Communication, Symbolic Communication, and Language: Reply to Seidenberg and Petitto

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Seidenberg and Petitto's (1987) assertion that Kanzi and Mulika's lexigram usage is not representational is evaluated by contrasting their abilities with Nim's. Kanzi and Mulika's data indicate that they (a) comprehend spoken English words; (b) can identify lexigram symbols when they hear these words; (c) can comprehend lexigram usage; (d) can use lexigrams when referents are absent and can, if asked, lead someone to the referent; and (e) that all these skills were acquired through observation, not conditioning. Nim evidenced no comprehension of signs and could not use signs when referents were absent. He was forced to sign and encouraged to imitate his teachers. Seidenberg and Petitto's negative experiences with Nim apparently led them to overgeneralize to all other apes, regardless of species, modality, or training history. Consequently, they unjustifiably disregard important components of Kanzi and Mulika's comprehension data which demonstrate that their lexical knowledge could not have been acquired in an instrumental fashion.

The main thrust of Seidenberg and Petitto's (1987) critique focuses on the nature of Kanzi and Mulika's symbol usage. We view Kanzi and Mulika's symbol usage as representational, whereas they, as a result of their personal association with Nim, conclude that Kanzi's and Mulika's symbol usage must be simply instrumental. Is this difference in perspective an important one to resolve? Can it be clearly resolved on the basis of available data? The answer to both questions is yes.

The goal of the Language Research Center has been to develop programs which go beyond the limitations of instrumentally conditioned response patterns, to communications that are representational (Savage-Rumbaugh, 1986). The issue of representational symbol usage has been the focus of our research program across the past 10 years. While there is not space here to review that work in detail, it would seem appropriate to cover some of the major findings.

Our initial work with common chimpanzees (*Pan troglodytes*) led us to conclude that symbolic skills were acquired by chimpanzees only after considerable training (Savage-Rumbaugh, 1979; Savage-Rumbaugh & Rumbaugh, 1979; Savage-Rumbaugh, Rumbaugh, & Boysen, 1980). We found, in agreement with Seidenberg and Petitto, that common chimpanzees tended to acquire symbols in a very instrumental manner. They learned symbols only when they could not otherwise obtain a desired object or event (Savage-Rumbaugh, 1986).

One critical language skill that our common chimpanzees

lacked was an ability to comprehend and respond reliably to the use of symbols by others. Although research reports stated that Washoe and Nim understood many more signs than they produced, data were not presented to support these assertions (Gardner & Gardner, 1971; Terrace, 1979). The lack of receptive capacity became evident to us as we attempted to establish symbolic communication between Sherman and Austin (Savage-Rumbaugh, 1979, 1984). These attempts revealed that although Sherman and Austin were competent "senders" of symbolic messages, they were incompetent "listeners" or "receivers."

We analyzed a videotape of Nim's signing and found his lack of receptive skills to be self-evident (Savage-Rumbaugh & Sevcik, 1984.) It appeared that Nim could sign "apple" and "banana" when he first saw these fruits. Yet later, when he was shown the same banana and asked "What's this?" he was unable to decode the signed question. He answered "name," apparently recalling that when Petitto had held up the banana previously she had signed "Name you name." Nim also evidenced an inability to receptively decode the signs "apple" and "banana" when Pettito asked him to place a slice of banana with other slices of banana and a slice of apple with other slices of apple. His behavior clearly revealed that he had no idea what was being requested of him.

A number of published studies (Fouts, Fouts, & Schoenfeld, 1984; Gardner & Gardner, 1978) have asserted that chimpanzees spontaneously sign to one another. Indeed, photographs and videotape of chimpanzees signing in one another's presence have been offered as evidence of this. What is lacking in each of these instances is an appropriate response on the part of the receiver that is clearly elicited by the sign and not by the context or nonverbal expressions of the animal.

We found it necessary to teach Sherman and Austin comprehension skills. However, once these skills were in place they could easily comply with simple comprehension tasks such as

selecting a banana from a group of foods, or sorting bananas with bananas, apples with apples, and so on. Not only could they carry out simple commands with the referent present, they could recall commands given while the referent was absent, travel to another room, locate the proper referent, and carry out the command (Savage-Rumbaugh, Rumbaugh, & Boysen, 1978a, 1978b). Statements about future actions also began to appear (Savage-Rumbaugh, Pate, Lawson, Smith, & Rosenbaum, 1983). This ability apparently never emerged in Nim or Washoe (or at least no data have been presented which demonstrates that it did).

Sherman and Austin revealed that their lexigram usage finally reached the representational level of functioning by showing that they could group, not just objects, but also lexigrams into proper superordinate categories even when the referents were absent (Savage-Rumbaugh, Rumbaugh, Smith, & Lawson, 1980). That is, they could sort lexigrams such as *lever* and *apple* into categories of *food* or *tool* even when no apple, lever, or other foods or tools were present. They were able to categorize many such lexigrams correctly on the first trial of a blind test (Savage-Rumbaugh, 1981). Crucial to this development of symbolic representation was the presence of both productive and receptive skills and the emergence of statement capacities.

Petitto and Seidenberg apparently did not recognize the importance of comprehension for the acquisition of language. Consequently, they concluded that Nim's symbol usage was completely instrumental (Petitto & Seidenberg, 1979). However, they generalized incorrectly from Nim to Sherman, Austin, Kanzi, and Mulika. Sherman's and Austin's training continued from where Nim's left off. They went on to comprehend symbolic messages, to make statements about intended actions, and finally to representational symbol usage (Savage-Rumbaugh, 1986).

But what of Kanzi and Mulika? Because they were not trained as were Sherman and Austin, what evidence exists to show that their symbol usage is representational? Again, the key issue that Seidenberg and Petitto overlook is that of comprehension. Unlike all other chimpanzees, Kanzi and Mulika's symbol comprehension *preceded and guided* their symbol production. Their symbol acquisition followed the pattern of (a) comprehension of the spoken word, (b) comprehension of the lexigram symbol, and (c) productive use of the lexigram symbol.

Because receptive acquisition of the spoken word occurred spontaneously, it cannot be even partially explained by an instrumental account. Kanzi and Mulika learned to comprehend spoken English words without any direct consequences. Comprehension of spoken words was not mediated by, nor linked to, any desired outcome such as food or travel. For example, the first spoken word that Kanzi clearly comprehended was "light." Comprehension was initially evidenced by his running to the light switch whenever we said anything about turning the lights off or on. Before he understood the word, he would go over to the light switch only when he observed us approach it. He was always allowed to watch this process whenever he wanted and we generally turned the lights off and on several times until he lost interest.

Later, as Kanzi began to display comprehension of other words, his response to the word "light" broadened to permit comprehension of requests such as "Kanzi, can you show me the light?", "Can you bring me the light (also used for a flashlight)?", and "Can you turn the light on?" Again, responses to such requests provided no special consequences and did not permit Kanzi to obtain desired outcomes that he would not otherwise have received.

The ability to carry out such requests was often one of the clearest indications that Kanzi or Mulika understood a spoken word; however, there were also other contexts in which this ability appeared. Often they simply changed their behavior when they heard a particular topic being mentioned. For example, "strawberry" (like most other words) seemed to be acquired first as a response to the spoken English word "strawberry." Wild strawberries grow in patches around the lab. Kanzi noticed this and began to consume them. As Kanzi started to comprehend the word "strawberries," he began to rush over and search avidly for strawberries when anyone commented, "Kanzi, I see some strawberries over here." A bit later, one could simply mention something about going to look for strawberries, and Kanzi would change his direction of travel and head directly for a strawberry patch.

It was after Kanzi evidenced comprehension of the spoken English word that the strawberry lexigram was added to his keyboard. The acquisition of the lexigram *strawberry,* as described in Savage-Rumbaugh, McDonald, Sevcik, Hopkins, and Rubert (1986), took place when comprehension of the spoken word was already established. Thus, Kanzi recognized something about the spoken word "strawberry" that was common to many situations long before he ever used the lexigram symbol with any positive result. At this time Kanzi also comprehended English words for many other edible things that grew out-of-doors (i.e., mushrooms, blackberries, privet berries, leaves, wild muscadines, etc.), and could find these foods if they were mentioned, even when he had no interest in obtaining a particular food for himself.

He demonstrated this capacity in the blind test reported on page 227 of Savage-Rumbaugh et al. (1986). Kanzi showed no interest in requesting to travel to two of the food sites during this test. Consequently, the experimenter asked Kanzi to lead her to these two locations and he did so correctly. It took 10–15 min to travel to these places in the forest, and Kanzi had to select the right path at many points. Upon arrival, however, Kanzi showed no interest in eating any of the food located at the sites and received no reward.

Seidenberg and Petitto (1987) seek to differentiate between Kanzi's performance on vocabulary tests and his communicative use of lexigrams in naturalistic exchanges. What they seemingly fail to understand is that Kanzi and Mulika's ability to perform as they do on these tests is a direct function of knowledge acquired during naturalistic exchanges. They were not taught to pair certain words with certain lexigrams for these tests.

If Kanzi and Mulika did not comprehend a lexigram that was used during naturalistic exchanges, they were *not* able to pass formal tests of comprehension for that lexigram because there was no formal training on lexigrams in either setting. There are many lexigrams that they do not know. They do not understand these lexigrams when we use them (though they often understand the spoken English word), they fail when tested on these lexigrams, and typically, they do not use these lexigrams them-

selves. If they do attempt to use them, their usage is often inappropriate.

They are able to pass formal tests on a given lexigram *only* when they also show evidence of comprehending that same lexigram in naturalistic exchanges. Comprehension often appears long before they actually use the lexigrams themselves.

The data in Tables 1, 2, 5, and 6 of Savage-Rumbaugh et al. (1986) support this contention. It can be seen that Kanzi and Mulika comprehended many lexigrams during formal tests that were not listed as vocabulary items. Kanzi passed comprehension tests on 64 lexigrams when his vocabulary consisted of only 44 items. The difference for Mulika was even greater. She passed comprehension tests on 42 items when her vocabulary consisted of only 6 items. In addition, Mulika was *able to identify, in all three test conditions, lexigrams that she had never used.* Because she had no training on the test items before the test and because she had not used these lexigrams in naturalistic exchanges, her knowledge of these items had to be based upon information gained as she observed others use the lexigrams. Clearly, the data do not support Seidenberg and Petitto's position that Kanzi and Mulika learned lexigrams solely to mediate desired outcomes.

Seidenberg and Petitto's view that Kanzi's symbol usage is strictly instrumental led them to make the prediction that if the outcome of Kanzi's utterances were altered, his symbol usage would alter concurrently. In fact, many natural occurrences do modify the conditions in which Kanzi finds himself and he must modify his communications accordingly. As Seidenberg and Petitto suggest, such events should provide insight into the nature of Kanzi's symbol usage.

Recently, we had the opportunity to observe such an occurrence. As was reported, Kanzi can ask to visit his mother at any time and he usually does so by using the lexigram for *Matata* and gesturing toward the colony room where she is housed. He had originally learned to ask to go to this area by using the lexigram *colony room*. Across time, a number of different animals have been housed in the colony room, including Matata, Sherman, Austin, and two orangutans. Thus, Kanzi has used the symbols *Matata, Sherman, Austin, orangs,* and *colony room* as a means of requesting a visit to this area. Once he is in the colony room he can visit whomever he wishes by running over to their enclosure. Most often, he requests to go to the colony room by saying "Matata." Seidenberg and Petitto would argue that Kanzi does not know that the "Matata" lexigram represents his mother, but rather that he anticipates the consequence of getting to go to the area where Matata can be found, as a consequence of touching the "Matata" lexigram. They would also assert that even though he has more than one means of asking to go to this area, there is no reason to believe that his *Sherman* lexigram represents Sherman, his *Austin* lexigram represents Austin, and so on.

To the contrary, when Sherman and Austin were moved to a new building, Kanzi immediately ceased using either of their lexigrams as a means of asking to visit the colony room area. If he requested "Austin" he always led appropriately to the new building where Austin and Sherman were housed. If Kanzi's request was denied because it was too cold to go outdoors, he would often modify it by using the lexigrams *Austin TV* and gesturing toward the television set. Thus, he used Austin's lexi-

gram to ask to see a representation of Austin on TV, clearly revealing that he had not confused the lexigram with the place. On many occasions he has also commented "Austin" upon seeing Austin appear on the television. In these instances the experimenter agrees that it is Austin on the TV, but nothing further happens as a result of Kanzi's usage of the symbol. More important, Kanzi shows no behavior, such as pointing to the door or asking to go outside, which would suggest that he is using the *Austin* lexigram to ask to go to the place were Austin would be found.

Similarly, when Matata was transferred to the Yerkes Field Station for breeding purposes, Kanzi immediately ceased using *Matata* as a way of asking to go to the colony room. He began to use the *colony room* lexigram again. However, on the first day of her return, he again asked to go to the colony room area by saying "Matata!" On ensuing days, he began to produce combinations such as "Matata grouproom" and "Matata grab here(g)" (grab is a game chimpanzees play) to indicate that he would prefer to have Matata come to where he was, rather than to visit her. Such combinations were never modeled for him and could only have reflected his own motivations. He could not have formed these combinations if the *Matata* lexigram was associated only with the consequences of being allowed to go to the colony room area and not with Matata herself.

Seidenberg and Petitto suggest that Kanzi's use of lexigrams shows no differentiation between object and event, as in his use of *juice* both to ask to go to the location and for the liquid. It should be noted that Kanzi shows this sort of general usage only for locations where the only salient activity is that of finding food. He does not do this when referring to locations where a variety of activities occur.

Kanzi's broad use of lexigram terms for food sites in the field is much like someone living on a farm who says "go to the apple tree," or "meet me at the grape vine." Other location lexigrams, such as *grouproom, trailer, childside,* and *Sue's office,* are differentiated from the food which might be placed there. These locations are salient for reasons other than food alone. When Kanzi does want to travel to these locations for food, he will frequently make combinations such as "trailer peanut" to indicate that he wants to go to the trailer to get peanuts (Greenfield & Savage-Rumbaugh, 1986).

Seidenberg and Petitto also raise the objection that much of Kanzi's symbol usage centers around the topic of food. To support this contention, they tallied the number of food-related utterances in the Appendix. They failed to note that, as stated in Savage-Rumbaugh et al. (1986), many of the utterances had to be deleted due to space limitations. Those that remained were not presented as a random sample, rather, they were purposefully selected to show how Kanzi used such utterances to control his movements about the forest. In fact, food is not his most frequent topic of conversation. A more appropriate data base for Seidenberg and Petitto to have referenced would have been Table 3 of Savage-Rumbaugh et al. (1986). Here Kanzi's most frequent two and three word utterances were listed in the order of their frequency of occurrence. Of the 25 most frequent two and three word utterances, *none* was related to the topic of food; *all* were related to social games. The majority of Nim's utterances were related to food however, and Seidenberg and Petitto seem to have incorrectly overgeneralized from their ex-

Table 1
Communicative Function

Modality	Emotion	Agree	Answer	Request	Comment	Total
Lexical		4	2	25	1	32
Gestural			3	20		23
Vocal	41	26	30	68	158	323
Lexical/gestural				6		6
Lexical/vocal		1	3	9	3	16
Gestural/vocal		1	6	13		20
Total	41	32	44	141	162	420

Note. The category of "emotional" vocalizations includes expressions of happiness, solicitations of affection and attention, and whimpering.

perience with Nim. The fact that Kanzi's most frequent utterances are not about food is particularly striking in light of the fact that his environment is designed to foster travelling to food sites as the major activity of each day.

A final point that Seidenberg and Petitto make is that most of Kanzi and Mulika's utterances are requests; furthermore, they suggest that those utterances which we classify as statements are dubious. In order for a usage to be coded as a statement or a comment Kanzi must either make it clear that he is not asking for the object or event (by refusing it if offered), or he must carry out the action on his own. These judgments are straightforward and depend upon overt behavior on Kanzi's part in all cases. For example, in the following observation (taken from the data base) Kanzi is not making a request and this is self-evident from his behavior.

> Kanzi is sitting and eating near the keyboard. He stops eating and touches the Matata lexigram, then vocalizes to Matata who is in the next room. She answers back. Kanzi makes no gesture to suggest that he is requesting a visit to Matata. To make certain, the experimenter queries "? go Matata." Kanzi ignores the question, touches the lexigram *food* and resumes eating.

We agree with Seidenberg and Petitto that most of Kanzi's lexigram usage is request based and that this is not true of normal children. However, we believe that this is a function of the output modality rather than a sign of cognitive incompetence. To use the keyboard, Kanzi must stop what he is doing, move across space to the keyboard, and touch a symbol.

This requirement prohibits the kind of commenting typically seen in children who generally comment on an action or an object while engaged in active behavior, such as saying "down" while falling down (Greenfield & Smith, 1976). However, Kanzi does produce frequent vocal comments. Although it is not yet appropriate to translate these vocalizations into "words," their communicative function, in context, is quite clear and often similar to what would be termed "commenting" in a human child.

For the purposes of presenting a more complete picture of how Kanzi uses the three communicative modalities available to him, 2 hr of videotape were reviewed and all of Kanzi's communicative episodes were recorded. A "communicative episode" was defined as any vocal, gestural, or lexical attempt on Kanzi's part to communicate with another party. The results of that analysis, which are shown in Table 1, revealed that of the 420 episodes in which Kanzi responded communicatively dur-

ing this 2-hr period, 48 were lexical (or lexical plus vocal) and 359 were vocal (or lexical plus vocal or gestural plus vocal). Kanzi's overriding perference for communication is the vocal modality. Additionally, where the function of a given communicative episode is to comment on ongoing events, Kanzi's is almost exclusively vocal. Similarly, when the communicative function is that of answering, disagreeing, or expressing emotion, Kanzi relies most heavily on the vocal modality. A few examples should help make this clear.

1. Kanzi is working on a video game task using a joystick to control the movement of a cursor on a screen. When he successfully completes this, the experimenter says "You did a good job." Kanzi looks at the experimenter and *comments,* "uhh um umm."

2. The experimenter is starting to pour some kool-aid in a bowl for Kanzi when he walks away, bowl in hand. She says, "I was going to put some kool-aid in your bowl, do you want some?" Kanzi *answers,* "unnn" then stops and waits while looking at the bowl.

3. Kanzi is looking out the door when he sees Rose returning after she had left to get him a surprise. He sees Rose coming before anyone else does and *comments,* "uh ooah" as he goes to the door, looking at Rose. Others look out the door in response to see what Kanzi was commenting about.

4. When Rose enters he *requests* the surprise by gesturing toward her pocket while vocalizing, "engggh."

5. Kanzi sits down to try the video game again and *comments* as he watches his cursor get closer to the target, "ooah ah engh ungh."

6. While Kanzi is vocalizing to Matata, the experimenter comments that several days ago Matata bit Kanzi. Kanzi looks back toward the experimenter and responds with the *comment,* "un huh."

The data shown in Table 1 suggest that Kanzi prefers the vocal modality and is attempting to use it in a broader manner than the lexical modality. The use of the vocal channel to communicate such messages is all but absent in *Pan troglodytes* (Savage-Rumbaugh, Romski, Hopkins, & Sevcik, in press). This absence accounts, in part, for Seidenberg and Petitto's (1987) conclusion that the only form of communication which Nim (a *Pan troglodytes*) demonstrated was the "request." Kanzi, on the other hand, as a member of a different species, appears to be able to utilize a wider array of communicative functions in the vocal modality. Unfortunately, he lacks the ability to produce the many consonants needed to render such sounds readily discriminable to the normal human ear.

Kanzi's tendency to engage in a broader array of communicative functions using the vocal modality indicates that the request–statement dichotomy that Seidenberg and Petitto offer to contrast child and chimpanzee is better evaluated in terms of a difference in output modality. Certainly if children had to walk across the room and then search among several hundred printed words each time they wanted to make a comment, their comments would become considerably less frequent.

In conclusion, the data do not support Seidenberg and Petitto's (1987) perspective. Rather, they demonstrate that Kanzi and Mulika's symbol usage is clearly representational and that an account based on instrumental conditioning principles cannot explain either their symbol acquisition or their use. The

data also reveal that Kanzi and Mulika's symbol usage shares many properties of word usage with that seen in young children, that the most frequent topic is social play rather than food, and that the differences regarding the relative proportion of statements and requests are, at least in part, a function of output modality rather than the linguistic incompetence of Kanzi or Mulika.

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