

SIGN LANGUAGE STUDIES WITH CHILDREN
AND CHIMPANZEES

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Abstract. With the beginning of Project Washoe in 1966 a new field of scientific inquiry opened. Sign language studies with chimpanzees provide a new tool for studying linguistic behavior as an expression of intelligence and for understanding the continuity between human and non-human intelligence. In this article we have answered many of the criticisms of sign language studies with chimpanzees by taking a close look at the procedures and results of this new field of scientific inquiry. We have tried to shed more light than heat on the subject and hope that we have shown how the work of comparative psychologists has contributed to the understanding of the nature of language and intelligence.

Introduction. Sign language studies with chimpanzees have been of interest to comparative psychologists, linguists, and psycholinguists:

It would no doubt be easy to devise definitions of language such that no examples of animal communication could readily find inclusion therein. There have always been, and no doubt there will continue to be, those who resist with great vigour any conclusions which seem to break down what they regard as one of the most important lines of demarcation between animals and men. We must surely be justified in accepting such preconceived definitions only with the utmost caution. One of the tasks of the scientific student of animal behaviour is to attempt

to establish whether or not there are such hard and fast dividing lines and if so what and where they are. Of one thing we can be certain: it is that work such as that of the Gardners and of Premack is only the beginning of the application of an important and powerful new technique from which we stand to learn much in years to come. I believe that no one should have anything to fear from its cautious and objective application. (Thorpe 1972: 47)

The application of formal linguistic analysis to the linguistic output of ape language projects offers to researchers in comparative psychology and psycholinguistics an additional tool for evaluating the results of their experiments... a distinct and fruitful area of comparative psycholinguistics is opened which will help to provide answers to the ancient question, "What is language?" (Stahlke 1980: 328)

Language can be studied from widely differing perspectives, and this diversity of viewpoints often forces new conceptions of the nature and use of language. An illustration of this point is the recent experiments in which chimpanzees have learned to use significant aspects of the sign language of the deaf. (Bonvillian, Nelson, and Charrow 1976: 211)

As Thorpe predicted there has indeed been vigorous resistance to and sharp criticism of the conclusion that there is continuity between human and nonhuman intelligence. The purpose of this article is to review the methodologies of the sign language studies with chimpanzees and to compare the major findings of these studies with the findings of studies of human children. The topics that we will consider are: (1) the relevance of input conditions for language acquisition, (2) the nature of the evidence that is used to demonstrate linguistic achievements, and (3) the application of rigorous testing procedures in developmental psycholinguistics. In each section we present the evidence reported for children, the evidence reported for chimpanzees, and a discussion of the questions that have been raised by certain critics.

1. REARING CONDITIONS

Environment Those psycholinguists who were influenced & language. by Chomsky maintained that the acquisition of language was completed quickly and was quite independent of environmental support and intellectual development.

Children all over the world learn to speak their native language at approximately the same time—3 to 4 years of age. Within a relatively brief period, the child appears to learn a complicated and abstract system of rules—a system which enables him to produce and understand an infinite variety of unique utterances. These rules are only indirectly represented in the corpus of utterances to which the child is exposed. The task becomes more difficult when we consider that the corpus does not typically consist of only well-formed, grammatical utterances. In the face of these obstacles children everywhere, without teaching or training, readily acquire their native language at about the same time—regardless of just about any variable one cares to look at, short of deafness or severe retardation. (Moore 1973: 4)

In contrast there are investigators of child development who argue that language development is dependent on the development of intelligence, which is, in turn, dependent on an appropriate rearing environment.

On the basis of current findings and theory, . . . it seems to me that the pacesetter in linguistic growth is the child's cognitive growth, as opposed to an autonomous linguistic development which can then reflect back on cognition. As Piaget (1967) has put it: "...language is not enough to explain thought, because the structures that characterize thought have their roots in action and in sensori-motor mechanisms that are deeper than linguistics." (1967: 98; quoted in Dale 1976: 163)

Comparative psychologists have long appreciated the intimate relationship between the intellectual development and a stimulating environment. In order to compare the chimpanzee Gua with their own child, the Kelloggs emphasized that

the rearing environments of the two must be comparable:

One important consideration upon which we would insist was that the psychological as well as the physical features of the environment be entirely of a human character. That is, the reactions of all those who came in contact with the subject, and the resulting stimulation which these reactions afforded the subject, should be without exception just such as a normal child might receive. Instances of anthropoid apes which have lived in human households are of course by no means unknown. But in all the cases of which we have any knowledge the "human" treatment accorded the animals was definitely limited by the attitude of the owner and by the degree of his willingness to be put to boundless labor. It is not unreasonable to suppose, if an organism of this kind is kept in a cage for a part of each day or night, if it is led about by means of a collar and a chain, or if it is fed from a plate upon the floor, that these things must surely develop responses which are different from those of a human. A child itself, if similarly treated, would most certainly acquire some genuinely unchildlike reactions. Again, if the organism is talked to and called like a dog or a cat, if it is consistently petted or scratched behind the ear as these animals are often treated, or if in other ways it is given pet stimuli instead of child stimuli, the resulting behavior may be expected to show the effects of such stimulation.

In this connection it was our earnest purpose to make the training of the ape what might be called incidental as opposed to systematic or controlled training. What it got from its surroundings it was to pick up by itself just as a growing child acquires new modes of behavior. We wished to avoid deliberately teaching the animal, trial by trial, a series of tricks or stunts which it might go through upon signal or command. The things that it learned were to be its own reactions to the stimuli about it. They were furthermore to be specifically responses to the household situation and not trained-in or meaningless rituals elicited by a sign from a keeper. The spoon-eating training, to take a concrete example, was to be taken up only in a gradual and irregular manner at mealtime, as the subject's muscular coordination fitted it for this sort of manipulation. We would make no attempts to set it down at specified intervals

and labor mechanically through a stated number of trials, rewarding or punishing the animal as it might succeed or fail. Such a proposed procedure, it will be readily seen, is loose and uncontrolled in that it precludes the obtaining of quantitative data on the number of trials necessary to learn, the number of errors made, or the elapsed time per trial. It has the advantage, nevertheless, of being the same sort of training to which the human infant is customarily subjected in the normal course of its upbringing. (Kellogg & Kellogg 1933: 12f; emphasis theirs)

The Gardners raised Washoe in a two and one-half room, eight by twenty-four foot house trailer that contained most of the usual items of a human dwelling. The trailer contained a general living and cooking area, a sleeping area, and a bathroom. It was equipped with typical human furnishings such as a bed with sheets and blankets, a couch, drawers and cupboards for storage, a stove, and a refrigerator. Washoe had access to, and used personal items like clothing and grooming aids—combs, brushes, lotions, and toothbrushes. Toys and picture books were freely available. Thus the living areas contained the items commonly available in a child's home. Washoe had constant human companionship from the time she awakened in the morning until she fell asleep at night. Washoe's human companions conversed with her only with the manual signs of sign language. Regular routines such as meals and grooming sessions, household chores, outdoor play at the research station (a 5,000 square foot area with trees, shrubs, flowers, and outdoor playthings) and car rides to interesting areas provided many opportunities for the use of sign language.

Terrace raised Nim quite differently, deliberately choosing not to treat him as a child. Of the training of teachers he wrote:

I tried to convince Susan [Quimby] that the best approach to Nim was to regard him as a young chimpanzee and not as a child. To reinforce this philosophy I reminded her of how well Laura [Petitto] and Andrea [Liebert] worked with Nim. Susan respected Laura and Andrea, both of whom felt strongly that Nim should not be regarded as a child. (1979a: 118)

From the age of 9 months on, Nim was driven daily (Monday through Friday) to a complex of special classrooms at Columbia University. From 11:00 am to 5:00 pm, Nim is given intensive instruction both in the comprehension

and expression of signs. Each day is broken up into three two-hour sessions. Each session, which is taught by a different teacher, includes activities whose goal is to increase his attention span, his interest in objects and situations conducive to signing. (Terrace et al. 1976)* While attending this class Nim was taught primarily in a small empty room by an everchanging staff of teachers, who Terrace noted "...cycled through Project Nim in a revolving door manner" (1979a: 108). When describing the classroom Terrace wrote, "I had paid little attention to the cold cinder block walls of the complex. . . I wondered how I and other teachers could have spent so much time in these oppressive rooms" (loc. cit. 209).

Spontaneity in signing. Gardner and Gardner (1974) reported that Washoe had often signed to herself and they described several situations in which this signing was likely to occur; these include being in places that afforded privacy and leafing through magazines and picture books. The film Teaching Sign Language to the Chimpanzee Washoe provides numerous examples of spontaneous signing. In this film Beatrix Gardner comments that "most of her [Washoe's] utterances were entirely spontaneous; we did not have to prod her with questions or tempt her with goodies to get her to talk with us. Washoe used ASL to comment on things around her, or just to start a conversation" (Gardner & Gardner 1974: 24). In a study of conversations between a chimpanzee and humans, Mandel and Fouts (1976) determined that the chimpanzee Lucy initiated 77.9% of the 267 separate conversations in the sample. In a later discussion of the same corpus, Fouts, Shapiro, and O'Neil concluded that: there seems every indication that Lucy not only participated in two-way interactions and conversations with her human companions but was also an active participant in these sessions in terms of initiating and terminating conversation with them. (1978: 173)

Similar observations have been made more recently in the University of Nevada laboratory with chimpanzees Moja, Pili, Tatu, and Dar. On the multiple chimpanzee signing project the subjects often played and signed with each other (Gardner & Gardner 1978).

In contrast, Terrace (et al. 1979) reported that Nim seldom initiated conversations, and one of Terrace's co-workers

* the quotation can be found on page 2 of the above mentioned article

Petitto has claimed that Nim had to be coerced into signing (Seldenberg & Petitto 1979). Perhaps this was true on Project Nim, in which stimulation was minimized. Terrace has described Nim's classroom as

bare and small, a mere eight feet square. This was by design. I felt that Nim would not romp around too much in a small area and would be more likely to concentrate on the activities introduced by his teachers. I also felt that a bare room would minimize distraction. (1979a: 49)

It is clear from Terrace's description that the classroom situation was so structured that Nim had little opportunity to introduce topics for conversation. Perhaps for this reason it appeared as if Nim was coerced or bribed into signing.

In the case of children, the effect of coercion is to depress the percentage of phrases expressing semantic relations; the children produce a minimum that satisfies the adults' demands:

Two notably lower values [expressing prevalent relations] were obtained for [the children] Sarah I and Sipili. The explanation of these values is the same for both cases; the mothers of these children did not, as they were asked to do, converse in a natural way with their children. . . but rather made a continuing determined effort to elicit speech from their children. The only way mothers in general can think of to do this is to ask the names of things. (Brown 1973: 178)

Terrace and associates have described their training procedures as follows:

Typically, Nim reached for something he might want to play with, eat, or inspect. The teacher withheld the item, molded the object's name sign [by manipulating the hand of the animal], and then asked Nim to sign for the object. Signs such as give, me, and Nim, while appropriate, were deemed unacceptable when we were trying to teach Nim a new sign. Since the age of 18 months, Nim often offered his hands to his teacher in an apparent request for the teacher to mold the new sign that the teacher wanted him to use. (Terrace et al. 1980: 377)

Given this training procedure, the findings of Project Nim were just as expected:

Our analysis of Nim's discourse with his teachers has

revealed that the vast majority of Nim's utterances were occasioned by the teacher's signing and that many of Nim's signs were identical with those of his teacher's most recent utterance(s). (loc. cit. 429f)

ASL and It is generally believed that human children can
ASL only. learn to speak because they can make all of the
 sounds of their native language. Deaf children
can learn to sign because of their congenital ability to produce
all of the configurations and actions of sign language morphemes
(Stokoe 1980). The success of Washoe and other chimpanzees
who learned to sign, and the failure of Vicki and other chimpan-
zees who did not learn to speak (Hayes & Hayes 1951 and
Kellogg 1968), depends on a congenital ability of the chimpan-
zee to make the handshapes of ASL and a congenital **deficit** that
prevents them from speaking. Before Project Washoe it had
been noted that some of the behaviors of infant chimpanzees
resemble certain configurations and actions in ASL signs.
This was a primary consideration in choosing ASL as a medium
to communicate with chimpanzees (Gardner & Gardner 1971).
Comparative psychologists have attempted to teach chimpan-
zees to combine the configurations of hands and arms and the
appropriate actions into ASL signs and to use them in appropri-
ate situations. When these gestures were consistently used
in appropriate contexts they were glossed as ASL signs. A
good example of this is the following:

Washoe soon developed what we would describe as an
impatient gesture, which consisted of raising her arm in
the air and shaking her open hand vigorously at the wrist.
We have received informal reports that this gesture is
often seen in other young chimpanzees and in human
children as well. The ASL sign for HURRY is quite similar.
It differs . . . in that the first and second fingers should
be extended to form the H of the manual alphabet but the
open-handed form is considered acceptable. We encour-
aged Washoe to use this sign in appropriate situations
by frequent modeling of the correct ASL version. Gradually,
HURRY became common in Washoe's signing, usually
added to the end of a phrase such as OPEN HURRY, GIMME
SWEET HURRY, or GO OUT HURRY. (Gardner & Gardner
1971: 137f)

Seidenberg and Petitto (1979) and Savage-Rumbaugh and

associates (1980) have argued that the use of naturally occurring gestures is a confounding factor; however, such an argument depends on a definition that distinguishes natural and unnatural gestures. Certainly everyone agrees that all of the signs that have been taught to chimpanzees are within their natural repertoire of movements, and certainly no one, least of all the Gardners, have claimed that any of Washoe's signs were unnatural.

Of the five behaviors that Seidenberg and Petitto (1979) listed as examples of natural ape behaviors, none were glossed as signs in Project Washoe. Washoe did use signs for 'hug', 'tickle', and 'kiss'; but they were not in the form described by Seidenberg and Petitto. In fact, the forms of the behaviors the latter described do not fit the PCM (position, configuration, movement) descriptions of any of the signing projects (see Table 1), although they come closest to those reported for Project Nim (Terrace 1979a). Further, we wrote to Seidenberg to ask for clarification of this discrepancy. He replied but wrote that "The above information is not for citation in any form, in particular no quotation, no paraphrase and no use as personal communication." In deference to his wishes, we leave his reply unstated.

Before the handshapes of the chimpanzees were listed as reliable items by the Gardners they had to resemble the forms of ASL signs and be used in appropriate contexts. For example, on Project Washoe the criterion of reliability was that a sign had to be reported on three independent occasions by three different observers; then the sign had to be reported to occur spontaneously and appropriately on 15 consecutive days. Not until this criterion of reliability had been met were these responses listed as reliable items of the vocabulary (Gardner & Gardner 1978). If Seidenberg and Petitto or Savage-Rumbaugh et al. have evidence that wild chimpanzees reliably use a significant proportion of the signs listed by Gardner and Gardner (1975) in forms and situations that meet these criteria, they would do well to publish their evidence. We for our part will remain skeptical until Seidenberg and Petitto demonstrate how African chimpanzees naturally use American Sign Language in appropriate situations, as opposed to Chinese Sign Language or Mexican Sign Language.

Unlike psycholinguists who minimize the effects of verbal input on language acquisition (e.g. Moore quoted on p. 17 above), the Gardners argue for the importance of presenting a good model

of the language that the subject is expected to acquire: Because the structure of Ameslan [ASL] is so different from the structure of English, it is difficult, perhaps impossible, to speak good English and sign good Ameslan at the same time. Attempts to do so are much like attempts to speak English and write German simultaneously: the fluency and intelligibility of one or both of the languages must suffer. Those who have acquired Ameslan recently as a second language soon find that they are speaking English sentences and producing the signs for a few key substantives. The only way that we can present good models of structured language to our chimpanzee subjects is by restricting verbal communication to Ameslan. (Gardner & Gardner 1978: 54)

This reasoning has been supported by research on simultaneous use of sign and speech:

Full processing (at least in production) of a complex message in two syntactically distinctive languages simultaneously may well be beyond the capacities of most or all individuals fluent in the two languages. (Bonvillian et al. 1976: 237 [see also Marmor & Petitto in *SLS* 23 and Kluwin in *SLS* 31])

Terrace, like Moore quoted above (p. 17), writes as if the linguistic model presented to the chimpanzee was of trivial importance, noting that for the first three years of the 46-month Project Nim most of Nim's teachers were not fluent in sign language (Terrace et al. 1980: 379, 441f), and that "A good non-fluent teacher could manage one, two, or three sentences on a given topic before going on to sign about the next topic" (Terrace 1979a: 124). On Project Nim it was standard procedure to make signs and speak English simultaneously (Terrace, personal communication, June 1975)*. With respect to this practice of signing and speaking simultaneously, Terrace has written that "Nim was exposed to a lot of spoken language" (1979a: 38). In a progress report, Terrace, Petitto, and Bever wrote, "From daily informal observations it was clear that he [Nim] was responsive to both mediums [spoken English and ASL]" (1976: 2).

Motherese register. The speech register that adults use with other adults is distinctly different from the one used with children. This adult to child speech register has been labelled "Motherese" (Snow and
* personal communication to R. Allen Gardner

Ferguson 1977). Snow has characterized the Motherese register as more simple, redundant, and repetitive than an adult speech register in English (Snow 1977). [Blount & Kempton in SLS 12 give detailed differences of adult and child registers in English and Spanish.] Similar Motherese registers have been reported for a number of other languages including ASL (cf. Bynon 1977 and Ruke-Dravina 1977). Maestas y Moores noted that deaf parents express ASL by normal sign formation, as well as by "infant-adapted" sign formation (1980: 3-5). Parents often use elements of ASL, signed English, and fingerspelling when attempting to communicate with their children; they also repeat signs and hold the signs in location longer when signing to children (Maestas y Moores 1980, Schlesinger & Meadow 1972, Schlesinger 1978). Since parents seldom converse with their children in the adult register of their language, it should not be expected that Washoe's teachers would use the adult form of ASL with her. On the later project, with the chimpanzees Moja, Pili, Tatu, and Dar, more than one-third of the teachers were native signers (deaf or hearing persons with deaf parents). These adults in particular used ASL Motherese in signing to the infant chimpanzees.

Seidenberg and Petitto criticized the signing skills of the teachers who worked with Washoe. Since neither Seidenberg nor Petitto have ever communicated in sign language with any of Washoe's teachers, we wondered how they made such an assessment. Again Seidenberg's reply that evaluation was based on films of people signing to an infant chimpanzee is not for publication in any form. Because the signing in the film was adult to infant, a Motherese register was appropriate. The use of an adult register would be quite inappropriate.

Summary 1. The Gardners provided an intellectual environment for Washoe that was comparable to the intellectual environment of a child, and they have reported similarities between the signing of Washoe and the signing of young children. In contrast, Nim was raised in an environment unlike that in which a human infant is customarily raised—more like that of a pet; and Terrace and associates have claimed that the signing of Nim is unlike the signing of children. This result is just what Kellogg and Kellogg (1933; quoted pp. 18f above) would have predicted.

Sign	KOKO ¹	NIM ²	WASHOE ³	ALI ⁴
HUG	P Chest & upper arms	Chest & shoulders	Trunk & upper arms	Chest & upper arms
	C Curved hands	Hands curved to signer	Curved hands	Curved hands
	M Arms cross & grasp P	Hands grasp contralat. shoulders	Arms cross & grasp P	Arms cross & grasp P
KISS	P Cheek	Protruding lips	Lips	Lips then cheek
	C Curved hand	Flat h, palm to signer	Curved hand	C-hand, tips to signer
	M Contact	C to P, kisses palm	C tips touch P, C rotates, knuckles to P	C touches lips, then cheek
PICK	P Tip of index finger	(not in vocabulary)	(not in vocabulary)	On body
	C Index hooked extended	(not in vocabulary)	(not in vocabulary)	F-hand
	M C contacts P & draws downward	(not in vocabulary)	(not in vocabulary)	Thumb & index grasp hair, then pull off
SCRATCH	P Back relaxed h, palm up	(not in vocabulary)	(not in vocabulary)	(not in vocabulary)
	C Claw hand	(not in vocabulary)	(not in vocabulary)	(not in vocabulary)
	M C is drawn across P	(not in vocabulary)	(not in vocabulary)	(not in vocabulary)
TICKLE	P Underarm	a) back of curved h, b) spot to be tickled	Back of hand	Back of hand, or place to be tickled
	C Index f from closed h	Index finger, palm to P	Index f hooked & extd	Index f hooked & extd
	M Contact, may repeat	Finger to P, contact may often repeated	C is drawn across P	Index of C scratches P

Table 1. Form descriptions for four signing subjects.

- P: position, alias location, tab
 C: configuration, alias handshape, dez
 M: movement, alias action, sig
- Sources: ¹ Francine Patterson, personal communication, Sept. 1980
² H. S. Terrace, *Nim*, 1979
³ Gardner & Gardner, *JGP* 104 (1975), 244-267
⁴ Roger Fouts, personal communication, September 1981

2. COMPARABILITY OF OBSERVATIONS

In this section we discuss the comparability of observations made of the signing of young children and of young chimpanzees. Before doing so it is important to review the way data for both human and nonhuman subjects are gathered, reported, and published. We then consider the use of linguistic devices for the modulation of meaning. We will see that when comparable criteria are used to evaluate the observations of young chimpanzees and children the results are comparable.

Raw data and summary data. When original evidence is reported in scientific journals, the data appear by and large in the form of summaries; the raw data are rarely published, except in the form of selected, illustrative examples. The Publication Manual of the American Psychological Association specifically recommends against the publication of raw data, and with rare exceptions this practice is generally adhered to.

When, in descriptive linguistics, an attempt is made to analyze an unknown language, an important step in the procedure is to obtain a large sample of utterances in the unknown language. Gleason suggests that the sample should include "a few thousand sentences" (1961: 196); his own sample for the subject Abel consisted of 2,081 utterances. As in all disciplines of natural science, the resulting analysis is normally published in the form of a summary with illustrative examples; rarely if ever has anyone published an entire sample of collected utterances.

Brown and his associates pioneered a procedure which assumes that the acquisition of language by human children occurs in a series of stages that evolve into the adult language. If this is true, then it is possible to analyze the early stages of language and describe these stages in the way field linguists do for hitherto unknown languages. Brown and his associates attempted to describe the stages of language acquisition by obtaining a sample from children at different stages of development. The psycholinguists who have done language acquisition research have followed the normal practice of descriptive linguistics, of experimental psychologists, and of natural scientists generally, in that they publish summaries and illustrative examples of their raw data and not the entire sample of the utterances on which their analysis is based.

Definition of a corpus. Brown, Fraser, and Bellugi in their early discussion (1964) identify the use of the term corpus with the detailed definition of Gleason (1961). In Gleason's text the definition of a corpus refers to the entire sample of utterances, including the contexts of each utterance. Gleason suggests a sample of thousands of utterances but cautions that "even the largest corpus can only be an infinitesimal portion of the language" (1961: 197); and he himself has never published more than summaries and illustrative examples.

Bloom defined a corpus as:

the group of utterances selected from the speech sample for linguistic analysis: that is, all utterances containing more than one tentative morpheme and excluding repetitions, imitations, and fragments of songs, rhymes, or stories. (Bloom 1970: 261)

This definition can be read with either of two meanings, the first strong, the second weak: (1) a corpus consists of the entire sample (after Gleason), with the exception of repetitions, etc.; or (2) ANY "group [or list] of utterances selected from the speech sample for linguistic analysis [that contains] . . . more than one tentative morpheme." If the second interpretation of Bloom's definition is used, then any list or set of illustrative examples published could be considered as a corpus.

Publication of a corpus. To see if psycholinguistic journals publish routinely complete corpora by the strong definition, we selected two journals, Journal of Psycholinguistic Research (1972-1978, vols. 1-7, concerned primarily with spoken language), and Sign Language Studies (1972-1979, issues 1-21, concerned with sign languages), in which we believed we might find published corpora. We found that complete corpora, as defined by Gleason (1961), are not published but that lexicons, partial lexicons, or small portions of a corpus are occasionally published (Bonvillian & Friedman 1978, Cicourel 1974, and Holzman 1972). If these two journals are typical, then it appears that linguists publish their data in much the same form as do psychologists.

As a first step in their evaluation of the progress of their chimpanzee subjects, the Gardners attempted to obtain observations of the acquisition of sign language by young chimpanzees that could be compared with observations of the acquisition

of signed or spoken language by human infants (1974, 1978). Brown (1973) and his associates made intermittent recordings of their subjects' speech. This was accomplished by one person making a written transcription of the speech of the child and mother (or others), together with context notes of important events, while a second person interacted with the child and attended to a tape recorder. Bloom (1970) used similar procedures in her extensive study of three English-speaking children. The Gardners used similar procedures to obtain samples of their chimpanzees' signing:

. . . during a specified period of time, usually 20 minutes, we record everything signed by the chimpanzee and a description of context, which includes all signing addressed to the chimpanzee. These comprehensive signing records require a team of two persons, both of whom remain near the subject throughout the recording period. One member of the team whispers an immediate spoken transcription of signing, together with notes about context, into the microphone of a miniature cassette recorder. The other person performs the usual role of teacher, caretaker, playmate, and interlocutor. . . In terms of quantitative characteristics such as rate of utterances and proportion of phrases, the technique yields material for young chimpanzees that is well within the range of language samples for the young English-speaking children, and of language samples obtained by videotaping young children who sign. (Gardner & Gardner 1980: 346f)

When Brown in a paper entitled *The First Sentences of Child and Chimpanzee* (1970) published a table of "The first sentences of child speech" (1970: 94, Tab. III), the Gardners demonstrated that the early combinations of Washoe could be summarized in a nearly parallel fashion (Gardner & Gardner 1971: 174, Tab. IV). When Bloom (1970) and Brown (1973) outlined the quantitative characteristics of children's speech—rate, proportion of phrases, etc.; the Gardners did a parallel analysis of Washoe's signing (1978: 57, Tab. 3). In fact, the Gardners have in every case in which they have demonstrated a parallel between child and chimpanzee published as much or more original evidence than could be found at the time in the literature on child language acquisition.

The consistent way in which the term corpus has been used to describe published and unpublished data is in sharp

contrast to the way that Seidenberg and Petitto use it:

In studies of the acquisition of spoken language by hearing children (e.g. Brown 1973) and sign languages by deaf children (e.g. Klima & Bellugi 1979, Hoffmeister 1978, Hoffmeister, Best, & Moores 1974), researchers typically report corpora of child speech sampled at varying intervals. . . . Occasionally, much larger corpora are published (e.g. Bloom 1973), so that substantial records of the language behavior of many children now exist, and detailed comparisons across subjects, ages, languages, cultures, and observers are possible. (Seidenberg & Petitto 1979: 181)

The example, Bloom 1973, of a larger than usual corpus cited here is One Word at a Time: The Use of Single Word Utterances before Syntax. The transcripts of four 40-minute, videotaped, mother-child interactions it contains are indeed unusually extensive and complete. As the title plainly states, however, this sample consists primarily of utterances of only one morpheme that Bloom considered to be too primitive for syntactic analysis. Since the evidence that chimpanzees can reach this primitive level is no longer seriously disputed, this example is irrelevant to the present discussion.

Of the four other studies they cite as examples of published corpora, one is an unpublished Ph.D. dissertation (Hoffmeister 1978), a second is a Bureau of Education progress report (Hoffmeister et al. 1974). Hoffmeister's dissertation contains no corpus as defined by Gleason (1961) but does contain short lists of utterances devoid of contextual information. In the progress report there is no corpus by any of the above definitions. A third source of published corpora is Brown (1973), but no Brown (1973) appears in Seidenberg and Petitto's references. We examined Brown's book, A First Language: The Early Stages, published in 1973. This extensive review of child language studies contains no corpora nor corpus of child speech. We could not find a corpus in any other 1973 publication by Brown, and when he was asked about the publication of corpora, he replied, "I did not publish the corpora for [Stages] I-IV" (Personal communication to R. Gardner, January 1981). Finally, Seidenberg and Petitto cite Klima and Bellugi (1979). The closest thing to a corpus in this book is a list of 30 Chinese signs in chapter six. If a list of 30 signs of Chinese Sign Language is a corpus, then certainly Gardner and Gardner's list of 132 signs used by the chimpanzee Washoe (1975) must also be considered a corpus.

It is not standard procedure for psycholinguists to publish

their corpora. Seidenberg and Petitto alone have made the claim that corpora are routinely published; such commentaries as do exist about the publication of corpora flatly disagree; e.g. Nelson's:

It has been suggested that studies of child language have been carried out with great care for full descriptions of the context of utterances and the complete analysis of all productions. This has been true in only a few cases for a small number of children for samples of speech. For the rest we have partial reports, serendipitous observation, and anecdotes, just as is the case with the chimpanzees. (1980)

Seidenberg and Petitto (1979) refer to Terrace et al. (1979 and 1980) as the only available published corpora of chimpanzee signing. Keeping in mind the above definitions of "corpus" and the importance of contextual information, we perused the references cited by Seidenberg and Petitto. We could not find any corpus as above defined; instead we found utterances that were collected over four years lumped together alphabetically without developmental notes or any contextual information. Because we were unable to find a corpus (as defined by Gleason 1961), we wrote to Terrace to find out what he considered a corpus. In his reply he wrote, "I was simply following a practice (of highly regarded psycholinguists such as Roger Brown and Martin Braine) to refer to a large body of utterances as a corpus" (Personal communication, March 1981).

Summary 2. In any scientific field the publication of [all] the raw data would be valuable. Since this is rarely practical, data are routinely published in the form of summaries. As we have demonstrated here, the publication of any complete corpus of a child's language output is rare, if indeed any such complete corpus has ever been published. Certainly neither the short list of references cited by Seidenberg and Petitto nor the extensive literature search that we have conducted yielded a single example. If the weak definition of corpus (any group or list of utterances selected from the speech sample that contains more than one tentative morpheme) is applied to the published work of psycholinguists, then it is true that many corpora of the utterances of children have been published. If this weak definition is also applied to the published work of comparative psychologists, then equally complete corpora of the utterances of signing chimpanzees have been routinely published.

Documenting sign usage. Psychologists and linguists have relied on illustrative examples and anecdotes when reporting on the acquisition of word meaning by children. Two early examples of this are Taine (1877, cited by Clark 1973b), who reported that a child used 'baby' (actually be'be') to refer to small statues and figures in small pictures and prints; and Sully (1897), who reported that a child extended the word baby to cover small objects, as when referring to a small coin as a 'baby dollar'. A more recent example can be found in Clark and Clark (1977), who reported that a young child who heard its mother, pointing at a dog, say "bow wow," later applied bow wow to horses, cows, and cats as well as dogs. This type of information often comes from diary studies rather than from systematic sampling. Both Clark and Clark (loc. cit.) and Bloom and Lahey (1978) have noted that when children begin to use words, the words have some meaning to the child but that meaning is not necessarily the same as the adult one. Therefore they have suggested that it is important to observe exactly what a child says in a particular context before attempting to interpret how a child is using the word.

The Gardners used several procedures to identify the typical contexts in which particular signs were used by each subject. Each time that the Gardners published an article that included new vocabulary material they published with it a list of all the signs that were credited to their subject (Gardner & Gardner 1969, 1971, 1972, 1975). To describe the usage of each individual sign they used a system similar to Bloom's codification scheme (1970) for noting contexts of child utterances. This scheme includes both aspects of referents and aspects of the linguistic context.

Bloom's codification procedure was used by the Gardners in recording observations of new signs produced by the chimpanzee subjects. In addition new signs had to be reported on three independent occasions by three different observers. Then they had to have been reported to occur spontaneously and appropriately at least once on each of 15 consecutive days before being counted as reliable vocabulary items (See Gardner & Gardner 1978 for details of this procedure). If a sign was missed on one day, the 15-day count was restarted. On each of the 15 days the observer recorded both form notes (PCM descriptions, for position, configuration, and movement) and detailed notes about contexts including aspects of the referents and aspects of the linguistic contexts.

Initially the reliable sign vocabularies of the subjects were small and the usage and form of each sign in the vocabulary were sampled daily. Eventually the reliable sign vocabularies grew to a point where daily sampling was impractical. For a time each sign was sampled weekly. When the vocabularies grew still larger, each sign was sampled quarterly. These quarterly sign descriptions were compiled, and provided information on the form of each sign and the range of contexts in which the sign occurred. This systematic sampling allowed the Gardners to report the changes that occurred in both the form and the semantic range of a sign as the subject matured. For example, they found

that Moja, by age two, had used her sign DRINK to name liquids of different kinds—milk, water, broth, coffee, and orange juice; in different containers—her own infant bottles and plastic cups, her companions' mugs, and soda-pop cans; and in different forms—a dripping kitchen faucet, raindrops on the outside of the window. (Gardner & Gardner 1978: 51)

In all samplings both the form and the contextual information were recorded, even if the sign occurred in what appeared to be an inappropriate context. Thus by recording both the usual and unusual contexts that signs occurred in, the Gardners (op. cit.) were able to show that when very young, Moja occasionally overgeneralized the sign DRINK to "food, and to nonedibles, as, for example, when requesting a balloon" (1978: 51).

The Gardners list Washoe's first 81 signs with contextual information (1971, Tab. 1); among the 81 signs are nominals (e.g. DOG, SUSAN), action words (e.g. OUT, GO), modifiers (e.g. GOOD, MINE), and personal-social words (e.g. PLEASE, SORRY). Based on their samples, the Gardners determined that Washoe used PLEASE when "asking for objects and activities . . . also when ordered to ASK POLITELY" (1971: 149). Frequently Washoe combined the sign PLEASE with other signs, e.g. PLEASE OPEN, PLEASE FLOWER, etc. Washoe used SORRY "for apology and appeasement; e.g. after biting someone or when someone had been hurt in some other way, not necessarily by Washoe. Also when ordered to ask pardon" (ibid.). Similar context notes were provided for the other types of signs (see Gardner & Gardner 1971: Tab. 1, and 1975, Tab. A1).

A second procedure for studying sign usage is to look at use in obligatory contexts. In such contexts the experimenter plus a particular question determine the correct response. Two examples of this, which will be discussed later, are the wh-question test and the slide test.

In discussing procedures for recording the subjects' vocabularies, the Gardners wrote:

Our procedures for recording the use of signs by chimpanzees are fashioned on those that have been developed for young children. They include diary records, inventories of phrases, repeated samples of all verbal input and output occurring during a brief period of time, and formal tests with pictures and questions. (1980: 337-340)

The criteria that the Gardners used for reports of spontaneous and appropriate usage, for determining that a sign has become a reliable item in a chimpanzee's vocabulary, for dating the initial appearance of an item, and for reassessment to determine whether and in what form a particular sign did indeed remain a reliable vocabulary item—all have been listed by Gardner and Gardner (1975, 1978).

To sum up, the last few years have seen a rising interest in the acquisition of vocabulary by children (e.g. Bloom 1973, Bowerman 1978, Clark 1973b, Nelson 1973). Arguments about the nature and development of children's early word meanings are typically supported by examples of child speech and refuted by counter-examples (e.g. Bowerman 1978, Ferrier 1978). By contrast with the case for signing chimpanzees, the conditions under which examples of child speech are obtained and the criteria by which some of these are counted as data are very loosely specified:

I made weekly notes of my daughter's vocabulary acquisitions with descriptions of the social and physical contexts in which they were first used and utterances of mine on which they appeared to be dependent. I noted subsequent uses of the same items and, in particular, any misuses. (Ferrier 1978: 301)

Even for overextension, one of the most frequently discussed characteristics of early child usage, Bloom and Lahey note:

The evidence in the literature is anecdotal and consists of reports of examples by parents and investigators. In some instances (e.g. Brown 1965, Clark 1973) these reports have been brought together for discussion. (Bloom & Lahey 1978: 119)

Modulation of meaning. Spoken languages use devices such as markers, inflections, and word order to modulate meaning. Each language uses a unique mixture of these devices. Sign languages use analogous devices, adapted to the needs and advantages of a visual mode of transmission. Just as these devices vary between languages, they also vary within a language, changing from a childish immature form to the adult form. The characteristic adult use of these devices in a sign language such as ASL is the product of a long developmental process (Bollinger 1975, Cokely & Gawlik 1974, Ellenberger & Steyaert 1978). The chimpanzees in the Gardners' laboratory at the University of Nevada have been exposed to ASL under conditions that are similar to those in which children acquire ASL. When we consider the first few years of development under these conditions, the only appropriate comparisons are with actual observations of children in the early stages of their acquisition of language.

From the beginning of their research with Washoe the Gardners based their conclusions on comparisons between observations of chimpanzees and observations of children (Gardner & Gardner 1971). In contrast, most of the criticism of this research has been based on comparisons between fragments of the chimpanzee data and idealized theoretical conceptions of human language (Sebeok & Umiker-Sebeok 1980, Seidenberg & Petitto 1979, Terrace et al. 1979, Terrace 1979a).

To modulate meanings of signs adult signers use various devices such as establishing loci, facial expression, eye gaze, repetition, sign order, etc. These devices change from the immature form to the adult form, and we will document the similarity between the signing behavior of young children and young chimpanzees.

a, establishing loci. In a conversation adult signers can incorporate references to participants and places into a sign for action. This ability has been called the establishment of loci. Fant gives the following example:

The sight line in Ameslan [ASL] is very important. This is an imaginary line between signer and observer, i.e. "speaker" and "listener." Whenever a sign such as SEE moves along the sight line towards the observer, the pronouns "I" and "you" are implied, thus they need not be signed. That is to say, instead of signing I see you you need to sign only see. Since the sign moves from

"I" towards "you," the pronouns are built into the movement. (Fant 1972: 2)

Signing children first begin to use this device when they are four or five years of age (Ellenberger & Steyaert 1978). In the earliest stage, the young deaf subject Ellenberger and Steyaert studied signed on actual objects instead of in the proximal signing space that adults use; e.g. "the child performed the sign BITE on his mother's knee and then leaned over and pretended to bite it" (op. cit., 265). Schlesinger & Meadow provide several additional examples; e.g.

Ann signed DOG on both mother and father around 18 and one-half months. She also signed GOOD on her mother (12 months), but displaced it upward—rubbing her mother's chest instead of the abdomen. There is frequent reciprocally playful communication between mother and child. (1972: 67f)

Young chimpanzees also show the immature forms of establishment of loci. We have seen the early forms of this device used by chimpanzees within the first twelve months of life. For example, the chimpanzee Dar often signed TICKLE on a favorite toy animal that he brought to his companion to be tickled with (cf Table 1 above). Dar would also sign TICKLE on the hands of his human companions as a request to be tickled by them. Dar also signed OPEN on objects such as the refrigerator door and soda-pop bottles. Similar behavior has been reported by Gardner and Gardner for the infant chimpanzees Moja and Pili. (1978)

Some psycholinguists (e.g. Seidenberg & Petitto 1979) have compared the adult use of modulations with the signing of young chimpanzees in which the modulations are still developing. The descriptive analysis of language acquisition shows that the establishment of loci is a developmental process in human children. All reports of chimpanzee signing that Seidenberg and Petitto have considered have been of subjects five years of age or less. The adult form of the establishment of loci has not been reported in very young children; it would be astonishing if it had been reported in equally young chimpanzees.

b, eye gaze & facial expression.	One of the most important uses of eye gaze and facial expression in ASL is to distinguish between declarative and interrogative sentences (Stokoe 1960: ch. 3). Covington
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has described how questions are indicated by human signers with a questioning look in which the eyes look straight at the eyes of the addressee (Covington 1973). This questioning look is accompanied by one of several behaviors that typically occur at the end of utterances. One of these is pausing of the signer's hands in the signing position, usually remaining there until the other participant begins to answer (ibid.). A signer may also hold this position throughout a short answer and begin a new utterance from this position. The use of eye gaze and facial expression in children learning ASL does not reach the mature form until adulthood (Cokely & Gawlik 1974, Stokoe, personal communication, May 1980). The same might be expected of young chimpanzees who are learning ASL. In fact several investigators have reported that chimpanzees and gorillas do use eye gaze to modulate meaning of signs (Fouts, Hannum, O'Sullivan, & Schneider, in press, Davis 1978, Patterson 1978). A chimpanzee's use of a questioning look can be seen several times in the film Teaching Sign Language to the Chimpanzee Washoe (Gardner & Gardner 1973), in which Washoe signs ME (pause) TIME EAT? and YOU, SUSAN, TIME EAT? Of these and other instances, the Gardners write:

In spoken languages, when children first begin to ask questions they use the questioning intonation. . . In ASL there is a gestural equivalent of the questioning intonation, and this is what Washoe used. . . Notice the eye to eye contact and how the last sign is held longer than usual. (Gardner & Gardner 1974: 30)

In the records at the University of Nevada laboratory, the chimpanzees Washoe, Moja, Pili, Tatu, and Dar have all used eye gaze and facial expression to modulate the meaning of signs they were using. Each has used the sign THAT in both a declarative and an interrogative form. For example, research assistants reported that Tatu as early as 15 months of age used the two forms of THAT in distinctive contexts. Most of the early interrogative forms occurred while Tatu was looking through picture books and were interpreted as her asking for the name of the object pictured; the declarative form typically occurred in a statement made by Tatu or in her response to a question asked by one of her companions.

In order to document these reports; a 15-day sample was obtained on the two forms of the sign THAT (above, p. 23, and Gardner & Gardner 1978). According to the 15-day record, the distinction between the two forms was eye contact and the

length of time that the sign formation was held. In Tatu's use of the interrogative form THAT? eye contact was made and maintained while the sign duration was longer than in the declarative form. This is similar to what Covington has reported for human signers (op. cit.).

Patterson has provided an example of a gorilla's use of facial expression in the modulation of the meaning of signs:

One day in response to a woodpecker's tapping outside, one of Koko's companions, Barbara, signed: "Koko listen bird." Koko responded: "Bird?" As she signed she turned her head toward Barbara, cocked it, and opened her eyes wide. . . (In this example taken from the diary records, my assistant's description of Koko's interrogative intonation was very similar to Fischer's description of it for the deaf (1972: 36): "Yes-no questions are marked by raising of the eyebrows and an expectant look on the face." (Patterson 1978: 79)

As in the case of establishment of loci, the use of eye gaze direction in the modulation of the meaning of signs is a developmental process and changes from child form to adult form (cf Cokely & Gawlik 1974).

It appears that the use of loci, facial expression, and direction of gaze to modulate the meaning of signs is a robust phenomenon in chimpanzees. The one exception is Seidenberg and Petitto's claim that Nim did not use these devices (1979). Either Nim's rearing conditions were so aberrant that these behaviors did not occur, or these behaviors did occur but Nim's teachers, novices with ASL, did not report them. Terrace has noted that Nim's teachers . . . could manage [only] one, two, or three sentences on a given topic before going on to sign about the next topic (1979a: 124) [and] New volunteers rarely came equipped with a knowledge of sign language and a solid understanding of the intellectual background of the project (1979a: 256).

c, repetition. In studies of language acquisition by English speaking children, investigators generally delete repetitious utterances; e.g. the explicit exclusion of repetition in Bloom's definition of a corpus (page 28 above). Also:

It must be borne in mind that when researchers have analyzed children's utterances, as when in the past they

have analyzed chimps': Repetitions do not count. This is true for both words and whole sentences. . . . My transcripts are full of false starts, repeated words, repeated phrases for one reason or another—sometimes for emphasis, sometimes because a wanted phrase cannot apparently be found, sometimes from something like absent mindedness. In a transcript that I have been analyzing recently a 24-month-girl, told that she was to go with her mother to pick up her brother John, launches into "Wait John up" "Wait John" "Wait John" "Wait John" repeated 11 times in succession. (Nelson 1980)

Because of the way transcripts are edited in the published literature, children's utterances may appear less repetitive than they actually are. In Nelson's words, "anyone who claims children do not repeat has led a sheltered library existence" (ibid.).

As to the functional use of repeating signs or words, it has been observed by Nelson that "the problem of making comparisons on this dimension across languages that use different modalities and different ways of marking boundaries is very great" (ibid.). We agree with Nelson that the most appropriate comparisons are made between subjects that are using the same language. Hoffmeister, Moores, and Ellenberger have described the use of repetition by signing children as difficult **to interpret**: "...children acquiring sign language often repeat signs without apparent significance. It is frequently impossible to determine whether or not the repetition is meaningful" (1975: 123).

In contrast to the evidence of the literature, Terrace, Petitto, Sanders, and Bever claim:

As far as we can tell from published reports describing children's utterances, the repetition in an utterance of a word or sequence of words that were not considered to be examples of stuttering, is a rather rare event. (1980: 414f)

Of course the reason that published studies make children's speech appear non-repetitive is that repetitions are routinely edited out of the corpus (see page 28 above). Further Terrace (et al. 1980) and Seidenberg and Petitto (1979) have claimed that the signing of young chimpanzees is more repetitive than the speech of young children. In addition to the problems in making comparisons across languages in different modes there are difficulties in determining the number of repetitions

in sign language; e.g. Terrace, Petitto, and Bever reported the sequence HAT HAT HAT as a three-sign combination for the chimpanzee Nim (1976: 28, Tab. 3). Yet in the same report, when describing the same sign, HAT, they list the movement as repeated. Although it is easy to count repetitions of spoken words, the repeated movement in certain signs (e.g. the repeated tap on the head for the sign HAT) makes it more difficult to determine if a movement is repetition of movement within a sign or is a repeated sign.

Seldenberg and Petitto characterize the early speech of children as telegraphic and contrasted that with the signing of chimpanzees, which they claim repetitiously expands. It is a mistake to assume that because children's speech can be characterized as telegraphic that it is not repetitive. Telegraphic speech is orthogonal to repetitive speech and not its opposite. Obviously telegraphic speech can be repetitive.

d, sign order. Word order is one of the syntactic devices that relates words in a spoken sentence, and chimpanzees can be trained to use sign order (Fouts et al. 1978). The device of order plays a much less important role in languages that are highly inflected (e.g. Russian). Since ASL is highly inflected (see Klima & Bellugi 1979: chs. 11, 12), questions about sign order in the spontaneous utterances of either chimpanzees or children are less important. Gardner and Gardner have maintained that "in the case of immature [human and nonhuman] primates whose utterances are brief, simple, and relatively homogeneous in context, there may be less need to infer that rules of order are syntactic rather than semantic" (1971: 176).

The obvious absence of other grammatical devices in these "early sentences" forced many writers to overstate the case for word order as a grammatical device in early speech. Some were ready to claim that two- and three-year old children are nearly perfect in their grammatical use of word order, and sometimes these extravagant claims have been contrasted with our rather conservative statements about Washoe's use of sign order. As more child data have accumulated, however, it has become clear that the evidence for grammatical use of word order does not fit the simple models that were first proposed. When the evidence is compared, rather than the claims, the parallels between child and chimpanzee are much stronger than the contrasts. (Gardner & Gardner 1978: 55)

In spite of the number of times that the Gardners have argued against using sign order as a criterion for judging the linguistic ability of either chimpanzees or children, Seidenberg and Petitto have attributed to the Gardners the belief that "a regular ordering of a subset of signs provides sufficient evidence for the use of syntax, and hence, provides critical evidence in favor of a linguistic interpretation of the apes' behavior" (Seidenberg & Petitto 1979: 187). Eight years earlier the Gardners had written

We are not forced to interpret either the existence of combined forms or the existence of nonrandom features in these combinations as evidence for syntax in Washoe's manual utterances. For roughly the same reasons, it may be as misleading to describe nonrandom aspects of the utterances of immature primates [human and nonhuman] in terms of syntax, as it is misleading to refer to nonrandom aspects of the running of rats in mazes in terms of hypotheses. (1971: 178)

In contrast, Terrace (et al. 1979) concentrated on analyzing the order of the chimpanzee Nim's signed combinations; order was the only evidence of grammar discussed. Seidenberg and Petitto reported that "the Nim data... indicated that while some of his combinations appeared in regular order, these regularities did not extend to classes of signs" (1979: 187). Because of the absence of these regularities, Terrace and his associates concluded that Nim's sequences lack the syntactic structure of sentences (1979).

There are at least three objections to this analysis of Nim's signing. First, the vast majority of Nim's sign combinations were two or three sign utterances (see Terrace et al. 1979: 894, Tabs. 4 & 5). Such short utterances are likely to be understood no matter how the signs are ordered. In discussing word order in the early stages of child speech, Bollinger noted

... a two-word sentence has little need for connective tissue. The elements are of equal rank, and if one knows their meaning it is not even necessary to put them in any particular order—a child is as apt to say awgone shoe as to say shoe awgone, not to mention his magisterial indifference to "correct" grammatical indications of agreement and subordination. (1975: 7).

Second, it is questionable that children at the two or three word stage have syntactic structure or produce grammatical sentences. Nelson has said "the appropriate conclusion to be drawn with respect to word combinations is . . . apes don't seem to produce grammatical sentences but [using the same criteria] neither do children at the 2 or 3 word stage" (1980). Finally, it is inappropriate to analyze signed combinations devoid of context:

The context in which language is used, by the child and by others speaking to the child, is as important as what is actually said for understanding children's language and making inferences about what children know.

(Bloom & Lahey 1978: 29)

Without examining the relationship between sign order and its context it is impossible to determine if the order is used in any meaningful way. Meaningful use of sign order **might** be shown if, for example NIM KISS and KISS NIM occurred in different contexts. In the absence of information about contexts, the best that Terrace's analysis could show was the relative frequency with which each order occurred; it is impossible to determine whether order was used to modulate meaning.

Analysis of It is relatively easy to obtain audiotaped filmed data. records of the speech of young children because of the technology of audio recording. Such records form an important portion of the data base for the analysis of linguistic development in children. Accessibility of such tapes is usually limited to the investigator and a few close associates. Transcripts of such records are rarely published, except in the form of illustrative excerpts. Such transcripts are usually heavily edited (pp. 28, 38f above).

It is much more expensive and technically more difficult to make video records of sign language. Unfavorable camera angles, focus, or lighting can make signs quite unintelligible. It is even more difficult to make video records of highly mobile children or young chimpanzees, since it is just the mobility of these subjects under spontaneous conditions that occasions the unfavorable camera angles, focus, and lighting.

In spite of these difficulties, video recording has been undertaken by investigators of sign language acquisition by children (Klima & Bellugi 1972, Hoffmeister et al. 1974, Schlesinger & Meadow 1972) and by chimpanzees (Gorcyca, Garner & Fouts, in press, Gardner & Gardner 1973, Terrace

et al. 1973). The Gardners have recorded about 30 hours of unstructured interaction between signing adults and young chimpanzees on 16-mm film and about 15 hours on videotape. Unpublished portions of this video record have been studied by students and colleagues in Reno. Published portions have been studied by hundreds of other viewers. When this video material is studied in the same way as the video records of young children, the results are comparable (Stokoe 1978). Stokoe calls special attention to the linguistic significance of the movement and rhythm in Washoe's signed utterances YOU ME YOU ME YOU SUSAN. ME WASHOE. YOU ME YOU SUSAN ME GO OUT:

I [Stokoe] have seen some parts of the film record of the early years of Washoe's life as many as a dozen times, and I still find one sequence most compelling. In it, Washoe initiates a verbal interaction with Susan. It begins slowly, and it must look to a nonsigner exactly like real-world deixis; but there is hesitation in Washoe's action that looks as if simple deixis is not the motivation. Washoe's pointing, we realize is more than simple deixis; even without its repetition and elaboration with proper names [signs], its perseveration makes it into what logicians call a conjunction. It means 'you and I' and 'together' and even in some contexts in the films it may mean 'you carrying me'. But what I find especially significant is the turning (before GO OUT). Just as signers of ASL use a turn of head and gaze to mark a change from one part of a complex sentence to another, Washoe here seems to find in the physical movement or the visual stimulus the impetus necessary to move her cognitively from the conjunction that has created a compound nominal to the actual predication, 'go out' — a structure that may be pretty complex for an infant chimpanzee making a suggestion instead of answering a familiar question. (1978: 83f)

In contrast, most if not all of the videotaped records of the chimpanzee Nim were made in a highly restrictive classroom under the teaching conditions described by Terrace (1979a). The results as reported in *Science* (Terrace et al. 1979) were most unchildlike. As we have already pointed out, the differences in the teaching and rearing conditions could easily account for the differences between Nim and the

chimpanzees filmed in spontaneous conversations. The unusual methods that Terrace and Petitto used to analyze their records may also account for some of the unchildlike results.

Although Terrace has not yet published or made available any portion of his videotapes of Nim or the written transcripts of these tapes, it is possible to examine Terrace's and Petitto's technique for analyzing film by reviewing the techniques used in their analysis of the published films of Washoe. (Terrace, Petitto, Sanders, & Bever 1979). According to Terrace, the analysis is based on transcripts prepared by Laura Petitto and verified by himself (op. cit., note 59).

Overlap and turn-taking. A degree of temporal overlap between the signs of two persons engaged in spontaneous conversation is a common feature of fluent signing. Baker noted that "approximately 30% of discourse involved either full or partial overlap of one interactant's signs with the other's" (1977: 228). When asking a question, a signer's hands pause in the signing position, usually remaining there until the other participant begins to answer. A signer may also hold this position throughout a short answer and begin a new utterance from this position (Covington 1973). In their published samples, Terrace and Petitto consistently misread the overlapping between the first sign of Washoe's replies and the last sign of her human companion's questions as interruption. In the examples of interruption that they cite, Washoe was using the normal devices of turn-taking in ASL much as a fluent human signer would.

Expansion and imitation. In one of the filmed exchanges, Beatrix Gardner asks, WHAT TIME NOW? and Washoe replies, TIME EAT. By the definition that Bloom and associates use for children, this reply would be classified as an expansion "that added information about the topic of a prior utterance" (Bloom et al. 1976: 530). The normal replies of human beings to questions commonly consist of such expansions, in which part of the immediately preceding question is repeated together with the new information asked for. Bloom in the work cited found that increase in the frequency of such expansions was a major development in child discourse. A child's utterance was

classified as imitation rather than expansion only when "all or part of the preceding utterance was repeated without change" (Bloom et al. 1976: 528). It is clear that Washoe's reply, TIME EAT, to the question, WHAT TIME NOW? was not an imitation. Nevertheless, Terrace classified this example as imitative because some time earlier in that scene Beatrix Gardner had signed, FEED ME. While the distinction between the ASL signs FEED and EAT may have been subtle in this film example, the appearance of this utterance (FEED ME) in the dialogue is remote rather than immediate in relation to Washoe's reply, TIME EAT. To make Washoe's EAT qualify as an imitation, Terrace and Petitto must go back through four different utterances of Beatrix Gardner and ignore a break for a non-signing activity that intervened. Terrace and Petitto's unusual use of the term "imitation" is the reason that their findings are so different from those of others who have scored the films the way that they would score human discourse.

Time and Sign like speech is based on time-bound movement. signals. When tapes or films of signing are played back slowly, the clues to motion and rhythm are lost. In slow motion many signs become indistinguishable. Played slowly enough signing becomes unintelligible in much the same way that speech becomes unintelligible when audiotapes are played back too slowly.

Stop motion photography, then, no matter how sophisticated, cannot reveal the elements of sign language contrasts.

When the tape is slowly moved past the heads (moving at their normal rate), a slow motion picture results; but it is no easier than at normal speed to identify particular parts of the recorded action with particular elements of the signs. Native signers, in fact, read and transcribe taped performances more readily at normal speed (though with many stops and rewinds when making written transcripts) than slowed—exactly as native speakers find normal audio recordings easier to understand than recordings played back at slower than normal speed. (Stokoe 1975: 220)

When signing is slowed, the first things lost are modulations that determine emphasis, juncture, and all of the prosodic features that give meaning to a multiple sign utterance. Terrace is certainly unique in this field to claim that slow motion is best for the analysis of turn-taking (1979a: 219), and in his claim that no discourse information was lost in

his frame-by-frame, i.e. stop motion, analysis (Terrace, in press). In any case, their published examples show that Terrace and Petitto did lose much of the information in the Washoe films. They confuse signs, as in their inability to distinguish among ME, MINE, and PLEASE, whether signed by Washoe or a human signer. Part of the ASL distinctions in these signs are given in the pattern of movement. [MINE brings the palm to the chest; PLEASE requires it to move there.] By discarding information that distinguishes one sign from another they reduced the number of different signs in the record and produced transcripts that appear to exhibit many cases of repetition and imitation.

The information that Terrace and Petitto discarded also caused them to mistake the beginnings and endings of utterances. This resulted in transcripts with more and shorter utterances than are in the filmed record (Compare the count of utterances in Terrace et al. 1979: 897, with the published film, Gardner & Gardner 1973). They are also confused about which of two signers began the overlaps that did occur. Thus, on page 897 they are confused about whether it was Beatrix Gardner or Washoe who initiated the overlaps, when this information is plain in the film played at normal speed.

The transcripts published by Terrace et al. (1979) thus contain much less information than the original film as shown in the Gardners' transcript (1974) and readings of portions of the record by others (e.g. Stokoe 1978). Terrace claims: "Our reviews of both films of Washoe yielded no instance in which the addition of information about movement would alter the interpretation of Washoe's or her teacher's signing" (Terrace et al. 1979: 902, note 59). In other words, they lost information at all speeds. We would urge readers to study the films of sign language studies with chimpanzees and come to their own conclusions.

Summary. Each language uses its own mixture of devices such as order, inflection, and markers to modulate the meaning of semantic units. Typically there is a wide range of variation in the skill with which these devices are deployed by the different users of a language. There are particularly dramatic differences between children's immature usage and adult usage. Chimpanzees, like human beings, have an extended period of development, and this is one of the primary reasons that they were chosen for sign

language studies. Linguistic devices used to modulate the meaning of words or signs are the result of a long developmental process in which these modulations change from immature form to the adult form. We have documented here that at least five chimpanzees and a gorilla while acquiring sign language have exhibited the juvenile forms of the establishment of loci, the use of eye gaze, facial expression, and repetition to modulate the meaning of signs in ASL. These non-human signers have also exhibited changes in the semantic range of signs as the signer matures.

A certain amount of confusion has been introduced by commentators who fail to consider the differences between signing and speech or between childish and adult forms. In this section we have tried to clear up some of this confusion.

3. TESTING PROCEDURES

In their work with chimpanzee subjects comparative psychologists have added rigor and experimental power to some of the techniques that psycholinguists use with children. Two good examples of this are the study of the use of spatial prepositions by the chimpanzee Ali, by Fouts, Shapiro, and O'Neil (1978), and the study of replies to Wh- questions made by the chimpanzee Washoe done by Gardner and Gardner (1975). In addition, the Gardners have developed a vocabulary test, which has not yet been attempted by psycholinguists working with children (Gardner & Gardner 1971, 1974). In this section we will discuss each of these three tests.

Spatial prepositions test. Clark has examined how children comprehend spatial prepositions (1973a). In her test children listened to a sentence containing a spatial preposition and performed an appropriate task; e.g. the experimenter asked the child to "put X in Y"—while the experimenter looked on. According to Clark, children begin by using certain nonlinguistic strategies, and they progress until they exhibit full semantic knowledge of the three words on, in, and under. Younger children always responded correctly to in, sometimes responded correctly to on, and never responded correctly to under. Clark concluded that young children used two nonlinguistic rules for solving the problems (1973a): if Y was a container, the children

usually put X in Y, and if Y was a flat surface they usually put X on Y, regardless of the experimenter's request.

Fouts, Shapiro, and O'Neil examined the use of spatial prepositions by the chimpanzee Ali (1978). Ali was taught to use the spatial preposition (of ASL) IN, ON, and UNDER to describe a variety of relationships between arranged objects. After this training he was shown new sets of arranged objects and questioned, WHERE X? (X of course being a sign for an object) by an experimenter who could not see the objects. Ali was expected to respond with an ordered sequence of signs; i.e. a sign for the object, a preposition sign, and a sign for the location. The objects were BALL and BABY (doll) and the like; the prepositions were IN, ON, and UNDER; and the locations were PURSE, PILLOW, and the like.

The experimenters report that "eighty trials were given per session and were arranged so that neither subject [object] nor location occurred on consecutive trials" (Fouts et al. 1978: 196). The signs IN, ON, and UNDER were neither subjects nor locations in this study. They are prepositions that specify a relationship between a subject (like a ball) and a location (such as a purse); e.g. on the first trial the test stimulus might be a ball in a purse. Then according to the rules on the second trial the stimulus could be a flower in a shoe, since only the subject and location had to be changed from trial to trial. In the first block of training trials, Ali used the correct preposition 49 % of the trials; by the fourth block of training trials, Ali reached testing criterion and was averaging 96 % correct responses on the prepositions (Fouts et al. 1978). As a further test for generalization, there was a transfer phase, with new subjects and new locations, and there was a slight decrement to 80 % correct use of prepositions. Clearly Ali was still performing at a level significantly above the expected chance level of 33 %.

Seldenberg and Pettito may have introduced some confusion about the above study when they wrote that "no sign was ever the correct response on two successive trials. That is, an 'in' trial was always followed by an 'on' or 'under' trial, etc." (1979: 206). Because they misinterpreted the procedure, they concluded, "...we would expect performance to be somewhere around 50 % accuracy. Ali's reported accuracy is 49.1 %" (op. cit., 207). This interpretation is clearly contradicted by the published record. Since any of the prepositions could occur on the consecutive trials, the expected performance was 33 %

as reported by Fouts, Shapiro, and O'Neil. Furthermore, the 49.1% cited by Seidenberg and Petitto was Ali's score on only the first block of training trials; he scored 80% correct in the testing phase of the study. Clearly Seidenberg and Petitto are mistaken about the procedure.

The Fouts, Shapiro, O'Neil study improves upon the study by Clark (1973) cited by Seidenberg and Petitto as a typical study of children's use of prepositions. First, in the Clark study, the experimenter could have (unconsciously) cued the subject, because the experimenter and subject interacted face to face and the experimenter knew the correct response. Second, the subject had only to move an object to one of two distinct places. In any test situation in which there are only two possible choices a minimal amount of cueing is sufficient to provide the correct response. In contrast the experiment with Ali is a measure of production: the subject produced an utterance after looking at an arrangement of objects. Ali's response was linguistic not performative, and he was free to choose any preposition (indeed any sign) in his vocabulary. As in Clark's study, the experimenter interacted with the subject, but a major difference was that in the study by Fouts and associates the experimenter could not see the arrangement of the objects and so could not cue the correct response. The test of Ali was a rigorous test of the use of spatial prepositions by a non-human signer and demonstrated that studies of multiple sign utterances could be done using blind procedures.

The Wh- question test. Another good example of adding experimental rigor to a technique used by psycholinguists is the Gardners' study of Washoe's skill at replying to Wh- questions (1975).

"The best evidence," according to Brown, in the child's spontaneous speech that he has such constituents is his ability to make the right sort of answers to the various Wh- questions addressed to him, giving noun phrases in response to Who and What questions, locatives to Where questions, predicates to What-do questions, etc. (Brown 1968:286)

In their pioneering studies, Brown (op. cit.) and Ervin-Tripp (1970) combed through transcripts of children's speech that had been collected earlier, searching for instances in which an adult interlocutor had asked one of the major question

types and for each case judged whether the child's answer contained an appropriate sentence constituent. In their study (1975), the Gardners reasoned that if the Wh- questions exerted control over the replies then sentence constituents should be distributed in an exclusive manner; i.e. not only should certain categories of constituents appear in the replies to certain question frames, but also these categories should not appear in replies to other question frames. The replies to a battery of questions yield a matrix, Table 2.

This procedure of the Gardners yielded a more detailed statistical analysis of the subject's responses than had been possible in previous studies. Brown reported that children at Level-III responded appropriately to Wh- questions "about 50% of the time" (1968). The Gardners were able to present a detailed distribution of Washoe's replies to 10 different types of Wh- questions, Table 3.

As in the case of transcripts of children's speech, the Gardners found that the transcripts of Washoe's signing contained many examples of appropriate answers to Wh- questions. Using the studies of Brown (1968) and Ervin-Tripp (1970) as models and incorporating basic techniques of experimental psychology, the Gardners obtained a fresh sample of Washoe's signing in which 10 previously specified question types (see Table 2) were answered by Washoe 50 times over a period of three weeks. The set of 500 replies were assigned to categories according to the sentence constituents that they contained. By applying a rigorous set of rules that uniquely assigned Washoe's replies to one and only one of the prespecified categories, they avoided the pitfalls of a retrospective analysis. This a priori categorization of the replies is a much more conservative approach than that of psycholinguists who rely on their skills as native speakers of English to determine the appropriateness of their subjects' replies. According to Brown, "The endless fine details [of determining the appropriateness of a response] have to be left to the judgement of a native speaker" (Personal communication, January 1981). Brown is clearly a competent speaker of adult English, but in what sense can an adult be considered a native or fluent speaker of Stage I, II, or III (child) speech?

Ervin-Tripp and Miller report that investigators tend to adapt their questions "to the difficulty level of the child" (1977: 19). Thus transcripts of children's speech usually contain a preponderance of replies to two or three types of

Question frame	Number of replies containing:										Other	Total appro- priate
	N	p	ps	C	n	TVP	V	VLP	L,LP	Appro- priate		
Who pronoun	48*				1					1*		49
Who action	10*	29*				1*		2*	1*	2*	5	45
Who trait	11*	20*			2	1				1*	12	42
Whose demonstrative	2	1	44*		1					1*	1	45
What color				43*	3					4*		47
What demonstrative					50*							50
What now	1	2			1	35*	4*	4*	1	1*	1	44
What want	3				17*	4*	7*	1*	3	6*	3	41
Where action	1	1			1	1		5*	33*		8	38
Where object	1	2			3		3	1	24*		5	24

Note. Cells for appropriate constituents are marked with asterisks. N= proper name, p= pronoun, ps= possessive, C= color, n=common noun, TVP= temporal verb phrase, V= verb, VLP= locative verb phrase, L= locative, LP= locative phrase. The where Object row contains only 43 cases because seven times wasnoe retrieved the object that she was questioned about.

From: B.T. Garuner and K.A. Gardner. Evidence for Sentence Constituents in the Early Utterances of Child and Chimpanzee. Journal of Experimental Psychology: General, 1955, 104, No.3, 244-267.

Table 2. Distribution of sentence constituents in all replies by Washoe to Wh- questions.

Question Frame	Target Category	Examples of Questions and Replies
Who pronoun	Proper name (N)	WHO YOU? WHO ME? ME WASHOE LINN
Who action	Proper name (N) or pronoun (p)	WHO SMOKE? WHO GO OUT? YOU SMOKE YOU ME
Who trait	Proper name (N) or pronoun (p)	WHO GOOD? WHO PRETTY? GOOD ME WASHOE
Whose demonstrative	Possessive (ps)	WHOSE THAT? WHOSE THOSE? MINE SHOES YOURS
What color	Color (C)	WHAT COLOR? WHAT COLOR THAT? BIRD WHITE GREEN
What demonstrative	Common noun (n)	WHAT THAT? WHAT THAT? BOOK FOOD FRUIT
What now	Verb (V)	WHAT NOW? NOW WHAT? TICKLE TIME DRINK
What want	Common noun (n) or verb (V)	WHAT WANT? WHAT YOU WANT? WANT BERRY YOU ME OUT
Where action	Locative (L)	WHERE WE GO? WHERE SHALL SUSAN PLAY BITE YOU? OUT SUSAN BITE THERE
Where object	Locative (L)	WHERE SHOE? WHERE BABY? THERE SHOE (fetches doll)

From: B.T. Gardner & R.A. Gardner. Evidence for sentence constituents in the early utterances of child and chimpanzee. Journal of Experimental Psychology: General, 1975, 104, 244-267.

Table 3. Relations between Wh- questions and Washoe's replies.

Wh- questions and few if any replies to other types of Wh- questions. The Gardners' procedure assures that all question types under investigation will be equally represented and questioners, days, and order of presentation during the day were all balanced.

To demonstrate that Washoe's replies to the Wh- question types could be reliably assigned to the target categories, the Gardners gave a graduate student who had not participated in Project Washoe the task of assigning the 500 replies to target categories based on the (later) published criteria. Her assignment of categories was in perfect agreement with that of the Gardners. Seven years later, we also obtained a copy of Washoe's replies to the 500 Wh- questions. Using the same rules (now published in Gardner & Gardner 1975), we assigned the replies to categories. We agreed on the assignment of 498 of the 500 responses. Our assignment would have increased the value of the chi-square slightly.

Before applying the rules to Washoe's replies, the Gardners sorted each sign that appeared in one of the replies into one of a set of types. This a priori assignment of Washoe's signs that occurred in the replies eliminated the need to rely on intuitive judgment. In Table 4 (p. 61) some of the signs that have been classified as nouns could also have been used as verbs (e.g. DRINK, BRUSH). As the Gardners explained:

In Ameslan, as in most natural languages, many signs can be used either as nouns or as verbs, although certain noun forms are rarely used as verbs and certain verb forms are rarely used as nouns. In Table 2 [Table 4 p. 61] we have listed as nouns those signs that could be used either as nouns or as verbs together with those that would rarely be used as verbs in good Ameslan. In the category of verbs (V) we have listed 9 signs that appeared in this sample of Washoe's replies and that would typically be used as verbs in good Ameslan. (1975: 251)

The Gardners' assignment of such items in Washoe's vocabulary is consistent with the description of those signs in the Dictionary of American Sign Language (Stokoe et al. 1965). Each sign in the dictionary is labeled N, V, or X, according to its use as nominal, verbal, or adjectival-adverbial. All of the signs that the Gardners classified as nouns were classified as N or as V N in the dictionary. Similarly, for all of the signs that the Gardners classified as verbs, the dictionary has the V classification, with the single exception of BITE, which in DASL is classified as a noun that may also be used as a verb.

Assigning Washoe's signs to categories and then setting up rules by which her replies could be judged as appropriate or not is much more conservative than using intuition to judge the responses. For example, WHERE LOLLIPOP? was asked of Washoe by Susan, after placing the lollipop in a cupboard; Washoe replied, OPEN LOLLIPOP PLEASE. Intuitively a native speaker could have classified this as a correct reply to the question; however, it was scored incorrect because it contains no locatives (Gardner & Gardner 1975: 252).

In the description of their scoring procedures, the Gardners pointed out that two types of redundancy that appeared in Washoe's replies to Wh- questions could not affect the appropriateness or inappropriateness of the replies. Consequently these redundant signs were ignored when scoring the replies. One type of redundancy that was ignored in this scoring was the repetition of a particular sign (e.g. GREG GREG) or the appearance of two signs from the same category (e.g. GREG SUSAN). Thus in response to the question, WHO COME? the reply SUSAN SUSAN COME is no more appropriate or inappropriate than SUSAN COME or SUSAN. Furthermore, because the purpose of the test is to demonstrate that certain categories are likely to appear in the replies to certain question frames, the reply SUSAN GREG COME is no more or less appropriate than SUSAN or GREG. What is important is that a name sign (or a pronoun) was used in the reply. The purpose of the Wh- question sample is to note the appropriateness of the response category to the Wh- question frame rather than to judge the grammaticality or situational accuracy of the response. Similarly, in his study of the way that children respond to Wh- questions, Brown points out that

The particular answer does not stand in a one-to-one relation with the particular question, and so is not a simple transform of the question. Grammatically acceptable answers to the question: "What will John read?" are all noun phrases. Acceptable answers to the question: "Where will John read the book?" are locative adverbials. In general, each kind of Wh- question calls for an answer which is an instance of a particular major sentence constituent. These constituents also occur, of course, in sentences which are not responsive to questions. (1968: 281)

As is normal in conversation, Washoe's replies often included one of the signs that appeared in the question. This

was the second type of redundancy to be ignored in scoring in this test procedure. To understand why this kind of redundancy is irrelevant to the scoring of replies to Wh- questions, consider Brown's example:

Q: Where will John read?

R: John will read in the library. (1968: 280, Tab. 1)

Brown noted that all parts of the response are redundant except the phrase "in the library." Similarly when Washoe replied SUSAN BITE THERE to the question, WHERE SHALL SUSAN PLAY BITE YOU? all the signs in the reply are redundant except THERE. This does not make all the other signs of the reply uninteresting but only redundant for the classification of replies to questions in the Wh- question test.

The development of this second type of redundancy in the rest of the records of the signing chimpanzees is an important measure of similarity with children. In Bloom's study of language development, repetition by the child of items in an adult's question was considered a developmentally advanced form of child discourse:

The major development in the children's discourse from stage 1 to stage 5 was the increase in messages that shared the topic of a prior utterance with added information. This increase in contingency was characterized primarily by expansions, in which the verb of the prior utterance was repeated and something was added to it: either major sentence constituents (SVO) were added or modified, or a wh- form was replaced by a word or a phrase. (Bloom, Rocissano, & Hood 1976: 547)

The rules by which these two types of redundancy were ignored in the scoring of replies to Wh- questions in this particular test are clearly presented by Gardner and Gardner (1975), along with the rationale for each rule. Seidenberg and Petitto accuse the Gardners of using the rules to improve the appearance of their data in some way, claiming that "the Gardners transform long, redundant utterances into strings which more closely resemble human utterances in their superficial form" (S. & P. 1979: 184). They give as an example the reduction of SUSAN BITE THERE to THERE. It is not clear on what linguistic basis THERE more closely resembles a human utterance than does SUSAN BITE THERE, but it is clear that as an answer to Susan's question WHERE...? the only scoreable answer is THERE in a Wh- question test.

Here, as in their other examples, Seidenberg and Petitto are ignoring the rationale of this or any Wh- question test.

Markers as listed in Table 4¹ are the third kind of sign that was not considered in scoring the Wh- question sample. The Gardners argued that while markers could function in the modulation of meaning, they would not alter the appropriateness or inappropriateness of the reply to a particular Wh-question.

Seidenberg and Petitto suggest that signs in this category could alter the appropriateness of the replies to Wh- questions, arguing that markers in a reply to a Who-pronoun question make that reply inappropriate (1979: 184). In their invented examples of replies, GIMME SUSAN, ENOUGH SUSAN, and MORE SUSAN are considered to be less appropriate answers to the question WHO SHE? than the answer YOU SUSAN. For a more direct answer, the present authors returned to their copy of the 500 questions and replies. First, we found that only 39 replies contained markers. Markers tended to show up in those categories that referred to matters of opinion and preference rather than to matters of fact (e.g. WHAT WANT? and WHAT NOW?). No markers appeared in answers to the following categories: WHO PRONOUN, WHOSE DEMONSTRATIVE, WHERE ACTION, WHAT COLOR, and WHAT DEMONSTRATIVE. The type of inappropriate response invented by Seidenberg and Petitto in fact did not occur in the sample. It is pertinent to note that Seidenberg and Petitto, or anyone else, could have determined the number and nature of replies containing markers by writing to the Gardners for a copy of the 500 questions and replies.

Seidenberg and Petitto suggest that the number of Washoe's appropriate replies was inflated by the rules applied to markers (1979). Clearly this is not the case as 19 out of 39 replies with grammatical markers in them were scored as inappropriate. For example, when Lynn asked Washoe, WHAT YOU WANT? Washoe replied, OUT HURRY HURRY. Intuitively a native signer might have classified this an appropriate reply, but the Gardners rules cause it to be scored as incorrect because HURRY is a marker, and OUT, a locative, did not belong to the target category for this question type.

To allay all doubts on this point we reanalyzed Washoe's replies, eliminating all replies containing grammatical markers from each cell, while keeping the marginal totals the same as in the published statistical analysis (Gardner & Gardner 1975: 253, tab. 3—see Table 2, page 51 above).

This of course is the most conservative way of doing the analysis and can only lower the chi-square. With 90 degrees of freedom, a chi-square value of 128.3 is required for significance at $p < 0.005$. The chi-square calculated by the Gardners was 1916.50. Our more conservative analysis yielded a chi-square of 1883.8. Obviously, the treatment of grammatical markers could not have significantly inflated Washoe's score.

Seidenberg and Petitto claimed several times (e.g. on pages 183 and 187 of the 1979 article) that the Gardners had used techniques for eliminating repetitious signs and otherwise reducing data. The original records were never reduced in any way. While the Gardners did not consider repetitions for the purpose of scoring in the Wh- question analysis, repetitions were not ignored in gathering data or in analyzing other aspects of Washoe's signing or the signing of any other chimpanzees thus far studied by the Gardners. Currently the chimpanzees' use of sign repetition is under investigation in our laboratory at the University of Nevada (Gaustad 1980).

Parents ask many questions of their children in their daily conversations. Many of these questions are of the Wh-question type. Washoe's training was similar to that of any child that is acquiring a language. The practice that Washoe had with answering Wh- questions resulted from her daily experience of conversations with her human signing companions. Seidenberg and Petitto complain that the

. . . Gardners' test [Wh- question] exhibits an impoverished conception of language, since Washoe is to be credited with the ability to answer questions if she can learn to associate a narrow class of signs with each wh- sign. Thus the ability to answer questions is reduced to a discrimination learning task. (1979: 205)

In fact, in defining specific classes of answers that are appropriate to specific Wh- questions, the Gardners were following the lead of Brown on what would seem to be the path of common sense (1968). One of the most vital products of face-to-face conversation would be made impossible unless requests for information could be phrased in ways that specify the class of information requested. This may be "an impoverished conception of language," but it is the only practical way of asking and answering questions in ordinary human discourse. Since children must learn their own language, and since each language has its own set of Wh- questions (see Table 3), children must discriminate among the Wh- question types if they are to give relevant answers.

It is obvious that any semantically correct answers to a common question, such as What's your name? Who is that? and What is that? must be learned by association.

At the conclusion of the Wh- question sample analysis, the Gardners were able to compare Washoe's replies to Wh-questions with those of children in Brown's study (1968):

The appearance of appropriate words in about half of the replies was sufficient for Brown and Ervin-Tripp to claim that children have grammatical mastery or control of a particular question type. Both agree that Stage III children should be credited with that much mastery of who, what, and where questions. They disagree about the ability of Stage III children to respond appropriately to whose and what do. Neither found evidence for mastery of why, how, or when.

The questions used (with Washoe) in the present study contained the interrogatives Who, What, Where, and Whose, and Washoe's replies contained appropriate sentence constituents 84 per cent of the time even when appropriateness is much more narrowly defined than in the child studies. Moreover, distributional analyses . . . demonstrate a degree of statistical control by the interrogatives that is far beyond anything that could be extrapolated from the children's data for Stage III. (1975: 255)

Since the data from Washoe were collected, similar studies have been run on four other chimpanzees who have been exposed to ASL since birth (Gardner & Gardner 1978).

The vocabulary test. The Gardners attempted to teach a natural human language, ASL, to Washoe, and more recently to Moja, Pili, Tatu, and Dar. The acquisition of this language occurred in an environment similar to that in which children learn their native language. The degree of similarity between the observations of signing of young chimpanzees and the observations of early speech and signing of very young children is the reason that the Gardners' results have had such a major impact on the scientific community. To provide comparative measures, the Gardners and their co-workers have analyzed samples of dialogue between their subjects and adult signers, using the same procedures used in studies of speech and signing in human children. Where possible, as in the Wh- question

study, more systematic and rigorous procedures have been used with the young chimpanzee subjects.

Comparative psychologists have always sought to corroborate their transcriptions by demonstrating that two independent observers would agree with each other under conditions in which the only information each had was the signs made by the chimpanzee subjects. They were also interested in determining that the chimpanzees were using the signs as they would be used in a natural language, that these signs were not merely associated with stimuli on a one-to-one basis but used to name novel exemplars of conceptually defined items of vocabulary.

To accomplish this the Gardners developed a special double blind vocabulary test after trying several different procedures. The first procedure tried was the "card test" (Gardner & Gardner 1971), in which color photographs were mounted on 5.5 X 8.5 inch cards. After one experimenter shuffled the cards and left them face down in the laboratory, the second experimenter held the cards up one at a time and asked Washoe to name the object shown. This experimenter recorded the first response made by Washoe and then looked at the card to verify Washoe's reply. The card test was succeeded by a box test, which used three-dimensional objects and pictures as test stimuli. In this case, Experimenter 1 baited the box with an object or picture according to a randomized list. The box was opaque on all sides except for one that was made of clear plastic. Experimenter 2, who was ignorant of the contents of the box, asked the name of the object which was in Washoe's sight. Similar tests have been given to four of Fouts's chimpanzee subjects (1973), and to Patterson's gorilla Koko (1978). The only project in this field that did not attempt any blind testing at all was Project Nim (Terrace 1979a).

Both the card test and the box test proved too cumbersome (each trial took 3-5 minutes), and neither test included a second observer. These problems were resolved with the development of the double-blind vocabulary test, "the slide test" (Gardner & Gardner 1971). Briefly, the slide test used a cabinet built into the wall between two rooms of the laboratory; 35 mm slides were rear projected onto a screen that was set within the cabinet. Observer 1 standing beside the cabinet could observe Washoe signing without seeing the picture. When Washoe opened the cabinet door, Observer 1 requested Washoe by signing to name what she saw. Observer 1 recorded

Washoe's reply on a slip of paper, which was passed through a slit in the wall to the experimenter. In the other room a one-way screen was built into the top of the cabinet, which allowed a second observer to see Washoe's signing without seeing the slide or being observed by Washoe. This second observer also recorded Washoe's response on a slip of paper and handed it to the experimenter. Thus Observer 2 could confirm (or contradict) the signs reported by Observer 1. The slide test demonstrated that independent observers could recognize and agree on what signs Washoe was making on about 90 % of the trials (Gardner & Gardner 1974). Although often overlooked, this is a major objective of the slide test: far from being vague gestures to which observers can attach various meanings appropriate to the context, the signs made by the chimpanzees were distinct and intelligible under context-free conditions. In our laboratory at the University of Nevada, the slide tests have been given to three more chimpanzees, with interobserver agreement scores of 71 % for Moja, 91 % for Tatu, and 94 % for Dar.

In discussing the slide test, we define a vocabulary item as a class of referents that can be correctly named by the use of a given sign, and an exemplar as a member of one of the item classes (Gardner & Gardner 1971). Since the major objective was to determine if a chimpanzee could label novel exemplars of vocabulary items, the published descriptions emphasize the use of photographic slides to provide novel exemplars. The Gardners report:

Our most versatile and successful testing procedure made use of 35 mm color transparencies to present exemplars. With photographic slides rather than actual objects. . . it became possible to produce exemplars for most of the nouns in Washoe's vocabulary. . . so that the test could consist of exemplars that were all new" (1978: 62)

Only picturable nouns were used as test items, eliminating adjectives like MINE and RED from the test as well as amorphous referents for nominals that are difficult to show in pictures as subject (e.g. LIGHT, WATER). On the slide test (the most advanced test) only slides were used; in the box test (a precursor to the slide test), both pictures of objects and actual objects were used as exemplars (Gardner & Gardner 1971, 1974, 1978).

In the scoring of the slide test there was one and only one prespecified correct response for each slide. The sign DOG was the correct sign for any and all pictures of dogs,

Proper names	Pronouns	Common nouns	Modifiers	Markers	Verbs	Locatives
(N)	(p)	(n)	Possessives	Temporal	(V)	(L)
DON	ME	BABY	(ps)	(Te)	BITE	IN
DR.G.	ME	BATH	NINE	TIME	CATCH	OUT
GREG	YOU	BEAD	YOURS	Negative	CRY	UP
LINN		BEERY		(Ne)	GO	THERE
MRS. G.		BIRD	Traits	CANT	HUG	
ROGER		BLANKET	(Tr)	ENOUGH	OPEN	
SUSAN		BOOK	FUNNY	NO	PEEKABOO	
WASHOE		BRUSH	GOOD	Imperative	SMILE	
		BUG	HUNGRY	(I)	TICKLE	
		CAR	STUPID	GIMME		
		CEREAL		HELP		
		CHAIR	Colors	Appetitive		
		CHEESE	(C)	(Ap)		
		CLOTHES	BLACK	PLEASE		
		COMB	WHITE	WANT		
		COW	GREEN	Quantitative		
		DIRTY	RED	(Q)		
		DRINK	SWALLOW	HURRY		
		FLOWER	SWEET	MORE		
		FOOD	TREE			
		FRUIT	WATER			
		GUN	WINDOW			
		HAMMER	WIPER			
		HAT	WOMAN			

From: B.T. Gardner & R.A. Gardner. Evidence for sentence constituents in the early utterances of child and chimpanzee. Journal of Experimental Psychology, General, 1975, 104, pp. 244-267.

Table 4. Signs in the sample of replies classified into general categories.

ITEMS	W	M	T	D	ITEMS	W	M	T	D
APPLE		x	x	x	HAT	x	x	x	x
BABY	x		x	x	HORSE		x		
BALL			x	x	ICE CREAM		x	x	x
BANANA			x	x	KEY	x	x	x	
BERRY		x	x	x	KNIFE		x		
BIB	x				LEAF	x	x		
BIRD	x	x	x	x	LIPSTICK			x	
BOOK	x	x			LISTEN	x	x		
BRUSH	x	x	x		MEAT	x		x	x
BUG	x	x	x	x	MILK		x		
CANDY		x			NUT	x	x	x	x
CAR	x		x	x	OIL	x		x	x
CARROT			x	x	ONION		x		
CAT	x	x	x	x	ORANGE		x		
CEREAL		x			PANTS	x			
CHEESE	x		x	x	PEA-BEAN		x		
CLOTHES	x				PEACH		x	x	x
COFFEE			x	x	PEEKABOO			x	
COMB		x	x		PIPE	x			
CORN		x	x	x	SANDWICH			x	x
COW	x	x	x	x	SEE	x			
DOG	x	x	x	x	SHOES	x	x	x	x
DRINK	x				SMELL	x			
FLOWER	x	x	x	x	SMOKE	x	x		
FRUIT	x				SODAPOP		x	x	x
GLASSES		x	x		TOMATO	x			
GRAPES		x			TOOTHBRUSH	x	x	x	x
HAMMER	x				TREE	x	x	x	x
HANDKERCHIEF			x						

Table 5. Vocabulary items presented on slide tests to the chimpanzees Washoe (W), Moja (M), Tatu (T), and Dar (D).

and the sign TREE was correct for any and all pictures of trees. Each answer (e.g. DOG or TREE) is correct for one and only one category. The Gardners report:

In our tests the subject could make many different responses, and hence the chance expectation of obtaining the correct response (that is, the correct sign) for a given exemplar was extremely low. For a test involving N items, Washoe's expected chance score was $1/N$ items correct, if her responses were confined to the items of the test. (1974: 14)

Washoe could have used a sign that was a superordinate category label (e.g. FOOD for APPLE) to name some of the exemplars on the test,* and this kept the chance score at one out of N. While Washoe had only one sign to name potable liquids, DRINK; Moja, Tatu, and Dar had several signs, e.g. MILK, SODAPOP, WATER, COFFEE. Thus for Washoe, DRINK was considered a correct reply for slides showing potable liquids, but for Moja, Tatu, and Dar, DRINK could not be a correct answer (See Table 5). When one of the later subjects used a superordinate category name, such as DRINK, Observer 1 further questioned the chimpanzee in signs to NAME THAT DRINK, or asked WHAT KIND DRINK?

While responses could contain more than one sign, the chimpanzee subjects usually responded with one sign per trial after the initial adaptation to the procedure. To determine the frequency with which multiple sign replies were reported, we examined the most recent slide tests for the subjects Tatu and Dar. Multiple sign utterances were reported on 15.8% and 12.1% of the trials for Tatu and Dar respectively. Some of these multiple sign replies were descriptive phrases, for example, Tatu signed BLACK DOG when shown a slide of a black dog. Although both signs were reported, only the noun was scored for the purpose of the test. Other multiple sign utterances were composed of nouns that might or might not have been semantically related. For example, the chimpanzee Dar signed COMB BRUSH when shown a slide of a brush, and Tatu signed OIL TOOTHBRUSH when shown a slide showing baby oil. The observers were instructed to record all signs on every trial and mark on their paper which sign the subject emphasized. When all the signs in the response seemed equally emphatic or when the observer was in doubt, then the first recorded sign was counted as the subject's response.

Washoe's preparation for the slide test—i.e. learning to name objects—was much the same as that of children. Detailed ***superordinate category labels were never counted as correct**

descriptions of the procedures to teach young chimpanzees the ASL names for classes of objects appear throughout the writings of the Gardners and their co-workers. Briefly, adult human beings modelled the correct names, answered questions, and approved and disapproved of correct and incorrect answers. When psycholinguists (e.g. Seidenberg & Petitto 1979: 191) suggest that children do not learn the vocabularies of their native language by association of this kind, one can only wonder what other kinds they have in mind.

The double blind test presents novel stimuli on each test trial and eliminates both linguistic and non-linguistic cueing and the other problems that are associated with tests of comprehension (cf Gardner & Gardner 1975). Because exemplars were presented at random and only novel exemplars were used on the criterion tests, there is no way that rote memorization of exemplars or of sequences of trials could have enhanced Washoe's scores. Since Project Washoe, the results of the double blind vocabulary test have been replicated in our laboratory at the University of Nevada with three other chimpanzees, Moja, Tatu, and Dar.

Summary. Both psycholinguists and comparative psychologists have studied the relationship between language acquisition and intelligence. Comparative psychologists have borrowed techniques of psycholinguists and one of their major contributions is that they have improved upon the borrowed techniques. The comparative psychologists have also developed new techniques for testing linguistic skills. Psycholinguists can use these techniques to add experimental power and rigor to their studies of children.

CONCLUDING REMARKS

With the beginning of Project Washoe in 1966, a new field of scientific inquiry opened up. Sign language studies with chimpanzees provide a new tool for studying linguistic behavior as an expression of intelligence and for understanding the continuity between human and non-human intelligence. The work of the Gardners with Washoe has been extensively replicated and extended by them with the chimpanzees Moja, Pili, Tatu, and Dar. Meanwhile, related work in several other laboratories has supported some of the most important initial discoveries (Fouts et al. 1978, Patterson 1978).

A great deal more research remains to be done, and a great deal of what has been done remains to be published. Each new wave of findings seems to stimulate an even greater volume of commentary and debate. Despite, or perhaps because of the volume of discussion in secondary and tertiary sources, many of the basic methodological techniques have been widely misunderstood. The aim of this article has been to review the methodological problems in a way that would make them clear to the many scholars who, without being actively engaged in this research, are profoundly interested in what has been found so far and in the implications of these findings.

The first step in evaluating sign language studies with chimpanzees is to understand the distinction between "language" as an abstraction and linguistic behavior as an observable phenomenon. As Stokoe has put it, "we can conclude again that every member of our species can speak or sign at least one language but that no one can speak 'language' or sign 'language' or learn 'language' or teach 'language'" (in press). The only way to compare the linguistic behavior of human and non-human beings is by observing what they do when they speak or when they sign.

The validity of any comparative study of behavioral output depends upon the comparability of the input conditions. Only the most extreme of structuralists would agree with Moore's dictum about the irrelevance of rearing conditions to the acquisition of language skills by children (above, page 17). We have reviewed here how the Gardners provided their chimpanzee subjects with conditions comparable to those of children. The elements of these conditions included: (1) a comparably homelike environment, including adult human companions who treated the chimpanzees like children; (2) teaching, testing, and interacting with the chimpanzee subjects under conditions that stimulated spontaneous utterances; (3) adequate adult models, particularly the type of adult model that is provided for children.

The validity of any comparative study of behavioral output also depends upon the comparability of the samples of observed behavior. Too often the comparisons that are cited are between three-year-old chimpanzees and university-level human beings, or between observations of chimpanzee utterances and idealized, theoretical conceptions of human linguistic competence. Little can be gained when a rubber ruler is used to measure and separate human from non-human behavior.

The validity of comparisons also depends upon the comparability of procedures used to collect samples of behavior and to specify their contents. In reviewing the literature, we have found that the work of comparative psychologists like the Gardners compares favorably with the prevailing standards in child psycholinguistics. The former use clearly specified procedures, precise criteria for defining variables, and impressive amounts of data in their published work.

Certain principles of descriptive linguistics must be clearly understood. There are important differences between languages that depend heavily on word order and languages like ASL that depend more on inflections and markers. There are important differences between formal written or spoken usage and casual conversation. There are important differences between the utterances of adults and the utterances of young children. Little can be gained from comparisons in which these principles are ignored.

An important contribution that comparative psychology can make is in the application of rigorous principles of experimental method to the problems of developmental psycholinguistics. In this article we have examined cases in which comparative psychologists have added experimental rigor to procedures of existing research with children, and cases in which comparative psychologists applied experimental methods where none were used before. We have answered many of the criticisms of sign language studies with chimpanzees by taking a close look at the procedures and results of this new field of scientific inquiry. We have tried to shed more light than heat on the subject and hope that we have shown how the work of comparative psychologists has contributed to the understanding of the nature of language and intelligence.

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REFERENCES

- Baker, C.
 1977 Regulators and Turn-Taking in ASL Discourse, in On The Other Hand, Friedman ed. (N.Y., Academic Press), 215-236.
- Bloom, L.
 1970 Language Development: Form & Function in Emerging Grammar (Cambridge, MA, MIT Press).
 1973 One Word at a Time (The Hague, Mouton).
 - - - -, & M. Lahey
 1978 Language Development & Language Disorders (New York, Wiley).
 - - - -, L. Rocissano, & L. Hood
 1976 Adult-Child Discourse, Cognitive Psychology 8, 521-552.
- Bollinger, D.
 1975 Aspects of Language (New York, Harcourt Brace).
- Bonvillian, J., K. Nelson, & V. Charrow
 1976 Language and Language-Related Skills in Deaf & Hearing Children, Sign Language Studies 12, 211-250.
 - - - -, & R. Friedman
 1978 Language Development in Another Mode: The Acquisition of Signs by a Brain-Damaged Adult, Sign Language Studies 19, 111-120.
- Bowerman, M.
 1978 The Acquisition of Word Meaning, in The Development of Communication, Waterson & Snow eds. (New York, Wiley).
- Brown, R.
 1965 Social Psychology (New York, The Free Press).
 1968 The Development of Wh- questions in Child Speech, Journal of Verbal Learning & Verbal Behavior 7, 279-290.
 1970 The First Sentences of Child & Chimpanzee, in Psycholinguistic Papers, R. Brown ed. (New York, The Free Press).
 1973 A First Language: The Early Stages (Cambridge, MA, Harvard University Press).
 - - - -, C. Fraser, & U. Bellugi
 1964 The Acquisition of Language, Monographs of the Soc. for Research in Child Development 29, no. 92, 79-92.

- Bynon, J.
1977 The Derivational Processes Relating Berber Nursery Words to their Counterparts in Normal Interadult Speech, in Talking to Children, Snow & Ferguson eds. (Cambridge, Cambridge University Press).
- Cicourel, A.
1974 Gestural Sign Language and the Study of Nonverbal Communication, Sign Language Studies 4, 35-76.
- Clark, E.
1973a Non-Linguistic Strategies & the Acquisition of Word Meanings, Cognition 2, 161-182.
1973b What's in a Word? On the Child's Acquisition of Semantics in his First Language, in Cognitive Development & the Acquisition of Language, Moore ed. (New York, Academic Press).
- Clark, H., & E. Clark
1977 Psychology & Language (New York, Harcourt Brace).
- Cokely, D., & R. Gawlik
1974 Childrenese as Pidgin, Sign Language Studies 5, 72-81.
- Covington, V.
1973 Juncture in American Sign Language, Sign Language Studies 2, 29-38.
- Davis, D.
1978 Gaze behavior in sign language using chimpanzees during conversations. Unpub. Master's Thesis, University of Oklahoma.
- Dale, P.
1976 Language Development (New York, Holt, Rinehart).
- Ellenberger, R., & M. Steyaert
1978 A Child's Representation of Action in ASL, in Understanding Language through Sign Language Research, Siple ed. (New York, Academic Press).
- Ervin-Tripp, S.
1970 Discourse Agreement: How Children Answer Questions, in Cognition & the Development of Language, Hayes ed. (New York, Wiley).
- - - - , & W. Miller
1977 Early Discourse: Some Questions about Questions, in Interaction, Conversation & the Development of Language, Lewis & Rosenblum eds. (New York).
- Fant, L.
1972 Ameslan: An Introduction to American Sign Language (Northridge, CA, Joyce Motion Picture Co.).

Ferrier, L.

- 1978 Some Observations of Error in Context, in The Development of Communication, Waterson & Snow eds. (New York, Wiley).

Fischer, S.

- 1972 The Ontogenetic Development of Language, in Language & Language Disturbances, Straus ed. (Pittsburg, Duquesne University Press).

Fouts, R.

- 1973 Acquisition & Testing of Gestural Sign in Four Young Chimpanzees, Science 180, 978-980.
- - - -, M. Hannum, C. O'Sullivan, & K. Schneider
1.p. Chimpanzee Conversations, in Language Development, Kuzoj ed. (Hillsdale, NJ, Erlbaum Associates).
- - - -, G. Shapiro, & C. O'Neil
1978 Studies of Linguistic Behavior in Apes & Children, in Understanding Language through Sign Language Research, Siple ed. (New York, Academic Press).

Gardner, B. T., & R. A. Gardner

- 1971 Two-Way Communication with an Infant Chimpanzee, in Behavior of Non-Human Primates, Schrier & Stoltz eds. (New York, Academic Press). Vol. 4.
- 1974 Comparing the Early Utterances of Child and Chimpanzee, in Minnesota Symposium on Child Psychology, vol. 8, Pick ed. (Minneapolis, U. of Minnesota Press).
- 1980 Two Comparative Psychologists Look at Language Acquisition, in Children's Language, Nelson ed. (New York, Gardner Press). Vol. 2.

Gardner, R. A., & B. T. Gardner

- 1969 Teaching Sign Language to a Chimpanzee, Science 165, 664-672.
- 1972 Communication with a Young Chimpanzee: Washoe's Vocabulary, in Modeles Animaux du Comportement Humain, Chauvin ed. (Paris, CNRS).
- 1973 Teaching Sign Language to the Chimpanzee Washoe, 16 mm sound film (State College, PA, Psychological Cinema Register).
- 1974 Teaching Sign Language to the Chimpanzee Washoe, Bulletin D'Audio Phonologie 4 (5).
- 1975 Evidence for Sentence Constituents in the Early Utterances of Child & Chimpanzee, Journal of Experimental Psychology, General 104, 244-267.
- 1978 Comparative Psychology & Language Acquisition, Annals of the New York Academy of Sciences 309, 37-76.

- Gleason, H.
 1961 An Introduction to Descriptive Linguistics (New York, Holt, Rinehart & Winston).
- Gaustad, G.
 1980 Current research with three chimpanzees. Paper to Western Psychological Association, Honolulu, May.
- Gorcyca, D., P. Garner, & R. Fouts
 i.p. Deaf Children & Chimpanzees: A Comparative Sociolinguistic Investigation, in Nonverbal Communication Today, Key ed. (The Hague, Mouton).
- Hayes, K., & C. Hayes
 1951 The Intellectual Development of a Home-Raised Chimpanzee, Proceedings of the American Philosophical Society 95, 105-109.
- Hoffmeister, R.
 1978 The development of demonstrative pronouns, locatives, and personal pronouns in the acquisition of American Sign Language. Unpubl. Ph.D. dissertation, University of Minnesota.
- - - - -, D. Moores, & B. Best
 1974 The Acquisition of Sign Language in Deaf Children of Deaf Parents. Bureau of Education for the Handicapped Progress Report.
- - - - -, D. Moores, & R. Ellenberger
 1975 Some Procedural Guidelines for the Study of the Acquisition of Sign Language, Sign Language Studies 7, 121-137.
- Holzman, M.
 1972 The Use of Interrogative Forms in the Verbal Interaction of Three Mothers and Their Children, Journal of Psycholinguistic Research 1, 311-336.
- Kellogg, W.
 1968 Communication & Language in the Home-Raised Chimpanzee, Science 162, 423-427.
- - - - -, & L. Kellogg
 1933 The Ape and the Child (New York, Hafner).
- Klima, E., & U. Bellugi
 1972 The Signs of Language in Child & Chimpanzee, in Communication & Affect: A Comparative Approach, Alloway et al. eds. (New York, Academic Press).
- 1979 The Signs of Language (Cambridge, MA, Harvard U. P.).
- Maestas y Moores, J.
 1980 Early Linguistic Environment: Interactions of Deaf Parents with their Infants, Sign Language Studies 26, 1-13.
- Mandel, B., & R. Fouts.
 1976 Human-chimpanzee conversation in a social setting. American Sociological Association meeting, August.

- Moore, T.
1973 Cognitive Development & the Acquisition of Language (New York, Academic Press).
- Nelson, K.
1973 Some Evidence for the Cognitive Primacy of Categorization & its Function Basis, Merrill-Palmer Quarterly 19, 21-39.
1980 First words of chimp and child. Paper, Southeastern Psychological Association, March.
- Patterson, F.
1978 The Gestures of a Gorilla, Brain & Language 5, 72-97.
- Piaget, J.
1967 Language & Thought from the Genetic Point of View, Six Psychological Studies, Elkind ed. (New York, Random House).
- Ruke-Dravina, V.
1977 Modifications of Speech Addressed to Young Children in Latvian, in Talking to Children, Snow & Ferguson eds. (Cambridge, Cambridge University Press).
- Savage-Rumbaugh, E., D. Rumbaugh, & S. Boysen
1980 Do Apes Use Language? American Scientist 68, 49-61.
- Schlesinger, H.
1978 Acquisition of Sign & Spoken Language, in A Developmental Perspective, Liben ed. (N.Y., Academic).
- - - - -, & K. Meadow
1972 Deafness & Mental Health (Berkeley, U. Of Calif. Press).
- Sebeok, T., & D. Umiker-Sebeok (eds.)
1980 Speaking of Apes (New York, Plenum Press).
- Seidenberg, M., & L. Petitto
1979 Signing Behavior in Apes: A Critical Review, Cognition 7, 177-215.
- Snow, C.
1977 Mothers' Speech Research: From Input to Interaction, in Talking to Children, Snow & Ferguson eds. (Cambridge, Cambridge University Press).
- - - - -, & C. Ferguson (eds.)
1977 Talking to Children (Cambridge, CUP).
- Stahlke, H.
1980 On Asking the Question: Can Apes Learn Language? in Children's Language, Nelson ed. (New York, Gardner Press), Vol. 2.
- Stokoe, W.
1960 Sign Language Structure (Buffalo, Studies in Linguistics) (revised, 1978, Linstok Press).

Stokoe, W.

- 1975 The Shape of Soundless Language, in The Role of Speech in Language, Kavanagh & Cutting eds. (Cambridge, MA, MIT Press).
- 1978 Sign Language versus Spoken Language, Sign Language Studies 18, 69-90.
- 1980 Sign Language Structure, Annual Review of Anthropology 9, 165-190.
- i. p. Apes Who Sign & Critics Who Don't, in Language in Primates, Wilder & de Luce eds. (Bloomington, Indiana University Press).

- - - - -, D. Casterline, & C. Croneberg

- 1965 A Dictionary of American Sign Language on Linguistic Principles (Washington, Gallaudet; 2nd ed. Silver Spring, MD, Linstok Press, 1976).

Sully, J.

- 1971 Children's Ways (N.Y., Appleton, Century, Crofts 1897; reprinted in Child Language: A Book of Readings Bar-Adon & Leopold eds. (Englewood Cliffs, NJ, P-H).

Taine, H.

- 1877 Acquisition of Language by Children, Mind 2, 252-259.

Terrace, H.

- 1979a Nim (New York, Knopf).
- 1979b How Nim Chimpsky Changed My Mind, Psychology Today 13, 65-76.
- i. p. Evidence for Sign Language in Apes: What the Ape Signed or How Well the Ape Was Loved? Contemporary Psychology.

- - - - -, L. Petitto, & T. Bever

- 1976 Project Nim: progress report. Manuscript.

- - - - -, L. Petitto, R. Sanders, & T. Bever

- 1979 Can an Ape Create a Sentence? Science 206, 891-902.
- 1980 On the Grammatical Capacity of Apes, in Children's Language, Nelson ed. (New York, Gardner Press), Vol. 2.

Thorpe, W.

- 1972 The Comparison of Vocal Communication in Animals and Man, in Non-Verbal Communication, Hinde ed. (Cambridge, Cambridge University Press).