and became a more active partner in the communication process.

Auditory Feedback

One of the most significant aspects of using the VOIS 135 was the potential for linguistic auditory feedback. The TALK function available on the device allowed a selection of words, chosen serially from display cells, to be spoken as a whole phrase. (See Appendix 2 for details of VOIS 135 functions.) Through use of the TALK function, Ryan was able to hear his utterances as whole phrases, which may have contributed to development of an improved sense of structural and combinatorial possibilities. Given that auditory feedback was a novel part of Ryan's communication, it seems reasonable to assume that it may have been at least partly responsible for the gains seen in MLU and TTR.

Another important aspect of linguistic auditory feedback offered by the VOIS 135 was the degree of independence it afforded Ryan in the compilation, expression and repetition of messages. All of Ryan's other modalities (except his few spoken words) require full visual attention of the listener. In addition, the listener must store the message in his short-term memory and compile it for himself into a meaningful combination. The TALK function allowed Ryan to compile word combinations independently and use the auditory output of the device to attract the listener's attention. Independent output may have improved Ryan's image of himself as an autonomous communicator, leading to greater interest and confidence in selection and combination of words for production.

While auditory feedback from use of the VOIS 135 may have contributed to gains in production abilities, its role in the development of comprehension is less clear. All auditory feedback from the VOIS 135 came about as a result of Ryan's production performance with the device. Therefore, speech based auditory feedback for syntactic structures had to be first performed in production. Since there were no observed examples of embedded structures in Ryan's production it

is difficult to claim a link, (direct or indirect) between auditory feedback and comprehension of clefts. However, when we look at the structures Ryan produced using the device, there are examples from the Time 2 sample which suggest that he was using a telegraphic variation of concatenation productively.

(5) "Girl sit chair fall."

Example (5) was produced in the description of a girl who sat on a small chair which broke under her weight. The utterance could be interpreted as "The girl sat in the chair and fell." Thus, Ryan was using concatenation without marking it explicitly with the conjunction 'and'. In as much as auditory feedback contributed to increased length of utterance, it may have furthered the development of comprehension of concatenated structures, e.g. complex modification, and phrases conjoined with the conjunction 'and'.

With respect to the development of comprehension of syntactic structures, Shipley, Smith and Gleitman (1969) found that children at the single-word stage of production showed a response preference for reduced syntactic forms which more closely approximated their own output (i.e. single-word commands), whereas children at a telegraphic stage (two and three word utterances) responded better and more readily to well-formed structures (i.e. complete sentences). Ryan's MLU changed from 1.74 to 2.14 words from Time 1 to Time 2; table 10 documents a notable expansion in utterance length and variety between the two sample times. Although Ryan's utterances were telegraphic at the outset of the experiment, it may have been the case that development had not occurred to a sufficient level to be reflected in improvements in comprehension. I propose that there may be a critical level of development in the holophrastic to telegraphic stages correlated with the evolution of comprehension of complete (and perhaps complex) structures. A critical level, as such, may be related to the point at which production

performance becomes sufficiently salient to provide feedback information which is analyzable and accessible for application to the competence accessed by comprehension. While this proposal is supported by the conclusions of Shipley et al., it is a strong claim and would have to fit into a comprehensive theory of acquisition.

The issue of the role of feedback is pertinent to models of comprehension, production and competence considered in Chapter 1 (see figure 1). Let us restrict our discussion of the role of feedback for Ryan's acquisition to the structural type for which there is tangible data from both comprehension and production performance modes, i.e. concatenation. Bloom (1970) has suggested that children's early telegraphic utterances are often reductions of more complete underlying structures (e.g. "Mommy sock" may express "this sock belongs to Mommy" or "Mommy take my sock off," etc.). This 'rich' interpretation implies that competence for production may be greater than that reflected in performance. A similar gap between competence and performance for comprehension would imply that the child had the knowledge to understand but was unable to demonstrate it. Bloom used the 'rich' interpretation of production to explain children's ability to understand utterances beyond their production performance capacities. The case for 'rich' interpretation can be made with even greater ease in Ryan's use of concatenation (example 5), since there is more supporting surface structure and the omission of the function word and could be accounted for as characteristic of Ryan's efficient use of limited production performance abilities. In terms of comprehension it is possible that Ryan understood the concatenated structures at Time 1 but was unable to demonstrate comprehension in performance. At Time 2 Ryan may have (a) understood the context better or (b) developed better comprehension inferences (Chapman, 1981), which allowed him to demonstrate his

comprehension in performance. This discussion leads to the question of how models of competence and performance would apply to these observed developments. This question is addressed below with reference to the models presented in Chapter 1 (see figures 1 and 2).

(1) Competence as a single unified body of knowledge.

If linguistic competence forms a central body of knowledge, undifferentiated in its content with respect to comprehension or production (see figure 1), then underlying knowledge of both comprehension and production of concatenated structures would be available to Ryan for potential application in performance. The precedence of either comprehension or production over the other would be related to developments in respective performance abilities. The role of feedback between comprehension and production would be inconsequential in the development of competence since knowledge would be centrally acquired from both performance modes. This model supports the 'rich' interpretation hypothesis presented by Bloom (1970) and the conclusion drawn by Fernald (1972) that comprehension and production developed concurrently, in relative equilibrium.

(2) Competence as a dichotomous organization for comprehension and production.

If competence for comprehension and production are stored and organized separately (competence$_c$ versus competence$_p$), then feedback becomes a required mechanism for the transfer of knowledge between competence$_c$ and competence$_p$. This feedback may be indirectly observable at the performance level, e.g. the initial appearance of a structure in production and subsequent development in comprehension, or vice versa. This would support the contention that Ryan needed to develop his competence for production of concatenated structures before he

could comprehend them (or vice versa). This model is supported by the conclusions of (a) Fraser, Brown and Bellugi (1963) and Shipley, Smith and Gleitman (1969) for children in the single-word stage (even though they presented conflicting conclusions, both are possible in this model), and (b) Chapman and Miller (1975) for acquisition of word order.

In addition to these possible configurations for competence, there are various possible directions of interaction between performance modes of comprehension and production which were outlined in Chapter 1 (see figures 1 and 2) as

(a) Information flows only from competence to performance modes. There is no feedback from either performance mode.

(b) Information flows from competence to performance modes and competence receives feedback from comprehension performance only (no feedback from production performance).

(c) Information flows from competence to performance modes and both comprehension and production performance modes provide feedback to competence.

The results for concatenation suggest that, superficially for this structure at least, relation (c) applies best. However, this suggestion is weak since when (a), (b), and (c) are considered in various permutations with competence models (1) and (2), the relationships become quite intricate and it is difficult to make a strong case for one particular relationship over another.

All of these models hold potential application to the findings presented for Ryan and, as mentioned, it does not appear that the results empirically favour one in particular. The models discussed so far have been based on Chomsky's definitions of competence and performance. During the two decades since Chomsky first formulated these definitions there has been a plethora of alternate

competence-performance models and definitions (see Bever, 1970; Langendoen, 1975; McNeill, 1975; Miller, 1975; and Salzinger, 1975). Chapman (1981) outlined perhaps the most complete proposals on the cues, inferences and strategies employed in comprehension to date, but the relationship of comprehension to production and the continuing controversy of competence and performance remain unresolved. Indeed, one of the major stumbling blocks in interpreting the role of feedback between comprehension and production in language acquisition is the lack of a coherent model.

The issue of the contribution of feedback to the changes seen in Ryan's language could be examined from the viewpoint of metalinguistic[5] skills. It is possible that auditory feedback provided by the device allowed for development of an enlarged concept of sentences. There may have been a higher level (metalinguistic) realization that phrases or sentences are entities made up of related linguistic components. Bloom and Lahey's (1978) hypothesis that comprehension and production "represent different underlying processes, with a resulting shift in influence between them in the course of language development" (p.238), might be apparent in this metalinguistic realization of the nature of phrases and sentences and thus, differentially applied with respect to comprehension versus production. It is proposed that Ryan may have realized that structures could be built up or broken down. In production this realization meant creating longer utterances and taking advantage of concatenation possibilities. In comprehension it entailed recognizing structures as relational frameworks which associated words in particular ways. The investigation of children's metalinguistic

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[5]'Metalinguistic' is used here in the sense of 'abstract knowledge about language', separate and distinct from knowledge of language per se.

concepts as they relate to children's improvement in comprehension and production in intervention settings is a possible topic for future research.

Another observation from this experiment which supports Bloom and Lahey's hypothesis is that, while development of production vocabulary proceeded, comprehension vocabulary showed no development. There would appear to have been a shift in influence or focus between comprehension and production during the experimental period. It may be that Ryan attended to the most dynamic and salient aspect of his communication during this period, namely production, to the neglect of comprehension. An avenue of future research could be the exploration of developmental rates for comprehension versus production and factors influencing the changing priority of one over the other.

Improved Communication Experience

Naturally, the communication environment surrounding Ryan responded to the introduction of synthetic speech. The VOIS 135 was a novelty to all who knew Ryan; adults and children alike were fascinated with its voice, how it worked and how Ryan used it. Ryan's mother was impressed with the device and enthusiastically encouraged him to use it daily at the dinner table and on family outings (e.g. visits to friends, relatives, etc.). Informal observations indicated that with synthetic speech output, the family interacted more with Ryan and, due to the independence afforded by the device, interaction was more ongoing and not limited to specific periods when (a) the parents had time to visually attend, and (b) an adult was around to interpret Ryan's signs/symbols to his nonsigning, preliterate peers.

Ryan's teacher was also intrigued with the potential of the device. She encouraged its use in classroom speaking situations. For example, one daily

activity in the classroom is centered on the calendar; students take turns each day leading the rest of the class through the calendar, e.g. day of the week, month, weather, special events, etc. Prior to Ryan's use of the VOIS 135, his participation had consisted of the teacher interpreting his communication (whether sign or symbol) to the rest of the class. The device clearly allowed a degree of independence not previously enjoyed.

In summary, the capacity for synthetic speech meant that (a) Ryan received more attention and, therefore, interacted more, and (b) he was able to involve a wider diversity of communication partners. There is little doubt that children learn language through interaction -- whether passive or active. (Evidence of this assertion is amply presented in accounts of "feral" children (Fromkin et al., 1974; Itard, 1932).) It is quite probable that increased interaction contributed significantly to the gains observed for Ryan's comprehension and production during the experiment.

This Study as the Basis for Future Research

This study has provided interesting and useful data about the nature of the comprehension-production relationship even though the information is limited in scope. Many of the limitations of the study rest on the fact that it is a single case study conducted in a restricted time period, with materials that were largely exploratory. These limitations will be briefly developed to give direction for future research projects of a similar nature.

Time

As discussed in Chapter 3, this study was limited to eight months, a time frame pragmatically motivated by deadlines associated with the loan of the device

and use of facilities. The full eight months were required to test Ryan using the extensive measures outlined in Chapter 3, train him in the use of the device and allow him sufficient time and experience with the device. Measures of developmental rate in a pre-experimental control period would have provided a better base line from which to gauge development. A more optimal research period would be two years: one year in which to establish a control level and rate of development, and a second year to complete the experiment. It would not be ethical, however, to deny a nonverbal child the best intervention available to establish a baseline.

Subjects

Only limited generalizations which can be drawn from a single-subject study. Ideally, access to a number of nonverbal children who could be matched for relative age and cognitive, linguistic and physical level would produce results of much greater generality. Since there is little likelihood of such ideal conditions, inferences will continue to be drawn from single-subject case studies.

Stimuli

The wide range of syntactic structures tested in this study meant that picture stimulus arrays had to be adapted from a variety of sources. Pictures were all clear line drawings. The number and arrangement of pictures per array, however, varied depending on the source they were taken from. The optimal stimulus set would consist of items drawn specifically for each presentation array. Visual stimuli drawn specifically for the investigation would provide uniformity of drawing styles and foils, and allow for a consistent number of pictures per array. Uniformity would improve comparability between structures and allow for stronger conclusions.

Sampling

Language samples were taken at the endpoints of this study. It is therefore possible that subtle developments which took place during the research were missed. In an ideal experimental design, language samples should be taken at two-month intervals to capture developments as they take place.

In addition to methodological limitations of this study, some of the lack of conclusiveness is related to the inadequacy (or absence) of a coherent theory of comprehension, production and competence. Attempts to amend this theory are fraught with philosophical and theoretical obstacles beyond the scope of this discussion. However, by amending experimental design, as above, we can improve the generality of findings which would, in turn, provide better guidance for the formulation of coherent theories.

Longtidudinal single subject studies are extremely time consuming, placing considerable demands on both the investigator and the child. Indeed, enacting modifications of time, stimuli and sampling as above, with only a single subject could easily entail a fulltime five-year project for the investigator from beginning to end. The demands upon Ryan in this study were considerable, particularly in terms of the time and energy required to participate in the detailed comprehension assessments: one month of testing at each end point, on the basis of approximately three, one-hour sessions per week. The time and energy demands for subject(s) and investigator(s) following the revised methods outlined above would clearly not be feasible in most cases. Therefore, adequate answers to our questions on the comprehension-production relationship are more likely to come from the triangulation of different kinds of studies, each contributing a different piece of the puzzle. The present study has contributed information to the comprehension-production relationship by reiterating the positions that (1)

comprehension can develop in the absence of speech production, and (2) comprehension and production appear to be related in situations where they coexist.

Clinical Implications

The results indicate that Ryan experienced dramatic progress in development of his production. As discussed above, much of this progress can be related to improvements in pragmatic and discourse abilities. The advantages of an augmentative communication system such as the VOIS 135 are summed up in the conclusions drawn in the next section. From these conclusions, we can see that by providing nonverbal children with a facsimile of speech output, we improve not only linguistic auditory feedback but also enable them to participate in a wider range of communicative situations. It is a psychological maxim that humans learn through experience. Therefore, by improving communicative experience through the use of synthetic speech, we are enhancing the potential of nonverbal children to learn language.

Conclusion

The findings of this experiment (with respect to complexity and relative age levels), support Lenneberg's (1962) position that comprehension precedes production in language acquisition. Several factors have been discussed as possible explanations for developments observed in production. In summary they suggest that:

1. Auditory feedback led Ryan to listen to utterances as structural wholes.
2. Ryan became a more active and independent partner in the communication exchange.

3. The synthetic speech device garnered Ryan more attention and more opportunities for interaction.

4. Synthetic speech gave Ryan access to a greater range of communication partners.

All of these points imply improved conditions for practicing and monitoring production. To some extent, increased interaction may explain some of the gains in comprehension. However, the exact nature of the relationship between comprehension and production in Ryan's language development cannot be explained without a coherent theory. Although interesting, the data cannot explain the nature of the relationship.

REFERENCES

Bartel, N. R. The development of morphology in retarded children. Education and Training of the Mentally Retarded, 1970, 5, 164-168.

Bates, E., Camaioni, L. and Volterra, V. The acquisition of performatives prior to speech. Merrill-Palmer Quarterly, 1975, 21, 205-226.

Benedict, H. Early lexical development: comprehension and production. Journal of Child Language, 1979, 6, 183-200.

Bever, T. G. The cognitive basis for linguistic structure. In J. R. Hayes (ed.), Cognition and the development of language. New York: Wiley, 1970.

Bloom, L. Language Development: Form and Function in Emerging Grammars. Cambridge, Mass.: M.I.T. Press, 1970.

Bloom, L. Talking, understanding, and thinking. In R. Schiefelbusch and L. Lloyd (eds.), Language Perspectives- Acquisition, Retardation, and Intervention. Baltimore: University Park Press, 1973.

Bloom, L., and Lahey, M. Language Development and Language Disorders. New York: Wiley, 1978.

Brown, R., Cazden, C., and Bellugi, U. The child's grammar from I to III. In C. Ferguson and D. Slobin (eds.), Studies of Child Language Development. New York: Holt, Rinehart and Winston, Inc. 1968. (Reprinted from J. P. Hill (ed.), Minnesota Symposia on Child Psychology. Minneapolis: University of Minnesota Press, 1968.)

Carrow, E. Test for Auditory Comprehension of Language. Austin, Texas: Learning Concepts Press, 1973.

Carter, A. The disappearance schema: case study of a second-year communication behavior. In E. Ochs and B. Schieffelin (eds.), Developmental Pragmatics. New York: Academic Press, 1979.

Chapman, R. S. and Miller, J. F. Word order in early two and three word utterances: does production precede comprehension? Journal of Speech and Hearing Research, 1975, 18, 355-371.

Chapman, R. S. What about comprehension? Proceedings from the Second Wisconsin Symposium on Research in Child Language Disorders, 1981.

Chomsky, N. On certain formal properties of grammars. Information and Control, 1959, 2, 137-167. (Reprinted in R. Luce, R. Bush, and E. Galanter (eds.), Readings in Mathematical Psychology, Vol. II. New York: Wiley, 1965.)

Chomsky, N. Aspects of the Theory of Syntax. Cambridge, Mass.: M.I.T. Press, 1965.

Clark, E. Knowledge, context and strategy in the acquisition of meaning. In D. P. Dato (ed.), Georgetown University Round Table on Languages and Linguistics. Washington, D. C.: Georgetown University Press, 1975.

Cressey, J. Fourteen Rats and a Rat-Catcher. Englewood Cliffs, N.J.: Prentice-Hall, 1976.

Cromer, R. "Case studies of dissociations between language and cognition." Paper presented at the Eleventh Annual Boston Univ. Conference on Language Development, Boston. October, 1986.

Curtiss, S., Kempler, D., and Yamada, J. The relationship between language and cognition in development. UCLA Working Papers in Cognitive Linguistics, 1981, 3, 1-60.

Clark, R. Performing without competence. Journal of Child Language, 1974, 1, 1-10.

Dunn, L. M. and Dunn, L. M. Peabody Picture Vocabulary Test-Revised. Circle Pines, Minnesota: American Guidance Service, 1981.

Ervin-Tripp, S. M. Imitation and structural change in children's language. In C. Ferguson and D. Slobin (eds.), Studies of Child Language Development. New York: Holt, Rinehart and Winston, Inc. 1968. (Reprinted from E. H. Lenneberg (ed.), New Directions in the Study of Language. Cambridge, Mass.: M.I.T. Press, 1964.

Fernald, C. Control of grammar in imitation, comprehension and production: Problems of replication. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 606-613.

Fraser, C., Bellugi, U., and Brown, R. Control of grammar in imitation, comprehension, and production. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 121-135.

Foster, R., Giddan, J. and Stark, J. Assessment of Chidren's Language Comprehension. Palo Alto, California: Consulting Psychologists Press, Inc., 1973.

Fromkin, V., Krashen, S., Curtiss, S., Rigler, D., and Rigler, M. The development of language in Genie: A case study of language acquisition beyond the "critical period." Brain and Language, 1974. 1, 81-107.

Furth H. and Youniss J. Congenital deafness and the development of thinking. In Lenneberg and Lenneberg (eds.), Foundations of Language Development, (Vol. 2). New York: Academic Press, 1975.

Garman, M. Early grammatical development. In P. Fletcher, and M. Garman (eds.), Language Acquisition. Cambridge: Cambridge University Press, 1979.

Gleitman, L. R., Shipley, E. F., and Smith, C. Old and new ways not to study comprehension: comments on Petretic & Tweney's (1977) experimental review of Shipley, Smith & Gleitman (1969). Journal of Child Language, 1978, 5, 501-519.

Goodall, J.S. Adventures of Paddy Pork. New York: Harcourt and Brace, 1968.

Goodall, J.S. Shrewbettina's Birthday. Toronto: Macmillan, 1970.

Greene, J. Psycholinguistics: Chomsky and Psychology. New York: Penguin, 1972.

Ingram, D. The relationship between comprehension and production. In R. Schiefelbusch and L. Lloyd (eds.), Language Perspectives- Acquisition, Retardation, and Intervention. Baltimore: University Park Press, 1973.

Itard, J. M. G. The Wild Boy of Aveyron (Translated by G. and M. Humphrey). New York: Century, 1932.

Karmiloff-Smith, A. Language development after five. In P. Fletcher and M. Garman (eds.), Language Acquisition. Cambridge: Cambridge University Press, 1979.

Keeney,T., and Wolf, J. The acquisition of agreement in English. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 698-705.

Kuczaj, S. A., II. Language play and language acquisition. In W. H. Reese (ed.), Advances in Child Development and Behavior. New York: Academic Press, 1982.

Lackner, J. R. A developmental study of language behaviour in retarded children. Neuropsychologia, 1968, 6, 301-320.

Langendoen, T. The relation of competence to performance. In D. Aaronson and R. Rieber (eds.), Developmental Psycholinguistics and Communication Disorders. New York: New York Academy of Sciences, 1975.

Leiter, R. G. and Arthur, G. Leiter International Performance Scale: Arthur Adaptation. New York: C. H. Stoelting Co., 1955.

Lyle, J. G. A comparison of the language normal and imbecile children. Journal of Mental Deficiency Research, 1961, 5, 40-51.

Lempert, H. and Kinsbourne, M. Preschool children's sentence comprehension: strategies with respect to word order. Journal of Child Language, 1980, 7, 371-379.

Lenneberg, E. H., Understanding language without the ability to speak: A case report. J. Abnormal. Soc. Psychol., 1962, 65, 419-425.

Lenneberg, E. H. Biological Foundations of Language. New York: Wiley, 1967.

Leonard, L. B., Newhoff, M., and Fey, M. C. Some instances of word usage in the absence of comprehension. Journal of Child Language, 7, 189-196.

Lovell, K., and Dixon, E. M. The growth of the control of grammar in imitation, comprehension, and production. Journal of Child Psychology and Psychiatry, 1967, 8, 31-39.

McNeill, D. The place of grammar in a theory of performance. In D. Aaronson and R. Rieber (eds.), Developmental Psycholinguistics and Communication Disorders. New York: New York Academy of Sciences, 1975.

Macrae, A. Combining meanings in early language. In P. Fletcher, and M. Garman, (eds.), Language Acquisition. Cambridge: Cambridge University Press, 1979.

Miller, G. A. Some comments on competence and performance. In D. Aaronson and R. Rieber (eds.), Developmental Psycholinguistics and Communication Disorders. New York: New York Academy of Sciences, 1975.

Miller, J. F. Assessing Language Production in Children. Baltimore: University Park Press, 1981.

Miller, J. F. and Chapman, R. S. The relation between age and mean length of utterance in morphemes. Unpublished manuscript, University of Wisconson-Madison, 1979.

Miller, J. F., Chapman, R. S., Branston, M. B., and Reichle, J. Language comprehension in sensorimotor stages V and VI. Journal of Speech and Hearing Research, 1980, 23, 284-311.

Miller, W. and Ervin-Tripp, S. The development of grammar in child language. In C. Ferguson and D. Slobin (eds.), Studies of Child Language Development. New York: Holt, Rinehart and Winston, Inc. 1968. (Reprinted from U. Bellugi and R. Brown (eds.), The acquisition of language. Monograph of the Society for Research in Child Development, 1964, 29, 9-35.)

Munsch, R.N. Murmel Murmel Murmel. Toronto: Annick Press, 1982.

Ormerod, J. Sunshine. New York: Lothrop, Lee and Shepard, 1981.

Petretic, P. A. and Tweney, R. D. Does comprehension precede production? The development of children's responses to telegraphic sentences of varying grammatical adequacy. Journal of Child Language, 1977, 4, 201-210.

Rice, E. Benny Bakes a Cake. New York: Greenwillow Books, 1981.

Ruder, K. F., Smith, M. D., and Murai, H. M. Response to commands revisited again. Journal of Child Language, 7, 197-203.

Ryan, J. Mental subnormality and language development. In Lenneberg and Lenneberg (eds.), Foundations of Language Development, (Vol. 2). New York: Academic Press, 1975.

Salzinger, K. Are theories of competence necessary? In D. Aaronson and R. Rieber (eds.), Developmental Psycholinguistics and Communication Disorders. New York: New York Academy of Sciences, 1975.

Schiefelbusch, R. L., Loyd, L. L. and Hoyt, R. K. Language Perspectives-Acquisition, Retardation, and Intervention. Baltimore: University Park Press, 1974.

Shipley, E., Smith, C., and Gleitman, L. A study in the acquisition of language: Free responses to commands. Language, 1969, 45, 322-342.

Simon, H. A. Studying human intelligence by creating artificial intelligence. American Scientist, 1981, 69, 300-309.

Skinner, B. F. Verbal Behaviour. New York: Appleton-Century-Crofts, 1957.

Templin, M. C. Certain Language Skills in Children. Minneapolis: University of Minnesota Press, 1957.

Werner, H. and Kaplan, B. Symbol Formation. New York: Wiley, 1963.

Wiig, E. H. and Semel, E. M. Clinical Evaluations of Language Functions. Columbus, Ohio: Bell and Howell Co., 1980.

Winter, P. The Bear and the Fly. New York: Crown Publishers, 1976.

Wittgenstein, L. Philisophical Investigations. New York: Macmillan, 1953.

Yamada, J. Evidence for the independence of language and cognition: Case study of a "hyperlinguistic" adolescent. UCLA Working Papers in Cognitive Linguistics, 1981, 3, 121-160.

Zion, G. Harry the Dirty Dog. New York: Harper and Row, 1976.

APPENDIX 1

RECEPTIVE LANGUAGE STRUCTURES AND CATEGORIES

The comprehension assessment conducted in this research used a list of structures and categories adapted from Curtiss, Kempler and Yamada (1981: 33-47). The following list details the structures and categories with examples actually used in the presentations.

Morphology

Aux-Be Singular/Plural: tests comprehension of VP pluralization when marked only on the Be auxiliary, e.g."The fish are swimming" versus "The fish is swimming."

Comparative: comparative morpheme /-er/, e.g. "Which one is bigger?"

Noun Singular/Plural: e.g. "The car has a flat tire" versus "The car has flat tires."

Possessive Morpheme: e.g. "Show me the baby's chair" versus "Show me the baby chair."

Reflexive Pronouns: reflexive vs. object pronouns, e.g. "The boy pointed to himself."

Tense and Aspect: be + /-ing/: the progressive aspect, e.g. "The girl is jumping."

Tense and Aspect: /-ed/: regular past tense, e.g. " The mother dressed the baby."

Verb 3rd Person Singular/Plural: e.g. "The sheep eats" versus "The sheep eat."

Syntax

Active Voice Word Order: subject-verb-object word order with 'reversible' NPs, e.g. "The boy is shaking the girl."

Clefting: sentences with a preposed object, e.g. "It's the boy that the dog chases."

Complex Modification: a noun modified by two modifiers, e.g. "Point to the big blue ball."

Complex Negation: negative scope, i.e., whether the matrix clause or the embedded clause is negated, e.g. "The boy that doesn't have a stick is big."

Double Functions Relatives (S-O): sentences with a subject relative clause, where the relative pronoun plays a different grammatical role (object) in the embedded clause than its equivalent NP in the matrix sentence (subject), e.g. "The boy who the girl is washing is wearing pants."

Object Relative Clauses: relative clauses modifying the object NP, e.g. "The girl is chasing the dog who is little."

Passive Voice Word Order: e.g. "The dog is being chased by the boy."

Simple Declarative: e.g. "The lion is eating."

Simple Modification: a noun is modified by one modifier, e.g. "Point to the big box."

Subject Relative Clauses ending in N-V, e.g. "The girl feeding the baby is crying."

Subject Relative Clauses: e.g. "The dog who is brown is chasing the girl."

Wh-Questioning of Object: e.g. "Who is the dog biting?"

Wh-Questioning of Subject: e.g. "Who is washing the boy?"

Semantics

Attributive/Stative: e.g."The ball is big."

Before and After: I: "Touch your nose before you touch your foot." II. "Before you touch your nose, touch your foot."

Conjunction: "and," e.g. "Give me the spoon and the soap."

Disjunction: "or" e.g."Point to the spoon or the candle."

Locative Prepositions: in, on, under, in front of, in back of... under these conditions: I. with respect to the child's body, II. in relation to objects with intrinsic fronts, III. in pictures of objects with intrinsic fronts.

Object Pronouns: e.g. "Point to them."

Possessive Adjectives: his, her.

Simple Negation: negative marker in simple sentences. e.g. "The boy does not have a car."

Subject Pronouns: gender and number distinctions in third person subject pronouns. e.g. "They have ice cream."

Tense and aspect: future modal "will."

Who vs. What: animacy distinction, e.g. "Who is by the table?" versus "What is by the table?"

APPENDIX 2

VOIS 135

The augmentative communication device used in this research project was the VOIS 135, produced by Phonic Ear Ltd. of Canada, 7475 Kimbel St. Unit 10, Mississauga, Ontario. Use of the device for the duration of the research period was kindly provided by Phonic Ear.

The VOIS 135 is a programmable augmentative communication device with synthetic speech output. It has five levels; the first level is preprogrammed with 46 words, 45 phonemes, 12 morphemes, 10 commonly used phrases and also contains five function keys to assist in the programming of the other four levels. The five functions are

1. LOAD... signals the device's microprocessor that a sequence key strokes are about to be stored in the long-term memory,
2. REVIEW... allows the user to hear a partially compiled message without erasing it from the short-term memory,
3. CLEAR... allows the last item of a series of key strokes to be removed from either short-term or long-term memory,
4. MASTER CLEAR... clears all entries in held in the short-term memory
5. TALK... allows all items currently held in short-term memory to be spoken in the chosen sequence; depressing another key after activating TALK, will clear the

short-term memory and ready it for the next sequence.

The display consists of 128 touch sensitive cells of which 118 are available for personal programming on four different levels. For example, a single cell may contain four different words or phrases, one corresponding to each level, e.g. level 2, cell 14 "mom," level 3, cell 14 "dad," level 4, cell 14 "grandpa," etc.

The VOIS 135 has a memory capacity for programmed input of 5000 entries which may be apportioned between the programmable levels as the user wishes. Each individual programmable cell has a maximum storage capacity of 51 keystrokes which provides reasonable flexibility for sentence construction. Cell storage space can be used maximally by employing the preprogrammed words and morphemes of level 1 as much as possible in the programming process.

The instrument operates on a rechargeable battery which is good for approximately 18 hours per charge (although the manufacturer recommends that it be charged every night). Physically, it is portable and manageable weighing 1.6 kilograms (3 lbs. 12 oz.) and with dimensions: length 41.9 cm (16.5"), width 22.2 cm (8.75"), height 8.3 cm (3.25").