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 vigor 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 behavior 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 Gardeners 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 formall 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?" (Stieltjes 1990: 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 been taught to use significant aspects of the sign language of the deaf. (Bonvillian, Nelson, and Ch arrow 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

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 can 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 pace-setter in linguistic growth is the child's cognitive growth, as opposed to an autonomous linguistic development which can then reflect back on cognition. As Hageg (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 unfeasible to suppose, if an organism of this kind is kept in a cage for a part of each day or night, if it is fed about by means of a collar and a chain, as 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 caressed like a dog or a cat, if it is consistently patted 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 antics 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 responsive to the household situation and not trained-in or meaningless rituals elected by a sign from a keeper. The spoon-feeding 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. (Reflog & tabloq 1952: 12f; emphasis theirs)

The Gardiners raised Washoe in a two and one-half room, eight by twenty-five 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 bath-
room. 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 con-
versed with her only with the manual signs of sign language. Regular routines such as meals and grooming sessions, house-
hold chores, outdoor play at the research site in 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 [Quinby] 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 [Perutz] and Andrea [Lentner] worked with Nim. Susan respected Laura and Andrea, both of whom felt strongly that Nim should not be regarded as a child. (1978a: 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. [Terror, et al., 1976]

While attending this class Nim was taught generally in a small empty room by an ever-changing staff of teachers, who Terrace noted "...cycled through Project Nim in a revolving door manner" (1976a: 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 reading 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 goodie to get her to talk with us. Washoe read ASL to comment on things around her, or just to start a conversation" (Gardner & Gardner 1974: 241). In a study of conversations between a chimpanzee and humans, Mason 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'Neill concluded that: these aren't every indication that Lucy not only partici­ pated in two-way interactions and conversations with her human companions but was also an active participant in these sessions in terms of initiated and terminating conversation with them. (1978: 173)

Similar observations have been made more recently in the University of Nevada laboratory with chimpanzees Nova, VI, Tutu, 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., 1978) 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.
Petitio has claimed that Nim had to be coerced into signing (Goldenberg & Petitio 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 Slipi. 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 accompanied by the teacher's signing and that many of Nim's signs were identical with those of his teacher's most recent utterances (L. [sic.], p. 429).

ASL and It is generally believed that human children can 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 (Baker, 1980). The success of Washoe and other chimpanzees who learned to sign, and the failure of Vicki and other chimpanzees who did not learn to speak (Hayes & Hayes, 1951, and Kellogg, 1969) depends on a congenital ability of the chimpanzee 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 chimpanzees to combine the configurations of hands and arms and the appropriate actions into ASL signs and to use them in appropriate 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 encouraged 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
Van Campfort & Rimutsi 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 Gardeners, have claimed that any of Washoe's signs were unnatural.

Of the five behaviors that Seldenberg and Pettito (1979) listed as examples of natural ape behaviors, none were glossed as signs in Project Washoe. Washoe did use signs for "hey", "lickle", and "vlas"; but they were not in the form described by Seldenberg and Pettito. In fact, the forms of the behaviors the latter described do not fit the PCM (posture, configuration, movement) descriptions of any of the signing projects (see Table 1), although they come closest to those reported for Project Nim (Terman 1973a). Further, we wrote to Seldenberg 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 unquoted.

Before the handshapes of the chimpanzees were listed as reliable items by the Gardeners 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 nine independent occasions by three different observers; then the sign had to be reported to occur spontaneously and appropriately on 10 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 Seldenberg and Pettito 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 familiar situations that meet these criteria, they would do well to publish their evidence. We, for our part will remain skeptical until Seldenberg and Pettito 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 Gardeners argue for the importance of presenting a good model
of the language that the subject is expected to acquire: Because the structure of Amezan (ASL) is so different from the structure of English, it is difficult, perhaps impossible, to speak good English and sign good Amezan 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 Amezan 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 Amezan. (Eisenberg & Gardner 1978: 54)

This reasoning has been supported by research on simultaneous use of signs 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 Event in the two languages. (Ronvold et al., 1976: 237 [see also Marmer & Pettito in SL 22 and Kluwaj in SL 39])

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, 441), 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, Pettito, 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)

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Ferguson 1977). Snow has characterized the Motherese register as more simple, redundant, and repetitive than an adult speech register in English (Snow 1977). (Alcott & Kenyon in ASD 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. Byun 1977 and Rude-Davia 1977), Masatez y Morez 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 finger-spelling when attempting to communicate with their children; they also repeat signs and hold the signs in location longer when signing to children (Masatez y Morez 1980, Schlesinger & Mason 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, Pilli, Tatu, and Dot, more than one-third of the teachers were native signers (dead or hearing persons with deaf parents). These adults in particular used ASL Motherese in signing to the infant chimpanzees.

Seldenberg and Pettito criticized the signing skills of the teachers who worked with Washoe. Since neither Seldenberg nor Pettito have ever communicated in sign language with any of Washoe's teachers, we wondered how they made such an assessment. Again Seldenbery'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 Gardens 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 Kailoog and Kailoog (193; quoted pp. 18f above) would have predicted.
<table>
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<tr>
<th>HUG</th>
<th>KOKO</th>
<th>2EM</th>
<th>WATER</th>
<th>ALL</th>
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<tbody>
<tr>
<td>M: Curved hands, contact</td>
<td>Contact, shoulders</td>
<td>Curved hands, contact</td>
<td>Curved hands, contact</td>
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<tr>
<th>KISS</th>
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<tr>
<td>P: Cheek</td>
<td>Lips, touch to chin</td>
<td>Lips, touch to chin</td>
<td>Lips, touch to chin</td>
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<tr>
<td>C: Curved hand</td>
<td></td>
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<td>M: Contact</td>
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<tr>
<th>PICK</th>
<th></th>
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<tr>
<td>F: Tip of index finger</td>
<td>On body, index finger extended</td>
<td>On body, index finger extended</td>
<td>On body, index finger extended</td>
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<tr>
<td>C: Index finger extended</td>
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<tr>
<td>M: C contacts F, P draws downward</td>
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<tr>
<th>SCRATCH</th>
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<tr>
<td>P: Back relaxed, palm up</td>
<td>Back of hand to be touched</td>
<td>Back of hand to be touched</td>
<td>Back of hand to be touched</td>
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<tr>
<td>C: Curved hand</td>
<td>Fingers, palm to F</td>
<td>Fingers, palm to F</td>
<td>Fingers, palm to F</td>
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<tr>
<td>M: C drawn across</td>
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<tr>
<th>Tickle</th>
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<tbody>
<tr>
<td>P: Dorsum</td>
<td>Back of hand</td>
<td>Back of hand</td>
<td>Back of hand, palm to be tickled</td>
</tr>
<tr>
<td>C: Index finger extended</td>
<td>Fingers, palm to F</td>
<td>Fingers, palm to F</td>
<td>Fingers, palm to F</td>
</tr>
<tr>
<td>M: Contact, may repeat</td>
<td></td>
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Table 1. Term descriptions for four signing subjects.

Sources:
1. Pemberton, alias location, kinship, configuration, allographs, des
2. movement, alias action, esp
3. Travis Patterson, personal communication, Sept. 1980
4. H. S. Ternov, 1979
5. Gardner & O'Grady, Res. J. 14 (1975), 244-257
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 1,001 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 psychologists 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. 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 that "even the largest corpus can only be an intensional 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, elisions, 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 exclusion of repetitions, etc.; or (2) ANY "group of 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. To see if psycholinguistic journals publish routinely complete corpora by the strong definition, we selected two journals, Journal of Psycholinguistic Research (1972-1974, 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 sections, partial lexicons, or small portions of a corpus are occasionally published (Bovillihan & Tsiodras 1978, Ciccorrel 1974, and Holzmann 1972). If these two journals are typical, then it appears that linguists publish their data in much the same form as do psycholinguists.

As a first step in their evaluation of the progress of their children's subjects, the Gardeners 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 chimpanzees and a description of context, which includes all signing addressed to the chimpanzees. 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: 346).

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. II). When Bloom (1970) and Brown (1973) outlined the quantitative characteristics of children's speech —rate, proportion of phrases, etc.; the Gardners did a similar 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 theturn corpus has been used to describe published and unpublished data is in sharp
contrast to the way that Seidenberg and Pettito 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, Hofmeyster 1979, Hinzmeister, Reetz, & Mothes 1974), researchers typically record corpora of child speech sampled at varying intervals. Occasionally, much larger corpora are published (e.g., Bloom 1973), so that substantial records of the linguistic behavior of many children now exist, and detailed comparisons across subjects, ages, languages, cultures, and observers are possible. (Seidenberg & Pettito 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 transcript of four 45-minute, video-recorded, mother-child interactions it contains are indeed unusually extensive and complete. As the title plainly notes, however, this sample contains 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 M.A. dissertation (Hofmeyster 1978), a second is a Bureau of Education progress report (Hoffmeyer et al. 1974). Hofmeyster's dissertation contains no corpus as defined by Glazoun (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 Pettito'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 we was asked about the publication of corpora, he replied, "I did not publish the corpora for [stages 1-5]" (Personal communication to R. Gardner, January 1981). Finally, Seidenberg and Pettito 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 chimpanzees Washoe (1975) must also be considered a corpus.

It is not standard procedure for psycholinguists to publish
their corpora. Selzemberg and Petito 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)

Selzemberg and Petito (1979) refer to Terrace et al. (1979 and 1980) as the only available published corpora of chimpanzee signing. Keeping in mind the above definition of “corpus” and the importance of contextual information, we pursued the references cited by Selzemberg and Petito. 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 Johnson 1967), 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**

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. Contrarily neither the short list of references cited by Selzemberg and Petito nor the extensive literature search that we have conducted yielded a suitable 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 psycholinguists, then equally complete corpora of the utterances of signing chimpanzees have been routinely published.
Documenting: 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 1973), who reported that a child used 'baby' (literally 'bâhé') to refer to small statues and figures in small pictures and prints; and Hulley (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 his mother pointing at a dog, say "how wow," later applied how 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, 1973). 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.

A new codification procedure was used by the Gardners in recording observations of new signs produced by the children. 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 in the subject matured. For example, they found

that Moja, by age two, had used her sign DRINK to name Ayudas of different kinds—milk, water, broth, coffee, and orange juice; in different containers—her own infant bottles and plastic cups, her companion’s cup, and a sippy-pop cup; 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 inedibles, as, for example, when requesting a balloon" (1978: 52).

The Gardners list Washoe’s first 81 signs with contextual information (1971, Tab. 1); among the 81 signs are nominals (e.g. DOG, SUSA), action words (e.g. GO, CRY), 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" (1971: 149). Similar contextual 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 investigating 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. (1960: 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 reinstatement 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 repeated 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 retained 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 acquisition 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 item and, in particular, any elucubrations. (Ferrier 1978: 301)

Even for comprehension, one of the most frequently discussed characteristics of early child usage, Bloom and Lahay 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 & Lahay 1978: 119)
Modulation. Spoken languages use devices such as 
of meaning, markers, inflections, and word order to 
modulate meaning. Sign language uses a 
unique mixture of these devices. Sign languages are 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 & Seyfarth 1978). The "chimpanzees 
in the Gardners' laboratory at the University of New 
Haven 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 appro-
riate 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 frag-
ments of the chimpanzee data and idealized theoretical concep-
tions of human language (Sebeok & Unger-Sebeok 1989, 

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.

9. 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 Amsloin (Alt.) 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
towards "you," the pronouns are built into the movement. (Fenz 1972: 2)

Signing children first begin to use this device when they are four or five years of age (Elliason & St. Peere 1978). In the earliest stage, the young deaf subject Ellinason and St. Peere studied signed in actual objects instead of in the proximal signing space that adults use; e.g., "the child performed the sign BITC on his mother's knee and then leaned over and pretended to bite it" (e.g. cit. 1975). Schlesinger & Moseh 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 displayed it upward-rolling her mother's chest instead of the abdomen. There is frequent reciprocal, playfully communicative between mother and child.

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 Der often signed TICKLE on a favorite toy animal that he brought to his companion to be tickled with (see Table 3 above). Der would also sign TICKLE on the hands of his human companion as a request to be tickled by her. Der also signed OPEN on objects such as the refrigerator door and soda-pop bottles. Similar behavior has been reported by Gardiner and Gardner for the infant chimpanzee Moja and Pil. (1970)

Some psychologists (e.g., Seldenberg & Pettito 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-mediated shows that the establishment of loci is a developmentally processes in human children. All reports of chimpanzees' signs that Skidmore and Pettito 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 as it would be astonishing if it had been reported in equally young chimpanzees.

b, eye gaze 6. One of the most important uses of eye facial expression in ASL is to distinguish between declarative and interrogative sentences (Skidmore 1964). ch 31, Covington
Van Czarnitz & Rimpau 37

has described how questions are indicated by human signers with a question-looking look in which the eyes look straight at the eyes of the addressee (Corrington 1973). This questioning look is accompanied by one of several behaviors that typically occur at the end of utterances. One of these is pushing 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 (Corkaly & Gewik 1984, Stokoe, personal communication, May 1980). The same might be expected of young chimpanzees who are learning ASL to fact several investigators have reported that chimpanzees and goats do use eye gaze to modulate meaning of signs (Fouts, Hauser, O'Byrne, & Schickersd, in press, Davis 1976, 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 Gardneres write:

In spoken languages, when children first begin to ask questions they use the questioning intonation... In ASL, there is a visual 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 & Glyderd 1974: 30)

In the recents at the University of Nevada laboratory, the chimpanzees Washoe, Moja, Phil, Tru, and Dee 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 Tru as early as 15 months of age used the two forms of THAT in distinctive contexts. Most of the early interrogative forms occurred while Tru 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 Tru 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 performance 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 Cocking 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... On 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 locket, 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. Cokerly & Gawlik 1974).

It appears that the use of locket, facial expression, and direction of gaze to modulate the meaning of signs is a robust phenomenon in chimpanzees. The one exception is Seldenberg and Pezzuto’s claim that Nim did not use these devices (1973). Early Nim’s writing conditions were so adverse 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 (1978a: 124) [and] New volunteers rarely came equipped with a knowledge of sign language and a solid understanding of the intellectual background of the project (1978a: 256).

c. repetition. In studies of language acquisition by English speaking children, investigators generally delete repetitions or 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 chimp's 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 absentmindedness. In a transcript that I have been analyzing recently a 24-month-old 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" "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 literary 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. Hoffman, Moses, 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: 23).

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 stammering is rather rare event. (1980: 414)

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 Weismer 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 nodes there are difficulties in determining the number of repetitions
In sign language: e.g. Terrace, Pettito, 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 listed 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.

Goldin-Meadow and Pettito characterize the early speech of children as telegraphic and contrasted with the signing of chimpanzees, which they claim repetitously expands. It is a mistake to assume that because children's speech can be characterized as telegraphic that it is not repetitious. 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 deviation of order plays a much less important role in languages that are highly inflected (e.g. Russian). Since ASL is highly inflected (see Klein & 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) primate 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 one 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 Gardner's 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 Gardner 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 1974: 187). Eight years earlier the Gardner's had written:

We are not forced to interpret either the existence of combined forms or the existence of anaromatic features in these combinations as evidence for syntax in Warne'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. (1973) concentrated on analyzing the order of the chimpanzees' 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: 197). 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, Boboinder 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 not apt to say anyone alone as to say show anyone, not to mention his magisterial indifference to correct grammatical indications of agreement and subordination. (1973: 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... perhaps 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 & Labov 1979: 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 XES and XES 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 signed language is relatively easy to obtain well-litographed filmed data, records of the speech of young children because of the technology of audio recording. Such recordings 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 severely edited (pp. 20, 30 above).

It is much more expensive and technologically 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 in 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; Schiebleymer & Meadow 1972) and by chimpanzees (Stycus, Garner & Pouts, 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 Beaverton. Published portions have been studied by hundreds of other viewers. When this video material is studied in the same way as the video-record of young children, the results are comparable (Stokes, 1978). Stokes 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 Stokes] 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; it must look to a nonsign 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 linguists 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 signpost instead of answering a familiar question, (1978: 83).

In contrast, at least 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 (1978a). The results as reported in Science (Terence et al., 1979) were most unconvincing. As we have already pointed out, the differences in the teaching and caring conditions could easily account for the differences between Nim and the
chimpanzees filmed in spontaneous conversations. The unusual methods that Terrace and Pettito used to analyze their records may also account for some of the unidiomatic results.

Although Terrace has not yet published or made available any portion of his videotapes of Bon or the written transcripts of these tapes, it is possible to examine Terrace's and Pettito's technique for analyzing film by reviewing the techniques used in their analysis of the published films of Washoe. (Terrace, Pettito, Sanders, & Bever 1978). According to Terrace, the analysis is based on transcripts prepared by Lava Pettito and verified by himself (op. cit., note 59).

Overlap and A degree of temporal overlap between the turn-taking 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 interlocutor's signs with the other's" (1977: 210). When asking a question, a signer's hand 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 (Cuttington 1973). In their published samples, Terrace and Pettito 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 In one of the filmed exchanges, Béatrice imitation. Gardner asks, WHAT TIME NOW? and Washoe replies, TIME 6:15. By the definition that Bloom and associates have for children, this reply would be classified as an expansion "that added new information about the topic of a prior utterance" (Bloom et al. 1976: 530). The normal reply of human beings to questions commonly consists of such expansions. If which part of the immediately preceding question is repeating 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. 1975:528). It is clear that Washoe's reply, TIME EAT, to the question, WHAT TIME NOW? was not an imitation. Nevertheless, Terrence classified this example as imitative because some time earlier in that scene Beatrice Gardner had asked, FEED ME. While the distinction between the AIs 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, Terrence and Pettito must go back through four different utterances of Beatrice Gardner and ignore a break for a non-signing activity that intervened. Terrence and Pettito'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. When hands or fingers 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 unclassifiable in much the same way that speech becomes unclassifiable when audiotapes are played back too slowly.

Sign motion photographed, then, no matter how sophisticated, cannot reveal the elements of sign language contrasts. When the lips are 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 rewrites when making written transcription) than slow—exactly as native speakers find normal audio recordings easier to understand than recordings played back at slower than normal speed. (Shaw 1975:310)

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. Terrence is certainly unique in his field to claim that slow motion is best for the analysis of turn-taking (1979a:319), 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 Pettito did lose much of the information in the Washoe films. They confuse signs, as in their inability to distinguish among ME, MNE, and PLEASE, whether signed by Washoe or a human signer. Part of the ASL distinctions in these signs are given in the patterns of movement. MNE 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 Pettito discarded also caused them to mistake the beginnings and endings of utterances. This resulted in transcribing 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, 1975). They are also confused about which of two signs began the overlap that did occur. Thus, on page 897 they are confused about whether it was Bangel Gardner or Washoe who initiated the overlap; 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 Gardner's transcript (1974) and readings of portions of the record by others (e.g., Spivak, 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, induction, 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 how 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 childhood 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 All, by Fouts, Shapiro, and O'Neill (1978), and the study of replies to Wh- questions made by the chimpanzee Washoe done by Gardner and Gardner (1975). In addition, the Gardner's 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. Foote, Shagory, and O’Neill examined the use of spatial prepositions by the chimpanzees All (1978). All was taught to use the spatial preposition of ANI 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 ? Of course being a sign for an object) by an experimenter who could not see the objects. All 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 (DO) and the like; the prepositions were IN, ON, and UNDER; and the locations were FURIE, 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” (Foote 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 vase, since only the subject and location had to be changed from trial to trial. In the first block of training trials, All used the correct preposition 49% of the trials; by the fourth block of training trials, All reached testing criterion and was averaging 94% correct responses on the prepositions (Foote 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 All was still performing at a level significantly above the expected chance level of 33%.

Slobin and Pettito may have introduced some confusion about the above study when they wrote that “no sign was ever the correct response on two consecutive trials. That is, an ‘in’ trial was always followed by an ‘on’ or ‘under’ trial, etc.” (1979: 206). Because they misunderstood the procedure, they concluded, “…we would expect performance to be somewhere around 50% accuracy. All’s reported accuracy is 49.1% (op. cit., 207). This interpretation is clearly contradicted by the published record. Since any 10 of the prepositions could occur on the consecutive trials, the expected performance was 33%
as reported by Yates, Spisak, and O'Neil. Furthermore, the 49.3% cited by Seidenberg and Petitto was H.O.'s score on only the first block of tracing trials; he scored 80% correct in the testing phase of the study. Clearly Seidenberg and Petitto are mistaken about the procedure.

The Fouts, Spisak, 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 text situation in which there are only two possible choices a minimal amount of cued is sufficient to provide the correct response. In contrast the experiment with All is a measure of prediction: the subject produced an utterance after looking at an arrangement of objects. All's response was linguistically more 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 Ask嘻嘻 the experimenter could not see the arrangement of the objects and so could not give the correct response. The use of All was a rigorous test of the use of spatial prepositions by a non-human agent 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 Gardner's study of Washoe's ability to use 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, and questions to When do questions, etc. (Brown 1965: 256) in their pioneering studies, brown (op. cit.) and ervin-thur (1970) coaxed 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 judge whether the child’s answer
contained an appropriate sentence constituent. In their study
(1975), the Gardner’s reasoned that if the Wh- questions
exerting 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 yielded a matrix, Table 2.

This procedure of the Gardner’s 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 Gardner’s were able to present
detailed distribution of Washoe’s replies to 20 different
types of Wh- questions, Table 3.

As in the case of transcripts of children’s speech, the
Gardner’s found that the transcripts of Washoe’s signing con-
tained sixty examples of appropriate answers to Wh-questions.
Using the studies of Brown (1968) and Ervin-Thur (1970) as
models and incorporating basic techniques of experimental
psychology, the Gardner’s 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 con-
servative approach than that of psychologists who rely on
their skills as native speakers of English to determine the
appropriateness of their subjects’ replies. According to Brown,
"the endless labor details [of deriving the appropriateness of
a response] I have to be left to the judgment 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 Sign 1, 2, or 3 (child) speech?

Ervin-Thur and Miller report that investigators tend to
adapt their questions "to the difficulty level of the child"
(1977:26). Their transcripts of children’s speech usually
contain a preponderance of replies to two or three types of
<table>
<thead>
<tr>
<th>Question frame</th>
<th>N, p, p</th>
<th>A, n, TEP</th>
<th>VLP, VLP, Lp</th>
<th>Other phrase</th>
<th>Other approximate phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who pronoun</td>
<td>0.44</td>
<td>1</td>
<td>1</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Who action</td>
<td>10.0</td>
<td>20*</td>
<td>10*</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td>Where action</td>
<td>10.0</td>
<td>20*</td>
<td>10*</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td>Where administrative</td>
<td>10.0</td>
<td>20*</td>
<td>10*</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td>What demonstrative</td>
<td>10.0</td>
<td>20*</td>
<td>10*</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td>What now</td>
<td>2</td>
<td>2*</td>
<td>2*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>What want</td>
<td>2</td>
<td>2*</td>
<td>2*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Where action</td>
<td>2</td>
<td>2*</td>
<td>2*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Whole object</td>
<td>2</td>
<td>2*</td>
<td>2*</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: Cells for appropriate constituents are marked with asterisks. A = proper base, p = pronoun, pa = personal, TE = temporal, VLP = locative phrase. The entire object row contains only 41 cases because several times main referent the object that same was questions about.


Table 2. Distribution of sentence constituents in all replies by Washoe to Wh- questions.
<table>
<thead>
<tr>
<th>Question Frame</th>
<th>Target Category</th>
<th>Examples of Questions and Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>who pronoun</td>
<td>Proper noun (N)</td>
<td>WHO EAT? WHO ME? WHO ME?</td>
</tr>
<tr>
<td>who action</td>
<td>Proper name (A)</td>
<td>WHO BAKER? WHO DO I? WHO ME</td>
</tr>
<tr>
<td>who tr=k</td>
<td>Proper name (N)</td>
<td>WHO GOOD? WHO GOOD7 WHO PRETTY?</td>
</tr>
<tr>
<td>whose demonstrative</td>
<td>possessive (PO)</td>
<td>WHOSE THAT? WHOSE PROSE? WHOSE YOURS</td>
</tr>
<tr>
<td>what color</td>
<td>Color (N)</td>
<td>WHAT COLOR? WHAT COLOR SHAPE?</td>
</tr>
<tr>
<td>what demonstrative</td>
<td>common noun (N)</td>
<td>WHAT THAT? WHAT HOW? WHAT HOW7</td>
</tr>
<tr>
<td>what new</td>
<td>Verbo (V)</td>
<td>WHAT NEW? WHAT NEW7 TICKLE</td>
</tr>
<tr>
<td>what want</td>
<td>Common noun (n)</td>
<td>WHAT WANT? WHAT WANT7 WANT BEAKS</td>
</tr>
<tr>
<td>where action</td>
<td>locative (L)</td>
<td>WHERE DO? WHERE ARE YOU? WHERE ARE THEY?</td>
</tr>
</tbody>
</table>

Wh- questions and few if any replies to other types of Wh-
questions. The Gardeners' procedure assures that all question
2
5 types under investigation will be equally represented and
questionners, 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 Gardeners gave a graduate student who had not participated in
Project Washoe the task of assigning the 509 replies to target
categories based on the (later) published criteria. Her assign-
ment of categories was in perfect agreement with that of the
Gardeners. Seven years later, we also obtained a copy of
Washoe's replies to the 509 Wh- questions. Using the same
rules (now published in Gardner & Gardiner 1977), we assigned
the replies to categories. We agreed on the assignment of 496 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 Gardeners
rated 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, MURDER). As the Gardeners explained:
In American, 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 American. In the
category of verbs 20 we have listed 9 signs that appeared
in some sample of Washoe's replies and that would typically
be used as verbs in good American. (1975: 25)
The Gardeners' assignment of such items in Washoe's vocabulary
is consistent with the description of those signs in the
Dictionary
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 Gardeners classified as nouns were classified as \(N\) or as
\(V\) \& in the dictionary. Similarly, for all of the signs that
the Gardeners classified as verbs, the dictionary has the \(V\) clas-
Sification, with the single exception of RITE, which in \(DASS\) 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 locutives (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 (e.g. 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 judge the grammaticality or situationality accuracy of the response. Similarly, in his elicit or 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 a noun phrase. 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 in normal 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 Isma in an 'untutored' 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 meanings 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 (SVC) were added or modified, or a wh-form was replaced by a word or a phrase. (Bloom, Riccianni, & 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. Schendenberg and Pettito describe the Gardner's of using the rules to improve the appearance of their data in some way, claiming that "the Gardner transform long, redundant utterances into strings which more closely resemble human utterances in their superficial form" (E. & F. 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 an answer to Susan's question WHERE...? is the only scoreable answer if THERE is in a Wh-question test.
Here, as in their other examples, Seldenberg and Pettito are ignoring the rationale of this or any Wh- question test.

Markers as listed in Table 4 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.

Seldenberg and Pettito 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 BIL? 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 19 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, WHOM DEMONSTRATIVE, WHERE ACTION, WHAT COLOR, and WHAT DEMONSTRATIVE. The type of inappropriate response invented by Seldenberg and Pettito in fact did not occur in the sample. It is pertinent to note that Seldenberg and Pettito, 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.

Seldenberg and Pettito 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 Washoe was 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 ally all doubts on this point we reanalyzed Washoe's replies, eliminating 22 replies containing grammatical markers from each cell, while keeping the marginal totals the same as in the published statistical analysis (Gardner & Gardner 1975:251, tab. 3—see Table 2, page 31 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 signif-
icance at $p<0.005$. The chi-square calculated by the Gardner
was 191.60. Our more conservative analysis yielded a chi-
square of 88.8. Clearly, the treatment of grammatical
markers could not have significantly inflated Washoe's score.
Seidenberg and Petitto claimed several times (e.g., on
pages 181 and 187 of the 1979 article) that the Gardner's had
used techniques for eliminating repetitious signs and otherwise
reducing data. The original records were never reduced in any
way. While the Gardner's 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 Gardner's. Currently the chimpanzees'
use of sign repetition is under investigation in our laboratory
at the University of Nevada (Cantrell 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 compan-
ions. Seidenberg and Petitto complain that the

... Gardner's test [Wh-question] exhibits an impov-
erished 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: 295)
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 lan-
guage, it is in each language that its own Wh-type
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-Thripp 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 question used with Washoe in the present study contained the interrogatives Who, What, Where, and Whose, and Washoe’s replies contained appropriate sentence constituting 88 per cent of the time even when appropriateness is much more narrowly defined than in the child studies. Moreover, distributional analysis . . . demonstrates 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. It is not surprising, therefore, 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 analyses of speech and signing in human children. Where possible, as in the WH-question
nately, more systematic and rigorous procedures have been used with the young chimpanzee subjects.

Comparative psychologists have always sought to control their transcriptions by demonstrating that two independent observers would agree with each other under conditions in which the only information which 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 Gardner developed a specific 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 Woshoe to name the object shown. This experimenter recorded the first response made by Woshoe and then looked at the card to verify Woshoe's reply. The card test was successful for a box test, which used three-dimensional objects and pictures as test stimuli. In this case, the experimenter held the box with an object or picture concealed in a randomized list. The box was opaque on all sides except for one that was made of clear plastic. Experiment 2, who was ignorant of the contents of the box, asked the name of the object which was in Woshoe's sight. Similar tests have been given to four of Fouts' 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 Yon (Dervar 1978).

Both the card test and the box test proved too cumbersome (took 3-5 minutes), and neither test included a scored 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. A screen slide was projected onto a screen that was set within the cabinet. Observer 1 standing beside the cabinet could observe Woshoe signing without seeing the picture. When Woshoe opened the cabinet door, Observer 1 requested Woshoe 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 leg 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 responses on a slip of paper and handed it to the experimenter. Thus Observer 2 could scrutinize for conformity the signs reported by Observer 1. The slide test demonstrated that independent observers could recognize and agree on what signs Washoe was making up 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 used by the chimpanzees were distinct and intelligible under constant 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 Doja, 31% for Tutu, 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). Race the major objective was to determine if a chimpanzee could label novel exemplars of vocabulary items, the established 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 transparency 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 pictureable nouns were used as test items. Common nouns like MINE and RED from the test as well as amorphous referents for nominals that are difficult to show in pictures as a subject (e.g., LIGHT, WATER). On the slide test (the most advanced test) only slides were used in the box test (a procedure to the slide test), both pictures of objects and noun 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,
<table>
<thead>
<tr>
<th>Proper names</th>
<th>Pronouns</th>
<th>Common nouns</th>
<th>Nouns</th>
<th>Markers</th>
<th>Verbs</th>
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<tr>
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Table 4. Signs in the sample of replies classified into general categories.
<table>
<thead>
<tr>
<th>Item</th>
<th>W</th>
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<th>D</th>
<th>Y</th>
<th>N</th>
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<tbody>
<tr>
<td>Apple</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>Bat</td>
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<td>x</td>
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<td></td>
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<td>x</td>
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<tr>
<td>Ball</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Banana</td>
<td>x</td>
<td>x</td>
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<td>Broom</td>
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<td>x</td>
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<td>Bin</td>
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<td>Kool</td>
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<td>Flower</td>
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<td>CAR</td>
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<td>CAT</td>
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<td>CACTUS</td>
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<td>COFFEE</td>
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<td>CORK</td>
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<td>HANDKERCHIEF</td>
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</table>

Table 5. Vocabulary items presented on slide tests to the chimpanzees Washoe (W), Moja (M), Tutu (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 Gardiner 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 potatoable objects: DRINK, Mojo, Tatu, and Dar had several signs, e.g., MEAT, Snoopy, WATER, COFFEE. Thus for Washoe, DRINK was considered a correct reply for slides showing potatoable objects, 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 I further questioned the chimpanzee in signs to NAME THAT DRINK, or asked WHAT KIND DRINK?

While responses could contain more than one sign, the chimpanzees 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 15.0% 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 OH 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, 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; 19) 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 cuing and the other problems that are associated with tests of comprehension (44 Gardiner & Gardner 1975). Because exemplars were presented at random and only novel exemplars were used on the criterion tests, there is no way that note 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, Moj, Tutu, and Der.

Summary. Both psycholinguists and comparative psycholo-
gists have studied the relationship between language acquisition and intelligence. Comparative psycholo-
gists 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 under-
standing the continuity between human and non-human intel-
ligence. The work of the Gardners with Washoe has been extensively replicated and extended by them with the chimp-


ances Moja, Pili, Tutu, and Der. Meanwhile, related work in several other laboratories has supported some of the most important initial discoveries (Fouts et al. 1978, Patte-
sia 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 behaviors 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 Ganzbars 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 simulated spontaneous utterances; (3) adequate adult models, particularly the type of adult model that is provided for children.

The validity of any comparative study of behaviors 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 content. 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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