

Signing behavior in apes: A critical review^{*,**}

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Introduction

The recent attempts by several groups of researchers to teach rudiments of manual-visual (sign) languages to lower primates have generated uncommon interest. The possibility that apes might be able to learn to communicate through this modality was noted by the primatologist R. M. Yerkes in 1925:

I am inclined to conclude from the various evidences that the great apes have plenty to talk about, but no gift for the use of sounds to represent individual... feelings or ideas. Perhaps they can be taught to use their fingers, somewhat as does the deaf and dumb [sic] person, and thus helped to acquire a simple, non-vocal "sign language". (1925, pp. 179-180)

It is ten years since Beatrice and Allen Gardner first reported signing behavior by their chimpanzee Washoe. During this period, the claims on behalf of the language abilities of non-human primates have grown steadily. The Gardners initially reported establishing "two way communication" with Washoe via a "standardized system of gestures" (Gardner & Gardner, 1969). In a later paper, they claimed that Washoe's knowledge of "sentence con-

*An early version of this paper appears in *Papers from the 14th Regional Meeting, Chicago Linguistic Society, 1978*. This paper subsumes that one. We are indebted to T. G. Bever and H. S. Terrace, and especially to U. Bellugi and E. Klima, whose pioneering work on ASL we draw upon continually. However, none of the above should be held responsible for or identified with the contents of this paper.

**This paper is concerned with those studies in which experimenters attempted to teach non-human primates to communicate in a manual-visual mode. Projects in which apes learned to arrange sequences of plastic chips (Premack, 1977) or press sequences on a computer keyboard (Rumbaugh, 1977) entail somewhat different claims and methodological issues (e.g., which essential features of language and communication are preserved in these paradigms?). For discussion of these issues, see Seidenberg and Petitto (in preparation). Requests for reprints should be addressed to: M. S. Seidenberg, Psychology Dept., Columbia University, New York, N.Y. 10027, U.S.A.

stituents" and her ability to answer questions were superior to those of children at Roger Brown's Stage III (Gardner & Gardner, 1975). They have also stated that,

If the standards of experimentation in child psycholinguistics do not improve soon, we will find ourselves in the paradoxical situation of having solid experimental evidence for the syntactic abilities of chimpanzees and a complete lack of acceptable evidence for any syntactic ability in young children. (1974b, p. 735)

It is clear from such statements and others that their focus has shifted from the question, "Is it possible for non-human primates to learn aspects of human languages?" to "How may we characterize the language abilities of apes and their limits?" Patterson (1978) has perhaps summarized the prevailing view of these projects in stating that the accomplishments of her signing gorilla Koko indicate that "language is no longer the exclusive domain of man". In addition, the Gardners, Patterson, Fouts (1977) and others have described the signing of apes as American Sign Language or ASL, the language of the North American deaf. It is asserted, then, not merely that the apes learned to communicate with the experimenters via a system that is not utilized by wild apes, but also that this system shares significant features with a human language, ASL.

These interpretations of the ape signing research are widely held, among both the general public and the scientific community. The projects of the Gardners, Fouts, Patterson and others appear to hold great attraction for the general public, as evidenced by the many reports on ape language on television and in the mass circulation magazines. These reports have faithfully conveyed the interpretations of the ape researchers summarized above. That these interpretations are shared by many psychologists as well is seen, for example, in the discussions of these projects in the introductory textbooks.

The responses of linguists and psycholinguists to these reports show far less uniformity. The major reviews include those of Bronowski & Bellugi (1970), Brown (1970, 1973), Fodor, Bever & Garrett (1974), Watt (1974), Katz (1976) and Limber (1977). The attitudes in these papers range from open scepticism towards this work (e.g. Fodor et al.) to enthusiastic approval (Watt). Reviewing the work through 1973 with Washoe and Premack's chimpanzee Sarah (Premack, 1977), Fodor et al., conclude that "The best one can say is that the present experiments provide no evidence that chimpanzees can learn a formal system in any important way similar to natural language." (p. 450) Brown, writing somewhat earlier, concluded, in a widely quoted remark, that "...as matters now stand... the evidence that Washoe has Stage I language is about the same as it is for children." (1973, p. 43) In his laudatory review, Watt states that

To put it as baldly as possible, chimps can "talk". They have now been shown to have an ability so irrefragably on a continuum with our own speech that the chimps' ability cannot well be denied the adjective linguistic... (p. 71)

The old claim that the other animals did not and could not have language has been overturned. No other terrestrial animals surely will be shown to have a capacity as developed as ours; but ours and theirs are comparable on a number of dimensions. (p. 75)

Bronowski & Bellugi's early reply to this work granted that Washoe had demonstrated the ability to name objects, but noted that evidence at that time gave no indication that she had acquired the use of formal sentence structure or the ability to analyze and synthesize complex messages. Limber (1977), noting that "an organism's use of names is surely not sufficient evidence that the organism is using human language", also concluded that evidence supporting the hypothesis that lower primates are able to learn significant aspects of human languages does not exist.

Katz (1976) has stated,

Nothing in the chimp studies to date suggests that these animals can do anything more significant than a dog or cat does when it rings a bell to communicate its desire to go outside. A chimp does, of course, acquire a far more complex set of discriminations in learning to arrange chips as a signal for food than a dog or cat does in learning to ring a bell, but such a difference in degree does not amount to the difference in kind required to refute Descartes' claim [that no animals other than humans utilize language]. (p. 33)

Although the hypothesis that signing apes show linguistic abilities has been met with generally negative evaluations by linguists and psycholinguists, their criticism has been perhaps critically weakened by lack of access to the relevant data. Normally an empirical claim can be evaluated by attempting to replicate the experiment from which it followed. This is infeasible for most researchers when the subjects are apes, creating a situation in which only the persons making the strongest claims are in possession of the relevant data.

In any case, it is clear that disagreements over the interpretation of ape signing behavior are substantial and continuing.

Our purpose in writing this paper is a simple one. We believe that the conclusion that apes show rudimentary linguistic abilities is a mistaken one that has been drawn for two reasons. First, the procedures utilized in these projects have not been subject to the standards applied to other work in developmental psycholinguistics, and to psychological research in general. When this work is subjected to careful scrutiny, it is seen that both the data and methodology are so highly questionable as to vitiate the radical conclusions that are offered. Second, the existing literature does not take into account infor-

mation that has recently emerged from two sources. Substantive studies of ASL in deaf children and adults now exist (e.g., Friedman, 1977; Schlesinger & Namir, 1978; Siple, 1978; Klima & Bellugi, 1979; papers in the journal *Sign Language Studies*), permitting direct comparisons to the signing of apes. In addition, a replication of the Gardners' work was attempted by an independent group of researchers (Terrace, Petitto, & Bever, 1976a and b; Terrace, in press; Terrace, Petitto, Sanders and Bever, in press. Information from these sources, combined with a careful reconsideration of the published data, yields the conclusion that the claims on behalf of ape language abilities are at best unsubstantiated, and quite probably false. In this paper, we will show that:

1. Data which are necessary in order to establish the claim that apes show linguistic abilities have never been published;

2. The fragmentary data which do exist have been consistently over-interpreted, and are subject to non-linguistic interpretations;

3. The apes' signing compares unfavorably with the speech of hearing children and the signing of deaf children. In particular, this behavior does not resemble signing in ASL in any important way.

Hence, we conclude that there is no evidence at this time for linguistic abilities in signing apes.

These considerations do not place an upper limit on what apes are capable of learning; in fact, it may be the case that the training procedures and other aspects of the current projects underestimate their cognitive and communicative capacities. Rather, they show that the existing claims are far too strong and, in addition, that many known aspects of their signing behavior suggest that it is fundamentally non-linguistic.

We will largely be concerned with the Gardners' claims on behalf of Washoe, since they are at once the best-documented and most widely known. Our observations apply as well, however, to the very similar claims of Fouts (1972, 1977), Patterson (1978), and others.

The Gardners themselves have acknowledged the importance of comparisons between Washoe's signing and the language of deaf and hearing children, stating

All of our procedures are governed by one principle: the observations obtained of the actual linguistic performance of an infant chimpanzee must be compared with the actual linguistic performance of human children... The deaf children of deaf parents comprise an essential control group for evaluating the progress of young chimpanzees that have acquired some facility in Ameslan. (1974b, p. 5)

1. Sampling: What Do Signing Apes Actually Say?

In presenting the accomplishments of their subjects to the scientific community, the ape sign language researchers faced an unusual problem, i.e., how to characterize complex behavior of a type never before reported. Although the Gardners place their work within the study of language acquisition, their task differed from that of the typical researcher in this area. Child language is something every adult is colloquially familiar with through direct experience; chimpanzee signing is not. In studies of the acquisition of spoken language by hearing children (e.g., Brown, 1973) and sign languages by deaf children (e.g., Klima & Bellugi, 1979; Hoffmeister, 1978¹, Hoffmeister, Best & Moores, 1974²), researchers typically report corpora of child speech sampled at varying intervals. Such samples are small relative to the total corpus of a child-subject's utterances over a given period, but are comparable in size to the samples used in other types of psychological research. Occasionally, much larger corpora are published (e.g., Bloom, 1973), so that substantial records of the language behavior of many children now exist, and detailed comparisons across subjects, ages, languages, cultures, and observers are possible (see, for example, Ferguson & Slobin, 1972).

In describing Washoe's behavior, the Gardners and Fouts did not conform to these established methods. Nor did Patterson in describing Koko's. As a result, it is very difficult to know exactly what each ape has signed. The data that are presented in their papers are confined to (a) cumulative vocabulary counts and vocabulary lists; (b) anecdotes, frequently cited as evidence of the apes' abilities to combine signs creatively into novel forms, e.g., Washoe signing *water bird* for duck, or Koko signing *cookie rock* for a stale sweet roll; (c) isolated summary statistics, such as Patterson's observation that "In a 1-hour dinnertime sample, Koko used a total of 251 signs" (1978, p. 78; these signs are not identified, however); and (d) the results of two tests of Washoe's signing abilities, the double-blind vocabulary tests (Gardner & Gardner, 1971, 1974a) and a test of her ability to answer questions (Gardner & Gardner, 1975). These sources fail to provide a full characterization of any ape's signing behavior. The fragmentary information provided is ambiguous among several competing interpretations, including ones which do not require attributing linguistic abilities to apes.

¹Hoffmeister, R. The development of demonstrative pronouns, locatives, and personal pronouns in the acquisition of American Sign Language by deaf children of deaf parents. Unpublished Ph.D. thesis, University of Minnesota, 1978.

²Hoffmeister, R., Best, B. and Moores, D. The acquisition of sign language in deaf children of deaf parents. Bureau of Education to the Handicapped Progress Report, 1974.

It is the absence of a substantial corpus of ape utterances which is the most serious omission. In contrast to the child language literature, there is no listing of all the ape utterances which occurred during a single period of time. By failing to provide a corpus, the Gardners and others obscure significant aspects of their subjects' behaviors, and make it difficult to independently verify their claims.

This problem is seen most clearly with respect to the anecdotes that are frequently cited (e.g., *water bird*). In the absence of a corpus, one cannot determine whether such sequences were synthesized through the application of linguistic rules, or merely the result of the ape acting as a random sign generator which happened to emit some interesting-looking strings. The *water bird* example loses much of its force if the ape also combined each of these signs with a large number of other signs (e.g., *water shoe*, *water banana*, *cookie bird*, etc.). This alternative is not implausible. As the Terrace et al., (in press) corpus indicates, their subject, a chimpanzee named Nim, combined signs into a very large number of permutations, most of which occurred with low frequency. Some of the resulting combinations are fortuitous, others are not. While even the most bizarre combinations could, of course, be interpreted metaphorically, it is simpler to assume that they occurred as the result of random pairings of signs or other non-linguistic combinatorial processes (see Terrace et al., in press). Determining whether or not signs were combined into meaningful strings requires extensive analyses of the structure and frequency of signs and combinations, and the contexts in which they occurred. Since neither the Gardners nor Patterson has provided such analyses, their claim that the cited examples show evidence for creative language abilities cannot be sustained.

Patterson's discussion of the *cookie rock* example is indicative of this sampling problem. She states, "Although Koko has produced uninterpretable strings (as do some children), most of her utterances are appropriate to the situation and some are strikingly apt". (1978, p. 88) She then cites some "interpretable" examples, including, "cookie rock"; the "uninterpretable" strings are not described. It is the case that only "interpretable" strings are ever documented in the reports on ape signing. Only by presenting an unedited corpus of responses, however, could Patterson's assertion be validated.

Bloom (1974a) has described the fundamental weakness of anecdotal data in studies of child language:

Anecdotal reports of isolated behaviors reflect what is important in a child's behavior from an adult's point of view. It may well be that the anecdote is important also for the child, but it may also be that it was observed in the first place because of its importance for the adult, and, in the larger scheme of things,

it is a relatively unimportant event. In analysis of behavior, one needs sufficient data to avoid emphasizing unique or only marginally important behaviors... (p. 87)

We cannot help but note that writers who remark positively on the linguistic abilities of apes repeatedly rely upon a small number of these anecdotes. While they are provocative, they cannot be seriously evaluated until a large body of data becomes available.

2. Data Reduction

The Gardners' and Patterson's claims are also seriously weakened by another aspect of their data-handling procedures. We have noted that they rely heavily upon anecdotes in describing their subjects' performance. Where quantitative data are reported, however, they have been transformed and reduced so extensively as to obscure rather than clarify the character of the apes' behavior. This is most obviously true of their treatment of the repetitions in ape signing. All of the ape researchers acknowledge that their subjects' utterances included long, repetitive, continuous sequences such as *me banana you banana me you give*. The Gardners and Patterson present summary data from which these repetitions and other signs are eliminated, a highly questionable methodology. Patterson (1978) notes the existence of repetitions in Koko's signing, but does not include them in her analyses. In their 1975 report on a test of Washoe's ability to answer questions—the only paper in which extensive quantitative data on her performance appears—the Gardners reduced her replies one or more times before entering them in their analyses. Since this paper is the source of many of the strongest claims on Washoe's behalf, and since it contains the most extensive documentation of her behavior, we will consider the Gardners' procedures in some detail.

The Gardners eliminated from Washoe's answers all signs that repeated those in a question, signs that appeared more than once in a reply, and signs from the class termed "markers". Signs were eliminated from 46% of her replies. Since her actual utterances are not appended, the precise number of signs which were deleted cannot be determined. From their description of this procedure, it appears likely that at least 25% of Washoe's signs were deleted. This is an extremely large loss of information. It is difficult to recall a study of child language in which such a large proportion of utterances were deleted and left unanalyzed.

An entire category of signs, termed "grammatical markers", was also eliminated.

Signs from this group serve important functions in the modulation of meaning. Nevertheless, with the exception of the temporal marker *time*, these signs could not alter the appropriateness or inappropriateness of the reply [to a question]. (Gardner & Gardner, 1975, p. 248)

The Gardners provide no evidence in support of this conclusion. In the absence of information on the use of "markers" such as *gimme*, *please*, *want*, *hurry*, *more*, *can't*, and others, the opposite interpretation—that they do affect the appropriateness of replies—is equally valid, and intuitively more plausible. The Gardners are forced, for example, to defend the interpretation that *Gimme Susan*, *Enough Susan* and *More Susan* are as appropriate in response to the question *Who she?* as are *You Susan* or *Susan there*.

The disturbing quality of these data transformations is revealed by considering how they would render a child's utterances. A father says to his son, "Where are you standing?" The child replies, "I are you gimme hurry where here where you are I". By the Gardners' rules, this would be tabulated as the presumably correct response "I here". The other words would be eliminated as repetitions or "markers". Yet one would require extraordinary contextual information in order to justify terming the untransformed reply "appropriate".

There are two points to be made here. The first is that we cannot determine from the Gardners' report the exact number of Washoe's responses which were rendered in this manner. We only know that such alterations were permitted under their rules, and that one or more signs were deleted from almost half her replies. The second is that data transformed in this manner present a substantially different picture than would the raw data. The Gardners' few examples from Washoe's replies illustrate this point. The response *You me you out me* became *you me*; *open lollipop please* became *open*; *Susan bite there* became *there*. By eliminating repetitions and "markers", the Gardners transform long, redundant utterances into strings which more closely resemble human utterances in their superficial form. This yields a perhaps distorted view of the character of ape utterances. While the Gardners believe that "this scheme of simplification cannot do justice to the richness of meaning that can be found in Washoe's replies" (1975, p. 252), its effect is to alter her utterances radically, before they have been documented. In the context of a paper containing a large corpus of actual utterances, these data reduction procedures might possess some legitimate heuristic value. In the absence of a corpus, these data are hopelessly ambiguous; rather than shedding light on Washoe's linguistic abilities, they obscure what she actually did.³

To summarize, the Gardners, Fouts, and Patterson have failed to provide a comprehensive characterization of their subjects' behaviors. They have not published systematic observational data or a corpus of even moderate size. The data in these reports are largely confined to anecdotes which describe isolated occurrences whose importance cannot be ascertained. In the few instances where quantitative data are provided, they have resulted from multiple transformations and reductions of actual utterances which are not made available.

Of course, the fact that the relevant data have never been reported does not mean that the conclusions of the ape signing researchers are incorrect. In the remainder of this paper, we will examine other aspects of the apes' known behaviors which suggest that linguistic interpretations are not merely unsubstantiated, but also in error.

3. Repetition and syntax

As we have seen, perhaps the most serious consequence of these sampling and data reduction procedures is that they effectively suppress information concerning the structure of ape sequences, especially their characteristic redundancy. The pervasive occurrence of repetitions poses a set of questions which bear critically on the hypothesis that apes show linguistic abilities. Because these utterances have never been fully documented, these questions have never been explicitly addressed.

First, how do the superficial forms of ape utterances compare with those of deaf and hearing children? Children in the early stages of language acquisition typically produce utterances that are reduced relative to the corresponding adult forms, leading to the characterization of their speech as "telegraphic" (Bloom, 1970b). In contrast, apes repetitiously expand. The occurrence of an utterance such as *you me banana me banana you* would be quite odd in the speech of any human. Limber (1977) notes the existence in child language of long utterances (e.g., I do pull it the way he hafta do that so he doesn't—so the big boy doesn't come out), but states that these typically exhibit hierarchical infrastructures that are not seen in ape sequences. Limber concludes that "Whereas virtually all children use hierarchically structured complex sentences by the beginning of their fourth year at the latest, there is little evidence that any ape ever did." We would more strongly assert that

³It should be noted that the Gardners provide neither the actual responses nor the transformed ones. Their data consist entirely of the number of responses to each question that contained signs from pre-designated target categories (see pp. 000–000 below).

³See facing page.

repetitive, inconsistently structured strings are in fact characteristic of ape signing (see Terrace et al., in press).

The Gardners' conclusion is quite different. They assert that "transcripts of Washoe's spontaneous signing... show striking similarities to the speech of children". (1974b, p. 734) However, they have never provided the transcripts that would substantiate their claim; the only data that do permit such comparisons, those of Terrace et al., appear to contradict their assertion. It is clear that, whatever their content or complexity, Nim's utterances were very different in their superficial form from those of either deaf or hearing children. In the absence of explicit comparisons of large samples of ape and child utterances, then, the Gardners' statement cannot be taken as fact.

In the face of this superabundance of repetition, some obvious questions concerning the organization of ape utterances arise. Are the signs combined into non-random, albeit repetitious, patterns? Do they show internal structure which may be described by simple syntactic rules? Or are they merely a hash of random combinations? Although there are several discussions in the literature of the possibility that Washoe's utterances showed evidence of syntactic structure, we take this issue to be moot until there is an accounting of a large number of utterances and their frequencies of occurrence. While the Gardners have presented examples of signs which Washoe combined in a consistent linear order as evidence for her use of syntax (e.g., *clothes white, baby mine, and tickle me* in Gardner & Gardner, 1974, p. 17), the status of these examples is similar to that of the *cookie rock* anecdotes: they cannot seriously be evaluated except in the context of a corpus and distributional analyses which have never been provided.

At a minimum, what is required are statistical analyses of the frequencies of occurrence for a large number of individual signs, signs in combination with each other, and repetitions. These analyses are necessary in order to eliminate certain trivial interpretations of ape signing. Each ape's output might be described by a finite state device, where the frequency of occurrence for a particular sign is merely a function of the frequency of the previous sign; their signs might be combined randomly, or into a small number of stereotypic patterns. Any of these outcomes would provide strong evidence against the hypothesis that the apes were signing linguistically, and until such analyses are performed, they cannot be discounted (see Terrace et al., in press).

Distributional analyses would also provide an empirical basis on which to evaluate any regularities in the ordering of signs. The interpretation of such ordered strings, should they occur in substantial numbers, presents some subtle issues of interpretation. From the discussions in Gardner & Gardner (1971, 1974), Patterson (1978) and elsewhere, it appears that the authors

believe 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. However, the *sine qua non* of syntax is not the mere fact that certain chains of responses occur in a fixed order; many lower animals show such sequencing in a wide variety of behaviors. Rather, as Wilson (1975) has stated,

True syntax occurs when separate signals, say A, B, and C, that have distinct meanings when alone create new messages when presented in various orders: AB, CBA, CAB, and so forth. In human speech, each of the three permutations "George hunts", "George hunts the bear", and "The bear hunts George" has a very different meaning. (p. 190)

In addition, syntactic structures underlie the combination of classes of words (nouns, verbs, etc.), rather than individual lexical items. In order to demonstrate that the apes' signing showed syntactic structure, then, three facts must be established:

1. That signs in isolation had particular meanings;
2. That signs combined in different linear orders had different meanings, e.g. You give me \neq Me give you;
3. That each regular ordering was not specific to a unique combination of lexical items.

As we argue below, it is questionable whether the apes' signs have the very specific meanings which are routinely attributed to them. Furthermore, none of the ape researchers has provided the contextual analyses which could indicate whether different orderings had different meanings. Finally, the Nim data—the only available corpus of ape signs analyzed by frequencies—indicates that while some of his combinations appeared in a regular order (e.g., *me Nim* occurred more often than *Nim me*), these regularities did not extend to classes of signs. Terrace et al. (in press) argue convincingly that Nim's sequences do not have the syntactic structure of sentences. At this time, then, there are no positive indications that the apes' signing showed evidence of syntax or contrastive use of sign order, although a definitive judgment must be deferred pending publication of more complete data.

3.1. Functions of repetition

The pervasive occurrence of repetitions in ape signing also raises the question of their function. The Gardners eliminate these signs from their analyses because they believe that they are "redundant and cannot alter the appropriateness or inappropriateness of Washoe's replies" (Gardner & Gardner, 1975, p. 252). Yet they are so characteristic of ape signing as to demand interpretation. Although we cannot confidently ascribe a function to these repetitions in the absence of a large corpus, some preliminary observations can be made.

First, it is clear that the apes' repetitions differ from those which occur in ASL. Several phenomena in ASL may be termed "repetitious", but these have conventionally-established communicative functions, and their occurrence is bound by grammatical rules. As far as can be determined from the existing reports, the apes' repetitions serve no communicative function and occur freely. In ASL, a fixed number of repetitions may be specified as part of the root or citation form of a sign. The grammatically-correct citation form of *eat*, for example, requires exactly two movements of its defining hand configuration in a specified direction (towards the mouth), with a specified hand orientation. More than the requisite number of repetitions may occur only if a signer wishes to alter the sign's meaning. These repetitions are accompanied by changes in the movement parameter of the sign; hence, they are not identical or verbatim. The exact forms of such repetitions and the contexts in which they may occur are specified by the grammar of ASL (see Klima & Bellugi, 1979; Friedman, 1977). For example, the idea of continuous eating (as conveyed by the utterance "I was so nervous I ate non-stop for an hour") could be communicated by drawing out, enlarging, and repeating the movement of the *eat* sign. This modulation must be accompanied by a contextually-appropriate facial expression (Liddell, 1975). The additional repetitions, the exact form of the movement, and the simultaneous facial expression together communicate the continuous aspect. Thus, repetition in ASL is used conventionally with other types of visual and temporal information as part of the grammar of the language. This usage is not seen in ape signing.⁴

In contrast, a simple, non-linguistic interpretation may suffice to explain the repetition in ape signing. One might reasonably assume that both the apes and their trainers utilized a simple rule to the effect that "more signing is better". That is, the training conditions in these projects are designed to encourage signing which would not otherwise occur. Trainers may perceive their task as the creation of contexts in which the quantity of signing is maximized with little regard to content (e.g., the presence of repetition). Apes may learn to discriminate that longer strings will be highly rewarded. On this interpretation, then, the apes' repetitions are similar to those which may be induced in laboratory animals such as rats and pigeons using tech-

niques of standard learning theory. Repetitive pecking or bar-pressing will result when anticipated reinforcement is withheld (as in the early stages of extinction). Similarly, repetitive signing would occur if reinforcement were withheld until the ape produced a lengthy sequence. No linguistic function need be attributed to the apes' signing under this interpretation because it is not the content or structure of their utterances that is critical, but rather their length and quantity.

It is possible, of course, that the functions of repetition are related to linguistic or conceptual processes in ways which have not been explored as yet. They might facilitate the mapping of concepts onto motor responses, for example; in this way they could function as pauses or hesitations do in spoken language. This is unlikely, however, as it is clear that deaf signers do not utilize repetitions in this way. Another possibility is that repetitions are a gestural analogue of stutter or sociocentric signals such as "you know" or "really" (Duncan, 1969). As with other interpretations of repetition, the available data do not permit evaluation of this hypothesis.

Rather than showing similarities to the signing of humans, the apes' repetitions appear to place their behavior squarely in the domain of animal communication systems. As Wilson (1975) has stated,

If a zoologist were required to select just one word that characterizes animal communication systems, he might well settle on "redundancy." Animal displays as they really occur in nature tend to be very repetitious, in extreme cases approaching the point of what seems like inanity to the human observer. (p. 200)

Inspection of the Nim corpus reveals that his signing showed this degree of redundancy, as we believe a corpus of any of the signing apes' utterances would as well.

Whatever the functions of repetitions, it is clear that they are a fundamental characteristic of ape signing; they should be the focus of future research, rather than be deleted as they have been until now.

4. Attributions of meaning and grammatical function

In the reports on ape signing, there is an apparent failure to confront the primary methodological issue in language acquisition research, namely, what evidence justifies the attribution of meanings and grammatical functions to a child or ape's behavior? Clearly, the assumption underlying the anecdotes, vocabulary counts, and other fragmentary data in these papers is that the signs have similar meanings for the apes and the experimenters. What, then is

⁴Another interesting use of repetition occurs in the signing of deaf children. At an early stage, they will repeat signs instead of using the system of modulations. For example, to communicate that one was "working very hard", the adult signer would modulate the citation form of *work*, using an appropriate facial expression and altering the movement parameter. Deaf children will instead repeat the *work* sign several times. The point is that the repetitions are of signs which will later carry modulations; they are a precursor to the modulation system, rather than random events.

the evidence that it is justified? In analyzing child language, two sorts of data are cited in support of such attributions—observational and experimental. Both are represented in the ape signing literature; we consider them in turn.

4.1. Observational data

As an empirical methodology, observation entails the accumulation of a large corpus of utterances and documentation of the contexts in which they occur. In discussing this method, Bloom & Lahey (1978) note,

Perhaps the most important single factor in obtaining evidence of child language and development is that what children do and what else goes on in the context is at least as important as what children say and what they hear... 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. (p. 29)

As we have noted, neither a large corpus nor contextual analyses of ape signing behaviors exist. Bloom & Lahey note that this inadequacy troubles many studies of child language as well:

There is very often a tendency in the literature to report lists of child utterances, perhaps categorized in some way; the assumption is that the meaning of the utterance is "transparent" and when it is not, then a translation or gloss of the utterance is provided. The problem is that such child utterances are very often interpreted from the adult's point of view. (p. 29)

This tendency is exemplified by the Gardners', Pattersons', and Fouts' reports on their subjects. They include long lists of the apes' vocabulary signs, assigning specific meanings and categorizing them in terms of their syntactic functions and case relations, while providing little discussion of the evidence which motivated particular attributions. In assigning meanings and grammatical functions, these researchers appeal to three general observations: first, that the apes' signs generally appeared in "appropriate" contexts; second, that the use of individual signs generalized to new referents and situations, and "overgeneralized" to conceptually-related referents; and third, that their signs had the form of signs in ASL. Both the relevance and veracity of these observations are questionable, however.

4.1.1. Generalization and overgeneralization

Although the ape researchers rely heavily upon the observation that their subjects used signs in "appropriate" contexts, the notion of "contextually appropriate utterance" is never defined in their papers. Even under an explicit definition of "contextually appropriate sign", however, this observation would not itself provide compelling evidence, since the apes could in general

produce contextually-appropriate signs by non-linguistic means, for example, imitation. Since the apes' teachers were presumably signing sequences relevant to each context, the apes would merely have to sign part or all of these inputs in return. This is reminiscent of Weitzenbaum's (1976) computer program ELIZA, which simulated the behavior of a therapist in part by echoing the "patient's" input. The extent to which ape signing was produced in this manner has not been evaluated. A very high correlation between teacher input and chimp response is seen in the films of Washoe (see footnote 12). The possibility that a large proportion of Nim's output—possibly more than 80%—resulted from direct or delayed imitation is being evaluated by Sanders⁵.

In claiming that Washoe and Koko used signs in "appropriate" contexts, both Patterson and the Gardners invoke a behavioral theory of meaning. A sign is presumed to have a particular meaning because it is associated with certain stimuli. Individual objects and actions (or classes of objects and actions) are the discriminative stimuli for particular signs. Many of the signs in the apes' vocabularies are in fact nouns and verbs which are exemplified by simple objects or actions; the Gardners' vocabulary tests (1971, 1974a) were intended to demonstrate that Washoe had learned associations between signs and objects (or pictures of objects). Leaving aside the usual criticisms of behavioral theories of meaning (see Fodor, 1977, for example), a characterization of the nature of these associations would be revealing of what the apes had learned. However, little can be ascertained from the published reports. Since the signs are assigned very specific English glosses, it is implied that the associations were quite close. One might conclude, for example, that the hand movement glossed as *tree* was consistently formed in the presence of these objects, and much less often in the presence of others. Again, however, we are forced to rely upon the authors' assertion that the signs were in general used "appropriately", since the contexts in which they occurred are never systematically documented. This problem is particularly acute with respect to putative vocabulary items such as *silly*, *good*, *please*, and *hurry*, which are not exemplified by simple actions or objects. In these cases, we have no knowledge of the actual referents.

The few discussions of the apes' use of individual signs in different contexts do not lend additional support to the hypothesis that they were consistently used to refer to well-defined classes of objects or actions. For example, the Gardners observe that,

In translating "Washoese", the problem is compounded by the small size of Washoe's repertoire of signs. She had fewer signs to use for the referents in her

⁵Sanders, R. Conversations with a chimpanzee. Columbia University Ph.D. thesis, in preparation.

world that [sic] an adult native signer would have, so that many of the signs she used had more referents than the same signs had when used by an adult native signer. In addition, we deliberately enlarged the reference of many signs in an attempt to simplify her training. For example, we taught Washoe the sign *bib* to refer to bibs, napkins, washcloths, handkerchiefs, facial tissues, toilet paper, etc., and we only modeled this one sign for these referents, even though there are about as many signs in ASL as there are words in English for this group of referents. (Gardner & Gardner, 1971, p. 144)

What cannot be determined from this or any other passage in the literature is this: in judging that Washoe or Koko used signs "appropriately" in referring to objects, what range of stimuli were permitted as the referents for individual signs, how many signs were accepted as the "correct" names for individual objects, and what were the nature and frequency of errors? In the absence of systematic data concerning the use of individual signs, one can make very little of the claim that the apes used signs in "appropriate" contexts, or the assertion that their use of a sign "generalized" to new objects and contexts.

The Gardners and Patterson also offer the global observation that the apes' errors were "overgeneralizations" of the sort observed in child language (Clark, 1973a). Patterson, for example, describes Koko's use of *tree*, which she "overgeneralized to asparagus, green onions, and other tall thick, objects presented vertically." (Patterson, 1978, p. 83) Similar observations are seen in discussions of Washoe's signing. These anecdotes leave the nature of the apes' errors opaque. Were these overgeneralizations (typically termed "over-extensions" in the child language literature) in the use of signs such as *bib* and *tree* specific to objects which showed some physical or functional relationship to the denoted referents, or did the apes use the signs with respect to a wide range of stimuli, some unknown (and possibly small) proportion of which were related? The belief that the apes exhibit conceptually-based over-extensions has been widely taken as important evidence that the apes' language behavior is similar to that of children. Given the failure to document the apes' use of any single sign, and the lack of any explicit comparisons of the over-extensions of apes and children, this claim has no empirical substance, and remains merely an intriguing possibility.

Instead of systematic observations which could answer the important questions concerning the use of individual signs, the following pattern is seen repeatedly: the apes learn hand configurations which the experimenters gloss as having specific meanings on the basis of their own knowledge of ASL or their intentions in training the animals. Then it is observed that the apes' use of a sign "generalized" to other referents and contexts, which is taken to indicate creative use of the sign. Except for anecdotal accounts, no attempt is made

to characterize the use of the sign, i.e., in terms of frequency, combination with other signs, contexts of occurrence, etc. In the absence of such information, one is simply left with the experimenter's initial attribution. By assigning specific meanings to the apes' hand shapes—when in fact they may be used with reference to heterogeneous groups of stimuli—close similarities to human language are implied when none may in fact exist.

This disturbing pattern is especially clear in the case of signs whose meanings are abstract. For example, both the Gardners and Patterson attribute knowledge of the sign *please* to their subjects. The grammar of *please* has of course interested linguists for some time. We know from Sadock (1974) and others that its use follows some very subtle constraints. Although Koko and Washoe formed hand configurations which their trainers glossed as *please*, no comparison of their use of these signs with the use of *please* in English or ASL is provided. Thus there is no evidence of any resemblance. Yet by glossing a response as *please*, such a correspondence is implied.

The sign *sorry* is also attributed to Washoe and Koko without any description of its use. Nim also used a hand configuration glossed as *sorry*. This gesture was largely under the control of his teachers' threats. If they appeared angry or ready to punish him, he would sign *sorry*. This sign appeared almost exclusively in contexts where such a threat was imminent. In common with many of the apes' behaviors, this one is not uninteresting; it may be that Nim learned to mediate threatening interactions in a manner unavailable to apes in the wild. However, the inclusion of this sign on lists of the apes' vocabularies—without documentation of its use—leaves the possibly disingenuous implication of a deep isomorphism with the use of *sorry* in English or ASL.

It is unclear exactly what knowledge the Gardners and the others intend to ascribe to the ape who "knows" these signs. Does the animal who signs *please* understand the human's system of social interaction and discourse, i.e., rules of the type described by Goffman (1954), Lakoff (1973), Searle (1975), Grice (1975) and others? Does it have a sense of politesse? Or is the Gardners' attribution solely based on the observation that chimpanzees can learn hand shapes which the observers intend to be read as *please*? The superficiality of the Gardners' claim is seen when compared to Bates' (1976) study of the acquisition of polite forms of expression in Italian children. Bates cites a wide range of data which trace the child's acquisition of several polite forms, including *please*; she interprets the data within a theory of the child's developing pragmatic competence.

Similarly, in signing *sorry*, does the ape intend to express remorse? If not, what is the sign's meaning or function? In this case, it is instructive to consider Van Lawick-Goodall's (1971) observations of "apologetic" behavior in wild chimpanzees:

When one human being begs forgiveness or gives forgiveness to another there are moral issues involved; it is when we consider these that we get into difficulties in trying to draw parallels between chimpanzees and human behavior. In chimpanzee society, the principle involved when a subordinate seeks reassurance from a superior or when a high ranking individual calms another is in no way concerned with the right or wrong of the aggressive act. A female who is attacked for no reason other than that she happens to be standing too close to a charging male is quite as likely to approach the male and beg for a reassuring touch as is the female who is bowled over by a male while she attempts to take a fruit from his pile of bananas. (p. 244)

Simply stated, then, the fact that an ape performs a particular behavior in threatening situations does not justify labeling that behavior as the sign "sorry". Rather, in signing *sorry*, the apes appear to have learned about the pragmatics of language use. Nim knew that by signing *sorry* in certain contexts, he could affect his teachers' behaviors in ways beneficial to him. He learned the consequences of the act of signing *sorry* rather than its meaning and grammatical function. This use of the sign is similar to the child's earliest use of words, before meanings and concepts have been mapped onto them, but after the pragmatic functions of language have begun to be understood (Bates, 1976).

There is, then, an enormous problem of over-attribution in the ape signing literature. Nowhere do the researchers describe the criteria that resulted in their crediting the apes with knowledge of signs such as *time*, *sorry*, *please*, *happy*, *good*, *bad*, *big*, *small*, *quite*, and *pound*. These attributions appear to entail strong claims about the apes' cognitive capacities—e.g., their ability to make comparative judgments or label affective states—that are vastly underdetermined with respect to the behavioral evidence offered. In place of this evidence, the researchers offer English glosses of the apes' behaviors. It is the connotations of meaning, grammatical function, and usage which these glosses suggest to the literate observer that imply that the apes possessed linguistic skills, not their largely undocumented behaviors.

4.1.2. Arguments from the form of signing behaviors

A third general observation that is weighted heavily in ascribing meanings and grammatical functions to the apes' utterances is that they produce hand shapes and movements which resemble those of deaf children who use ASL. Since developmental psycholinguists attribute linguistic knowledge to children who exhibit these behaviors, the argument goes, we must attribute this knowledge to apes who show similar behaviors (Gardner & Gardner, 1974b, 1975).

We argue below that the apes' behaviors resemble ASL very little. However, one cannot attribute linguistic functions to the apes' behaviors simply on the basis of physical resemblance in any case. This would be to mistakenly assume that it is the form of certain behaviors which qualify them as "linguistic" rather than their conceptual bases and communicative functions (Huttenlocher & Higgins, 1972; Nelson, 1977; McNeill⁶). The existing reports document the apes' ability to learn behaviors whose superficial forms resemble those of sign language behaviors. If the mere physical form of an utterance were crucial, however, it would be the case that mynah birds and telephone answering machines would exhibit linguistic abilities. In the case of the apes, one cannot abandon the distinction between speech and language simply because the channel of communication is visual. Although this point may appear trivial, it is overlooked by the ape signing researchers, who have documented the *form* of the apes' signs in far more detail than their *use* of these signs.

Although they do not provide sufficient evidence for linguistic attributions, analyses of the form of the apes' behaviors are revealing in other respects. A significant proportion of the apes' vocabularies consist of natural ape behaviors which are labelled as lexical items. These include *pick* (signed by picking a part of their anatomy), *hug* (signed by hugging), *tickle* (signed by tickling), *kiss* (signed by kissing activity), *scratch* (signed by scratching) and others. The behavioral basis of each of these "signs" is in fact an activity exhibited by apes in the wild (van Lawick-Goodall, 1968, 1971). In the sign language projects, however, they are glossed as lexical items, with attendant linguistic implications. These behaviors show almost none of the critical features of human language; estimates of the size of the apes' vocabularies are inflated when such activities are glossed as "signs".

The fact that simple activities and gestures are glossed as signs raises another important issue. In attempting to evaluate what the apes in the sign language projects have learned, it is necessary to distinguish between natural communicative behaviors common to all apes, and those which are learned in the course of training. The ape researchers do not draw this distinction; all of the apes' communicative behaviors (and some non-communicative ones as well, e.g., scratching) are together classified as "signs". This generic use of the term "sign" with reference to a diverse group of behaviors contributes to uncertainty over the interpretation of their activities. It is especially misleading because the term is at the same time applied to the units of ASL, to which the apes' behaviors show almost resemblance (see below).

⁶McNeill, D. Unpublished chapters from forthcoming book, 1975.

The Gardners mention the possibility that Washoe's "signs" may be confounded with her naturally-occurring gestures, but they do not pursue the issue. They note the importance of determining the nature of Washoe's "base population" of responses (Gardner & Gardner, 1971, p. 129), and state that some of these are similar to the chéremes which Stokoe, Casterline & Croneberg (1965) have identified as the basic components of signs (similar to phonemes in spoken language). They also write that

Washoe's signing was frequently observed both "live" and on film by outside observers... Some of these outside observers were deaf or were hearing persons who were already familiar with ASL. Others were hearing persons who had to be taught the rudiments of ASL for the purpose. All of these outside observers have agreed that, in general, Washoe's chéremic responses were quite distinct from her non-chéremic responses. Those observers who were most familiar with ASL had the least difficulty in making such discriminations. (p. 128)

Later in the same paper they state that

Many of Washoe's vocalizations were very similar to those observed in wild chimpanzees and chimpanzees raised in laboratories... Some of them are found in other primates, including man, and many of them can be interpreted by a human being the first time they are heard. We would also expect to find natural gestures, and some of these should be similar to the signs of ASL. If there were more complete information about the natural gestures of captive and wild chimpanzees it would be easier to identify them. Under the circumstances we know that a few of Washoe's gestures could have appeared without any specific training, and we guess that this was so for some others. (p. 137)

This is followed by two examples of Washoe's natural gestures which were glossed as signs, but the topic is not considered further (see Patterson, 1978, pp. 83-86 for similar discussion.)

At this time, it is an unresolved empirical issue whether any of the apes' naturally-occurring manual gestures resemble chéremic elements of ASL. It is clear, however, that the apes' natural behaviors do not resemble ASL signs. The latter are highly stylized and specific in form. The citation form of each sign is defined along four parameters (hand configuration, location, movement, and orientation); with the possible exception of a small number of very simple signs, the exact configurations of elements which characterize ASL signs are not observed in the gestures of apes.

These considerations suggest that an important experimental control is missing here. In order to de-confound the apes' natural gestures and their acquired "signs", a comparison between the behaviors of signing and non-signing chimps is needed. Two chimps could be raised from infancy in similar environments, exposed to human contact to an approximately equal

extent, engaged in similar activities. The experimenters could attempt to teach sign language to only one; they could perhaps communicate with the other through gesture and other non-signing means. Longitudinal comparisons between the communicative behaviors of the two would then provide a better test of what the signing chimp had learned.

A possibly more interesting group of ape signs may be indexical in the sense of Peirce (1932). This group includes *eat, me, you, go come, brush, groom, up, down, give, this, that, there*, and others. These may be indexical because the motion of each sign is part of its referent, or denotes it by means of pointing. The apes apparently sign *brush*, for example, by a brushing movement, *give* by a begging gesture, etc. Many of these signs purportedly involve pointing, e.g., they sign *me* by pointing to themselves, *you* by pointing to another, *eat* by pointing to the mouth, *this, that, and there* by pointing to objects or locations, etc.²

The claim that the apes utilized indexical signs, and pointing in particular, is itself a strong one. Although it is widely acknowledged that wild apes use a variety of gestures, these are not well documented. As Yerkes & Yerkes observed in 1929, the apes' "modes of affective expression" include

Position, pose, and movements, often termed gestures, of the hand, trunk, limbs, extremities... Particularly noteworthy are the so-called gestures made with the head, limbs, and extremities. Frequently these are mentioned in the literature, although seldom with sufficient precision and minuteness of description to provide the reader with a definite picture of the organism. (p. 285)

Existing naturalistic studies do not make clear whether these gestures involve pointing or other types of indexical reference (cf., deVore, 1965; Jay, 1968; Goodall, 1968, 1971; Menzel & Johnson, 1976; Chevalier-Skolnikoff & Poirer, 1977). The ape researchers' claim, then, that their subjects used pointing to communicate several semantically-distinct concepts is very strong in light of existing primatological evidence. Again, however, the systematic

²We will distinguish between indexical and iconic signs, although the two are usually collapsed. Indexical signs have the properties described in the text. Their meanings can be understood without special knowledge. Iconic signs contain visual information that is related to or schematically represents some aspects of the referent of the sign. This relationship varies in abstractness, but typically requires special knowledge in order to be identified. For example, the sign *shoe* is formed in ASL by hitting two fists together side by side exactly twice. It is iconic because the motion is thought to represent two heels clicking together. Iconicity has been defined operationally in tests such as Bellugi & Klima (1976). Typically, naive observers cannot determine the iconic basis of a sign unless they are told its meaning; then they show high levels of agreement as to the source of the iconicity. A sign such as *give* is indexical (as the apes form it) because the motion of the sign is its meaning. In this way, indexical signs are an analogue of certain speech acts (Searle, 1969). The motion of an iconic sign, in contrast, schematically represents some aspect of meaning or use of the actual referent.

observations which would provide compelling evidence for a radical conclusion are lacking.

If Washoe and Koko used indexical signs, this accomplishment would place their communication at a level beyond that of other apes and lower animals. It is important, then, that the ape researchers attempt to provide substantive supporting evidence. However, the use of indexical reference does not provide the basis for positive comparisons to human language behavior. In spoken languages, of course, words are largely symbolic rather than indexical. Speakers use arbitrary symbolic forms even for words such as *me* and *you* which could be communicated indexically. Indexical reference is utilized within American Sign Language; here the important difference is that its use is governed by the grammar of the language. As was true of repetition, this information is utilized within a complex, conventional system which is not observed in signing apes.

The use of pointing provides a good example of this profound difference. The signs *me* and *you* may be signed indexically in ASL through pointing in some contexts; however, they are also expressed by non-indexical means (e.g., via incorporation of pronouns into verbs) in others. The means by which *me* and *you* are expressed depends upon a set of grammatical constraints that are only beginning to be codified (Friedman, 1975). Pointing may also be used to refer to persons, objects, and locations that are *not* in the immediate environment. Signers will locate such nouns at metaphoric locations in the signing space. In a conversation about two persons who are not present, for example, the signer can in effect "place" them at points on the left and right within the signing space. Among other functions, this permits pronominal reference to be accomplished by merely re-pointing to (or looking at) these locations in space. This process is termed "establishing loci". Note that the signer points not to an actual person or place, but to an abstract locus in space. Thus, pointing is exploited in an elegant, systematic way. There is no evidence that pointing in apes follows conventions of this type, if it exists at all.

Given the large proportion of indexical signs such as *give* and gestural or behavioral "signs" such as *hug* in the apes' vocabularies, it would perhaps be a powerful test of what they had learned to attempt to teach them abstract (i.e., arbitrary) signs for messages that can be gestured or otherwise enacted. For example, they might be taught a wholly arbitrary sign for *kiss* or *eat*. On the basis of our experiences with Nim and the behavior exhibited by Washoe on film, we predict that the apes could learn such signs, but would quickly abandon them in favor of actual enactments of the behavior, unless intensive maintenance procedures were utilized. It appears that the apes will not use abstract forms to refer to activities they are themselves able to perform, ex-

cept under duress. This would follow from a failure to exploit the symbolic relationships among an abstract sign, its meaning, and its referent.⁸

We suggest, then, that a large proportion of ape signs can be interpreted without any special knowledge of apes or ASL because they are unlearned gestures and activities that are seen in the behavior of wild apes and other animals. Although the Gardners have attached great importance to the observation that signers of ASL had no difficulty in interpreting Washoe's behavior, we suggest that *the same would largely be true of any sensitive observer*. This too could be cast as an empirical question, by having both signing and non-signing observers independently interpret videotapes of Washoe signing. Although signing observers would enjoy an advantage (because the ape apparently did learn some arbitrary signs), we would expect their judgments to show high levels of agreement with those of naive observers.

We do not wish to claim that all ape signs involve behaviors such as hugging or pointing, nor do we claim that the existence of such behaviors in a communicative system disqualifies it as "language" or that because the apes'

⁸There are other sources of non-arbitrary visual information in ASL, in particular iconicity and the limited use of pantomime. The fact that such information is utilized in manual-visual languages such as ASL is sometimes used to draw similarities among signing in ASL, communication in wild apes, and gestural proto-languages (Hewes, 1976; Stokoe, 1978). However, the degree to which signs in ASL contain representational elements is a matter of considerable controversy (cf., Bellugi & Klima, 1976; Battison, 1978; Brown, 1978; Frishberg, 1975; Friedman, 1977; Newport & Bellugi, 1978). The essential facts are these: while it is clear that ASL embodies non-arbitrary information in its structure, the function of this information in the perception or production of utterances does not. Iconicity in particular may be a vestige of diachronic processes of sign evolution (Frishberg, 1975), rather than a perceptually salient feature of the language. Although the representational information provided by the forms of certain signs may prove to have some functional utility (perhaps in the creation of new signs, or in the acquisition of signs; Brown, 1978), much of this information is suppressed in effect by its occurrence in a discourse context where non-representational information (provided by the abstract formal parameters of signs, and by modulations, inflections, and other expressive elements) predominates (Bellugi & Klima, 1976). Identifying the sources and functions of non-arbitrary visual information in ASL remains an open empirical question, however.

Roger Brown (personal communication) has suggested that iconicity may have less salience for signing apes than for deaf children. We hesitate, however, to assign much importance to the issue of iconicity until it is clear that these signs form a coherent class on the basis of either formal structure or perceptual function in native signing. Brown's provocative hypothesis that iconicity is implicated in the sign acquisition process in deaf children is based on an experiment with hearing children who already had facility with spoken language, and who were explicitly shown the iconic bases of some signs. Note, however, that one could examine the value of iconicity to the apes by explicitly teaching both iconic and abstract forms, and comparing their acquisition and use. It would be quite interesting, for example, if abstract signs were abandoned in favor of enactments, but iconic signs were not, or if iconic signs were learned more rapidly. Given the lack of evidence concerning the functions of iconicity in child or adult signing, and the primitive nature of the apes' behavior, however, this speculation borders on fantasy.

behaviors do not show the complexity of ASL they cannot learn a manual-visual language. Rather, this analysis of the form of the apes' behaviors has several functions. First, it provides details of the apes' performance which are obscured by merely noting that their vocabularies were of a particular size. Second, it extends the comparisons of ape signing and ASL signing, and isolates substantial differences. Third, it suggests that much of the apes' "signing" behavior has a natural, non-linguistic basis. Finally, the demonstration that a large proportion of ape signs are natural gestures (and hence largely unlearned) increases the likelihood that the apes' other signs were learned as individual responses to particular objects, actions, or settings through intensive and specific training. If, in fact, a large proportion of the signs are gestural, possibly modifying or extending the apes' natural system of gestures, then the possibility that the remaining signs were learned in a rote fashion and signed using non-linguistic responding strategies increases. We should note that if our interpretations are correct, it is misleading to describe this behavior as "signing", since this term suggests a level of abstraction that is largely absent. Nor is pantomime the correct term, since the apes' behaviors are time-locked to on-going activities, unlike true pantomime. The correct description of this behavior was provided by the Gardners in their original (1969) paper. Nim, Washoe, Koko, and other signing pongids show evidence of having learned a "standardized system of gestures". Although modern languages may have evolved from such gestural systems (Hewes, 1976; Wilson, 1975), these gestures do not exhibit critical features of human languages.

Rather than showing similarities to human language use, many aspects of the apes' behavior (e.g., their use of gestures, imitation, and facial expressions) show similarities to the pre- and early-linguistic behaviors of very young children. As work by Piaget (1952), Werner & Kaplan (1963), and, more recently, Bates (1976) and Shatz (1978) has indicated, the infant or young child's gestures and sounds may be used for communicative purposes that are the precursors of language, rather than language itself. Bates has attempted to relate the development of the child's pre-lingual communicative behavior to its cognitive development, as considered from a Piagetian perspective. Chevalier-Skolnikoff (1976) has begun to consider the communicative behaviors of apes in a similar fashion. It is likely that both the nature and the limits of ape communicative capacities will be revealed by further studies which relate their overt communicative activities to their level of cognitive development.

4.2. Experimental tests

Investigations of language acquisition in children have employed experimental tests of both comprehension (e.g., Huttenlocher, Eisenberg, and

Strauss, 1968; de Villiers and de Villiers, 1973; Chapman and Miller, 1975) and production (e.g., Berko, 1958; Fernald, 1972). There are two widely known experimental tests of the apes' signing abilities, the Gardners' tests of Washoe's vocabulary (Gardner & Gardner, 1971, 1974a) and their test of her ability to answer wh-questions (Gardner & Gardner, 1975). There have been no rigorous tests of the apes' abilities to comprehend signs, a remarkable omission in light of recent theoretical work on the differences between comprehension and production (e.g., Bloom, 1974b; Chapman and Miller, 1975.)⁹

4.2.1. Vocabulary tests

Washoe was required to sign the names of pictures or objects which the experimenters could not see. Her performance on this task has led to the conclusion that she possessed the ability to name objects; however, the implied characterization of the naming process is quite sterile. The Gardners merely required of the animal the capacity to learn simple associations between individual behaviors and individual objects or classes of objects. Under this characterization, a limited ability to name objects is within the capacity of many animals, including standard laboratory subjects such as pigeons (Herrnstein, Loveland and Cable, 1977).¹⁰

It is important to realize that the complete results of these vocabulary tests have never been published. Although the Gardners stated in 1971 that "When the results of this testing program are complete, we will publish them

⁹The Gardners explicitly reject all tests of comprehension because of the "experimenter errors" they are believed to involve (Gardner & Gardner, 1975). They note that comprehension tests require controls of non-linguistic cuing that are "difficult to enforce". From the fact that such tests are difficult, however, it does not follow that they should be rejected entirely. The Gardners suggest that production tests avoid such biases; however, their own tests and that of Fouts et al. (1978, see p. 206 below) clearly show that such tests introduce other problems.

¹⁰Herrnstein et al. (1977) taught pigeons to differentially respond to pictures of objects from classes such as *tree* or *body of water*. If a pigeon learned to pair the presentation of a picture of a tree with the pecking of a particular colored keylight (and pair non-tree stimuli with a second light), it would be said to "name" trees under the Gardners' characterization. It seems clear that pigeons could be taught to simulate the "overgeneralizations" reported in the ape literature. The pigeons that learned to discriminate trees might be presented with pictures of stimuli physically similar to trees, e.g., asparagus, green onions, etc. False positives to these stimuli would then represent "overgeneralizations" or "conceptually-based overextensions". Varying the negative stimuli in this way would be a good way to explore what the pigeons in these "concept learning" experiments have learned.

See also Wittgenstein (1953), p. 187: "If you trained someone to emit a particular sound at the sight of something red, another at the sight of something yellow, and so on for the other colours, still he would not yet be describing objects by their colours. Though he might be a help to us in giving a description." Cited by Marshall (1971) in a very interesting discussion of some issues raised by chimpanzee signing.

in a separate article" (p. 160), they have never done so. The descriptions in Gardner & Gardner (1971, 1974a) make most aspects of their procedures clear, but Washoe's performance is not systematically characterized.¹¹ We are again given only partial descriptions of her performance. In one account, for example, the Gardners state that

Washoe's poorest performance on the self-paced version of the box test was obtained in a session in which 33 different items were presented with three different exemplars of each for a total of 99 trials... Washoe named 53 of the 99 exemplars correctly. The following week the same test was rerun in two sessions. The 99 exemplars were presented in reverse order and a different—hence equally blind—observer served as [experimenter]. The second time around Washoe's score was again 53. This is typical of the results that we have obtained in retests; improvement that could be attributed to practice on the original test was negligible. Most likely this was because Washoe received so much training on the items before testing, and there was so little opportunity for further training during the course of a test. (p. 160)

Again the important questions are begged. First, what stimuli were utilized in these tests? Nominals such as *bird*, *toothbrush*, or *dog* were apparently tested by presenting toys, the actual objects, or pictures. Were vocabulary signs such as *clean*, *hurry*, *good*, *mine*, *silly*, etc., which are not exemplified by simple objects, tested? If so, what was Washoe naming when she signed *clean* or *good*? Second, in scoring Washoe's responses, was there a single pre-specified correct response for each stimulus, or was any from a group of signs accepted? Since many of her signs were related (e.g., *banana*, *fruit*, *eat*, *brush*, *toothbrush*, *comb*), the latter possibility cannot be excluded. Third, how were her correct and incorrect responses distributed? If 53 of her responses were correct, and each exemplar was presented three times, then her correct responses could have been limited to as few as 18 signs, far fewer than the 100–150 attributed to her elsewhere. This number would shrink even further if a sign were scored as correct to more than a single item. Finally, what was Washoe's training for this test? How intensively was she drilled on items similar or identical to those used in these tests? Did she show similar levels of

performance in naturalistic settings where her behavior could not be routinized?

Although these vocabulary tests are the most widely cited evidence for language abilities in apes, they are of questionable interest. Certainly they cannot be taken seriously until Washoe's performance is exhaustively characterized.

4.2.2. Question answering

Although it is generally claimed that Washoe was able to form appropriate signs in the presence of particular objects or pictures, it is unclear whether her skill extended beyond the milieu of the double-blind vocabulary tests. In a somewhat different context, their 1975 test of Washoe's ability to answer questions, the Gardners abandoned this simple requirement. Washoe's response to a question was scored as correct if it contained a sign from a pre-designated target category. For example, the question *what's that* took a noun response; the question *where's that* took a locative, etc. Washoe's vocabulary signs were grouped into grammatical categories for scoring purposes; the sign glossed as *listen*, for example, was scored as a noun. The presumed meanings of her signs were ignored. Thus, if the Gardners held a ball in front of Washoe and asked her *what's that?* the response *listen come* would be scored as correct because it contains *listen*, a member of the target category noun. Given their liberal scoring procedure, it is not surprising that the Gardners could conclude that Washoe's responses were superior to those of children at stage III.

Note that the validity of this test rests upon several issues which are not discussed. First, the judgment that Washoe answered questions with signs drawn from appropriate target categories depends entirely on the manner in which her signs were classified. The assertion, for example, that she correctly answered the question *what's that* with signs from the category noun is uninteresting if signs were arbitrarily placed in this class. Since the sole criterion for a correct answer was that it belong to the appropriate target category, the method by which her signs were classified assumes great importance. The Gardners state that in performing these classifications they relied upon intuitions concerning "good usage" in Ameslan. This enterprise is of dubious validity. First, one questions the intuitions of non-native non-linguist signers of ASL. Second, many of the signs in question have multiple grammatical functions in ASL; hence intuitions do not provide a basis for placing each sign in a single category. Third, it has been unacceptable methodology for some time in developmental psycholinguistics to assume that child language is simply a reduced version of adult language. Bloom (1970a) has made this

¹¹One aspect of their training and testing procedures is not clear. It can be seen by stopping individual frames of two films of Washoe (see footnote 12) that she was sometimes reinforced with food after naming an object. In some cases, she is seen reaching off to the left side of the screen to be handed a reinforcer; in another test, she names an object in the testing box, reaches into the box, and pulls out a morsel from inside it. The use of food or other reinforcers would not necessarily reflect negatively on Washoe's signing abilities. However, this is an important part of the training and testing procedure which has not been documented.

point quite forcefully in her criticism of the generation of psycholinguistic research in which attempts were made to describe child language in terms of models developed on the basis of adult utterances. From the fact that a structure has a particular meaning or grammatical function in adult language one cannot conclude that a child employs the structure in the same way. The Gardners make this erroneous assumption in classifying Washoe's utterances on the basis of their meaning and function in adult ASL. Finally, Washoe's vocabulary signs could have grammatical functions only if they had meaning, which we have previously questioned.

Observe that if Washoe were signing in ASL, it would be possible to classify her signs on the basis of the use of grammatical inflections and modulations. It is somewhat disingenuous for the Gardners to assert that "In ASL as in most natural languages, many signs can be used either as nouns or as verbs..." (1975, p. 251), since it is the case that in ASL, such differences in grammatical function are signaled by modulations and inflections on the citation forms of signs. Determining the grammatical function of a sign in ASL, then, is not dependent primarily upon intuitions about general usage in "good Ameslan", but rather on identifying the inflectional elements and syntactic variations associated with nouns or verbs. There is no indication that the apes learned to distinguish nouns from verbs in these or any other ways, again suggesting that while the apes' signing is termed "Ameslan", it shows none of the characteristic structures or expressive devices of that language. It is highly questionable whether the Gardners or Patterson had an empirical basis on which to identify the grammatical function of a sign, or determine whether the apes' signs exhibited multiple functions.

Another important consideration in evaluating this test is that we cannot determine from the given information whether Washoe's responses were rote associations to particular questions and/or objects which were learned through intensive and specific training. As was true of the vocabulary tests, her preparation for this test is not described in detail, and her actual responses are not appended. As a result, we cannot evaluate the degree of flexibility and heterogeneity seen in her replies. Given the Gardners' description of their procedures, Washoe could have "correctly" answered the questions in this test by simply emitting signs from her vocabulary in random order until she produced one from the target category. Similarly, she could answer a question by learning to associate a single target sign with a *wh*-sign; since meaning was irrelevant, she could use this sign in any context where the discriminative stimulus (*wh*-sign) occurred.

The Gardners' test exhibits an impoverished conception of language, since Washoe is to be credited with the ability to answer questions if she can learn to associate a narrow class of signs with each *wh*-sign. Thus the ability to

answer questions is reduced to a discrimination learning task. It is not surprising to find that this task can be accomplished by apes who have experienced intensive training.

In summary, then, meanings and grammatical functions are attributed to the apes' utterances without sufficient evidence. The tests of Washoe's vocabulary and question-answering ability are subject to non-linguistic interpretations. In addition, they are orthogonal to a critical question: can the apes use their signs to refer to objects which are not in the immediate environment, or actions which are not concurrent? The design of these tests is such that they could never provide evidence that the apes had learned to use signs in this manner. In fact, there has been no test, and thus there is no evidence, of the apes' ability to use signs which are displaced relative to their referents. In the absence of such evidence, their behavior cannot be equated with that of humans using language.¹²

It might be argued that in evaluating the ape research we have applied more rigorous methodological standards than those applied to child language research. Our claim, however, is that understanding the apes' behavior requires data of the sort which are routinely reported in the child language literature: a corpus of substantial scope and detail, systematic studies which relate the

¹²There is another source of information on Washoe's behavior, two widely seen films, the Public Broadcasting System-Nova film, and a classroom film entitled "Teaching sign language to the chimpanzee Washoe". Although these films cannot be considered scientific records, they do provide important information concerning Washoe's behavior, and they are perhaps the primary source of information for most persons familiar with this work. As such, they warrant serious attention.

We have recently undertaken a frame-by-frame analysis of both films. They were transcribed using a system developed by Petitto for the analysis of ASL in deaf children. The transcription includes information concerning both the signing and non-signing behavior of ape and teachers, and the contexts in which it occurred. The transcription is currently being subjected to several analyses, and a complete report is in preparation. We will mention some preliminary findings here.

The most striking fact emerging from these analyses is the degree to which Washoe's signing was dependent upon that of her teachers. Signing occurred almost exclusively as a reaction to a teacher's input, and was highly imitative. For example, the sequence *body in my drink* is cited as evidence for Washoe's ability to combine signs creatively. Washoe does not form these signs in a continuous sequence; rather, they are prompted by the teacher (see also Terrace, Petitto, Sanders, and Bever, in press).

Two facts about the form of Washoe's signs are revealed on film. First, it is clear that all of the signs which are seen were formed out of a small number of hand configurations and movements, many fewer than are used in ASL. Most of these signs are so similar in form as to be indistinguishable, and in both films, individual hand movements are assigned multiple interpretations. In these cases, the researchers appear to have glossed the movements on the basis of their own knowledge of the context. The second fact is that the small number of movements and gestures which are seen bear a striking resemblance to those of apes who have not been taught "sign language", lending further support to our earlier observation that natural gestures are glossed as signs. Washoe's movements are highly similar to those seen in films of Vicki, a non-signing chimp raised by Hayes & Hayes (1952). The possibility that the apes' natural system of communicative gestures is highly unamenable should be investigated further.

comprehension and production of utterances to the contexts in which they occur, and non-trivial experimental tests of aspects of the apes' signing abilities. The methodology of observational studies of both comprehension and production is described in thorough detail by Bloom & Lahey (1978), Huttenlocher (1975) and others. There is also a lively and extensive literature on experimental approaches to language acquisition research. Elegant, ingenious studies such as Clark (1973b), Huttenlocher et al. (1968), Chapman & Miller (1975), Glucksberg, Krauss, & Higgins (1975), Bates (1977), Shatz (1978) and others have demonstrated some possible strategies for experimental research; see also Bellugi-Klima (1971). Premack (1977) has considered the issue of comprehension tests for lower primates.

The ape researchers frequently demonstrate unfamiliarity with the basic methodology of language acquisition research. A particularly clear example is provided by a recent report by Fouts, Shapiro, & O'Neil (1978). Fouts et al. report a test of a signing ape's ability to produce the signs *in*, *on*, and *under* in appropriate contexts. The subject, Ali, is a chimp who is reported to comprehend 130 signs and "at least as many" words in spoken English. There is an excellent study on the acquisition of *in*, *on* and *under* in children (Clark, 1973b). One of Clark's major points is that children in the early stages of acquisition use non-linguistic responding strategies in following instructions containing these words (i.e., instructions of the form, "Put the X _____ the Y", where X is an object, Y is a target location and the blank is filled by *in*, *on* or *under*). In Clark's experiments, successful performance depended critically upon the nature of the objects used in the test. If Y was a container, children followed most requests by placing a toy animal in it. If Y was a flat surface, they typically placed the object in it. In the former case, children appeared to "comprehend" *in* but not *on* or *under*; in the latter, they "comprehended" *on* but not *in* or *under*. Hence, properties of the testing situation and non-linguistic responding strategies controlled subjects' performance. Failing to explore these would yield misleading conclusions concerning their comprehension abilities.

Fouts et al. (1978) offer no acknowledgement that their test controlled for the use of similar strategies. In fact, it appears from their description that the subject could use a very simple non-linguistic strategy to perform at the reported levels. After an unspecified training period, Ali was tested on 80 trials in which he was requested to name the relationship between a pair of objects. The critical feature of their design is that no sign was ever the correct response on two successive trials. That is, an *in* trial was always followed by an *on* or *under* trial, etc. The ape could perform reasonably well on this task by learning the rule, "respond with one of the two signs which were not used on the previous trial." If the ape randomly selected between the two remain-

ing alternatives, we would expect performance to be somewhere around 50% accuracy. Ali's reported accuracy is 49.1%.

It is seen, then, that there are considerable methodological problems associated with testing a child or chimp's production and comprehension of the words *in*, *on*, and *under*. These are typical of the problems involved in language acquisition research. In common with the other ape researchers, Fouts et al. (1978) show no awareness of the fact that these problems have been explored in the child language literature.¹³

A major conclusion to be drawn from studies such as Clark's (1973b) is that children are able to produce and respond to utterances before they have acquired knowledge of their meanings and grammatical structures, by exploiting non-linguistic contextual information and other knowledge (see also Chapman, 1977). The ape sign language researchers have failed to explore—or even acknowledge—the possibility that the apes used such non-linguistic strategies. What is required in the ape signing literature, then, is evidence that the apes' production is not merely imitative, that they can produce or comprehend signs in non-stereotypic situations, that sign production or comprehension is not exclusively a function of cuing by non-linguistic aspects of the environment, or the teacher's behavior, or the structure of a particular test, and that their behavior is not merely the routinized, inflexible, over-learned product of intensive and specific training.

Obtaining the relevant sorts of evidence is a difficult task, whether the subject is an ape or child. Unfortunately, there is no simple test which would establish that the apes' utterances have meaning. A case can only be built by drawing together evidence from multiple sources. If the ape is able to name objects consistently across a variety of settings and exemplars, if it is able to identify a particular property in unfamiliar objects, if it is able to identify multiple properties in a single object, if it is able to comprehend or produce signs without prompting or immediate feedback following errors, if it produces signs spontaneously without tangible reward, if it can identify relations among objects—if it can use language in some of these ways and others, then one may begin to have some confidence that linguistic attributions are appropriate.

What is required, then, is a systematic documentation and characterization of the apes' use of signs. Merely establishing through casual observation that they are able to produce behaviors whose forms superficially resemble those

¹³Comprehension tests of the signs *in*, *on* and *under* would present other problems because the mere form of the signs could cue correct answers.

of signs in ASL is inadequate, at least as a basis for interesting claims about linguistic competence.¹⁴

5. Other comparisons to ASL

The frequent invocation of ASL in discussions of ape signing (e.g., Gardner & Gardner, 1971, 1974a; Patterson, 1978; Fouts, 1977) makes it clear that these researchers believe that the apes are learning a communicative system that shares significant features with ASL. However, evidence concerning the structures and/or expressive devices common to the apes' behavior and to signing in ASL is superficial at best. The discussions of ASL in these reports are very shallow; for example, in a recent paper by Fouts (1977), there is no mention of ASL beyond the title, "Ameslan in Pan [Troglodytes]." That the apes use ASL is merely assumed, rather than adduced from behavioral data.

It is highly questionable whether Washoe or Koko were taught ASL at all. American Sign Language is radically different from English; its grammar does not resemble English, and although some signs can be glossed as English words, its lexical structure is different as well. It is possible to sign English, that is, to use signs (embellished with fingerspelling) in English syntax; this is, in fact, termed "Signed English", "Straight English" or "Siglish" depending on exactly how much of spoken English is rendered. It appears that none of the apes were presented with ASL as a model. Rather, the apes were taught individual vocabulary signs, some taken directly from ASL, some reduced from ASL signs, and some invented for the ape; these were signed largely in English word order. Since neither the apes nor their teachers used the appropriate grammatical structure or expressive devices, their signing was not ASL; since they did not use grammatical morphemes (e.g., -ing, -ed, -ly) or function words (e.g., a, the, are) they were not following Signed English. The language model in each project was a pidgin sign. In light of these facts, it is misleading to term their behavior signing in ASL.

The fact that many of the apes' signs were non-ASL forms is acknowledged but not emphasized in the existing reports. In the Washoe films, this distinction is not observed at all. In the PBS-"Nova" program called "The first signs of Washoe", it is asserted many times that Washoe was taught ASL. A signing, hearing person is seen forming and explaining Washoe's signs prior to films of Washoe forming the same signs. Although the narration repeatedly describes Washoe's signs as ASL, some of the demonstrated signs are *not* ASL; rather, they are idealizations of signs unique to Washoe. This fact alone does not imply that Washoe had not "acquired language". However, it does show a remarkable lack of accuracy.

Note also that the ape researchers describe their subjects' behaviors exclusively in terms of hand configurations; the structure of signing in ASL is much more complex (Stokoe et al., 1965; Klima & Bellugi, 1979). We have noted some of the dimensions of signing already. Signs are defined along three parameters in addition to hand configuration; a change within any one of them signals a change in meaning. Signing in ASL is not merely a matter of producing the citation forms of signs in a particular order, however; an extensive system of modulations and inflections on signs is used at the same time. This system is used to signal syntactic information, tensing, subtle variations in meaning, and other aspects of the message. This is effected through the systematic use of movement and visual information provided by facial expressions, eye gaze, head and body orientation, the structured use of the signing space, and other means. A sign in ASL, then, is defined not by a unique hand configuration, but along several dimensions simultaneously. We take the fact that the apes show no ability to use these expressive devices as immediate refutation of the claim that they are using ASL. Their failure to learn to use them, despite years of intensive training, purportedly in ASL, contrasts strongly with the fact that deaf children rapidly learn to use them in the course of natural, non-intrusive interactions.

Many of these expressive devices are seen in nascent or primitive form in the early utterances of deaf children. For example, deaf children progressively learn to establish loci. At early stages, they will sign on or toward an actual object or location, moving around a room if necessary, rather than placing it at a metaphoric location in the proximal signing space. Over time, they learn to stay within the signing space and establish loci through pointing, eye gaze, and body shifts.

Another primary communicative device in ASL is the use of eye gaze and facial expressions in conjunction with signs. It is interesting that while lower primates use facial expressions and eye gaze as part of their natural communicative system, they do not use them to modulate the meanings of the hand shapes they learn, in contrast to the child learning ASL. It is an inter-

¹⁴It is interesting in this light to note Lashley's (1913) observation, cited by Mowrer in a discussion of "talking birds" (Mowrer, 1950):

The older literature of animal psychology abounds with anecdotes designed to display the intelligence of the parrots, but there has been no experimental study of the birds and nothing is known of the manner in which they learn to speak, whether by direct imitation, by the gradual imitative modification of instinctive notes, or by chance combinations of instinctive notes which, meeting the approval of the trainer, are rewarded and so 'set' in memory. (Lashley, 1913, p. 362)

esting empirical question whether apes can learn to use this information within a conventionalized, non-natural system.

A third example is provided by the deaf child's use of the signing space in denoting time reference. This is accomplished through use of the time line, an imaginary vertical plane which passes through the signer's body just behind his ears. A forward thrust of the signer's hand(s), relative to this plane, at ear level denotes reference to the future. A backward thrust at the same level indicates reference to the past. The present is represented in front of the signer's body, centered around the chest-stomach area. It would be important, of course, to determine whether lower primates can make reference to past or future activities, or learn to use this system; at present there is no evidence that they can, again distinguishing them from deaf children and adults using ASL.

These examples are only illustrative. They serve to indicate some fundamental ways in which chimpanzee signing differs from signing in ASL. In their failure to even mention the basic structures and devices which characterize the language, the existing comparisons of ASL and ape signing behavior are exceedingly shallow.

These examples fail to convey the dramatic differences between the signing of deaf children and the apes' behavior. These differences cannot be over-estimated. Deaf children use their language as do hearing children—in spontaneous, inventive, inquisitive conversation. The apes' behavior is of a wholly different nature—it must be coerced, extracted, manipulated. The apes do not sign spontaneously, but rather because it is demanded of them; this is clearly seen in the Washoe films, and would be revealed, we believe, by analyses of extended discourse between an ape and its teacher. Signing must be imposed on these animals and maintained through intensive, intrusive intervention. Whatever the scope of their cognitive and communicative abilities, it cannot be claimed that their behavior resembled that of children.

6. Conclusions

We have demonstrated that the conclusion that signing apes show linguistic abilities is vitiated by the absence of appropriate data and analyses. The omission of information which is routinely included in psycholinguistic studies of child language obscures the essentially non-linguistic character of the apes' behavior; the fragmentary data which are provided are consistently over-interpreted. Thus the widespread claims on the apes' behalf are at best premature.

What have the apes learned? They appear to have learned about the communicative context. They knew, for example, that signing was highly valued by their teachers. They signed because the mere act of signing had positive consequences, regardless of its content. They learned to solve particular problems, such as finding the sign or signs which the experimenters were seeking in a particular context. They learned responding strategies of varying degrees of complexity. A simple strategy might be: "Sign until the experimenter terminates the trial." A more complex strategy might be: "In an eating situation, sign any from the class of signs including *eat, drink, more, banana, give, please, sweet, finish*." These may be interesting behaviors to study, but they relate only tangentially to language.

We conclude with three observations. First, we await longitudinal studies of the apes' signing. There are as yet no indications that they can retain large sign vocabularies beyond puberty. The claim that they possess the capacity to learn languages rests on demonstrations that their signing does not disappear when their intensive training is relaxed, and that they can in fact internalize rules of the sort which underlie human language capacities.

Second, the source of many of the problems in the existing literature may be traced to the Gardners' statement that their analyses "do not depend on any special theory of linguistics or psycholinguistics" (1975, p. 256). Their analyses depend upon a special theory that is created de facto by their acceptance of a simplistic set of assumptions about language structure and language learning. The Gardners simply fail to acknowledge their theory. Their antipathy to current linguistics (e.g., 1974b) has led them to embrace a theory of learning. It is possible that Washoe could have accomplished more if her trainers had possessed a richer conception of language and communication.

Finally, it should be clear that there are genuinely interesting aspects of the apes' cognitive and communicative capacities that have not been explored as yet. It is apparent from the sign language projects that the apes are extremely intelligent. Studying their natural abilities may ultimately be more revealing about the behaviors of both apes and humans than attempts to impose restricted forms of languages upon them.

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