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M.D. Bodamer
D.H. and R.S. Fouts

M.L.A. Jensvold

*Chimpanzee and Human
Communication Institute,
Central Washington University,
Ellensburg WA 98926 USA*

Functional Analysis of Chimpanzee (Pan troglodytes) Private Signing

The chimpanzee's use of American Sign Language (ASL) to communicate with humans and with each other has been empirically demonstrated in several reports, but this is the first research to experimentally examine their use of sign language in a nonsocial fashion: private signing. This experiment examined the private signing behavior of five signing chimpanzees, using a remote videotaping technique with no human present. It was found that all five chimpanzees signed to themselves for a total of 368 instances. These instances of private signing were classified into nine different functional categories as has been done in the analysis of private speech and signing in hearing and deaf human children. Similar to humans, a few of the categories accounted for the majority of the instances of private signing. These findings empirically demonstrate a behavior similar to private speech and signing in humans.

Key words: Private signing, Chimpanzees, American Sign Language, Primate Behavior

Human speech is either directed to an audience or it is not. When it is not directed to an audience it is referred to as private speech (Zivin, 1979). American Sign Language (ASL) can also be used in a private manner and when it is it can be referred to as "private signing". The purpose of this research was to examine the use of private signing in a group of five signing chimpanzees.

Piaget (1926) studied the early speech of children as a method of examining the cognitive development of children. As Zivin (1979) stated: "Speech was for Piaget a window to the mind" (p.16). Piaget referred to the early behaviors of the children who seemed to lack an awareness of the world beyond their own experiences as "egocentric" (Piaget, 1926). He called children's nonsocial verbal behaviour "egocentric speech". Like Piaget, Vygotsky (1962) also used the term egocentric speech. While Piaget emphasized the immature and egocentric quality of this type of verbal behavior, Vygotsky emphasized its use for self-regulation. Vygotsky considered egocentric speech to be thought spoken out loud by the child.

Flavell (1964), who coined the term "private speech" to refer to the speech-like cognitive functions of nonsocial speech, stated that it had a multiplicity of functions. Based on the idea of multiple functions Kohlberg, Yeager, and Hjertholm (1968) proposed a five level developmental hierarchy that incorporated both Piaget's and Vygotsky's examples of private speech. Berk and Garvin (1984) expanded the categories of Kohlberg et al. (1968) to include other types of private speech. Berk's (1986) research on private speech supported Vygotsky's approach because she found that the self-regulating function of private speech was the most common. However, she also found several instances of private speech which served functions other than self-regulation. She concluded that: "children's private speech seems to be multifaceted and diverse" (p. 49).

Furrow (1984) also looked at the multifunctional use of private speech. He developed the following twelve functional categories: Instrumental, Regulatory, Self-regulatory, Attentional, Interactional, Expressive, Referential, Describing Own Activity, Question, Imaginary, Informative, and Incomprehensible. Furrow's classification system was chosen as a model for the analysis

of private signing in chimpanzees because it was the most extensive list of operationally defined categories.

Private signing had been noted in a signing chimpanzee (Gardner & Gardner, 1974, pp. 20-21). The Gardners reported that "Washoe often signed to herself in play, particularly in places that afforded her privacy, i.e., when she was high in the tree or alone in her bedroom before going to sleep" (p. 20). Washoe would also sign to herself while looking at magazines and picture books.

The five chimpanzees in this study have extensive experience with ASL and they use these signs to converse with humans and with each other (Gardner & Gardner, 1969, 1971, 1974, 1978, 1984, 1989; Gardner, Gardner & Van Cantfort, 1989). They have also been observed to sign to themselves (Fouts, Hirsch & Fouts, 1982; Fouts & Schoenfeld, 1984; Bodamer, 1986). A remote videotaping procedure (Fouts, 1984) was used to record non-interactive behavior in this group of five signing chimpanzees. These tapes were then analyzed for instances of private signing. Instances of private signing were classified into functional categories based on Furrow's definitions. A systematic sampling technique was used to examine the range and function of private signing in signing chimpanzees.

Method

Subjects

The five chimpanzees in this study were housed in the primate laboratory at Central Washington University. At the start of this experiment, Washoe, a female, was 21 years old; Moja, a female, was 14 years old; Tatu, a female, was 10 1/2 years old; Dar, a male, was 10 years old; and Loulis, a male, was 6 1/2 years old. The four older chimpanzees acquired the signs of ASL when they were cross-fostered by humans in an enriched social environment where the humans used the signs of ASL to communicate with the chimpanzees (Gardner & Gardner 1971, 1978, 1984, 1989; Gardner, Gardner & Van Cantfort, 1989). Loulis acquired his signs from the other chimpanzees (Fouts, 1989; Fouts, Hirsch & Fouts 1982; Fouts, Fouts & Schoenfeld, 1984; Fouts, Fouts & Van Cantfort, 1987). Since 1981 the five chimpanzees have lived together in a social group and video recordings have shown that they sign to each other in chimpanzee to chimpanzee conversations (Fouts & Fouts, 1989). Table 1 provides further background information on these chimpanzees.

Procedure

A remote videotaping technique was employed from 11/6/86 to 1/21/88. This was designed to focus on non-interactive behavior to record instances of private signing. Videotaping took place in one of the enclosure areas (Enclosure 1) however the chimpanzees had free access to all four enclosures in the facility as well as the connecting tunnels.

Enclosure 1 was 2.13 x 3.35 x 2.18 meters and made of woven wire. Three stationary video cameras were used to observe the chimpanzees in this area. Each camera was positioned to cover approximately one third of the enclosure. There was some overlap of the areas covered by each of the cameras such that 75% of the total enclosure area was monitored. On 6/8/87, at the start of the second half of data collection, a fourth camera was added. It was placed on the opposite side of Enclosure 1, facing the three original cameras. This additional camera allowed visual and recording access to a previously occluded area directly beneath and in front of the three original cameras. This increased the area that could be monitored and recorded in Enclosure 1 to 90%.

All the cameras were connected to monitors located in a separate recording room. One video recorder was used and an observer watching the monitors used a videoswitcher to select from

TABLE 1 - Biographical Information for each Chimpanzee

	Washoe	Moja	Tatu	Dar	Loulis
Sex	female	female	female	male	male
Date of birth	9/65*	11/18/72	12/30/75	8/2/76	5/10/78
Cross-fostering/ASL immersion					
U. Oklahoma	8/70	12/79	----	----	3/24/79**
U. Nevada	6/21/66	11/19/72	1/2/76	8/6/76	
Central Washington	9/80	9/80	5/81	5/81	
Signs as of 2/89					
Reliable	184	171	142	123	12***
Observed	60	38	57	43	62
TOTAL	244	209	199	166	74

* Since Washoe was wild-collected this is an estimated date of birth.

** Loulis' ASL exposure was primarily from chimpanzees until 6/84.

*** Since the reliability criterion of the different observers for 15 consecutive days was impossible to institute under the cultural transmission study (Fouts, Fouts & Hirsch, 1982) and the later methodologies emphasizing observation and remote video recording, this measure is attenuated for Loulis.

which monitor to record. The observer was instructed to give preference to recording solitary behavior and any signing. For example, if the observer had to choose between a multi-chimpanzee interaction in which there was no signing and a chimpanzee involved in solitary play they were instructed to record the latter. The cameras were identical and since there was no signal to indicate when they were operating, the chimpanzees had no cues as to when their behavior was being recorded. This procedure allowed the experimenter to monitor and record the chimpanzees' behavior without any humans being present.

A total of 56 hours of black and white footage was collected. Twelve minutes of videotape were collected each day from Monday through Friday for a total of one hour each week. The 12 minute videotaping sessions were randomly sampled and counter balanced across the day from 9:00 a.m. through 4:00 p.m.

The cameras were placed outside of Enclosure 1 for a period of one to two hours each day and it was during this period that the 12 minutes of chimpanzee behavior was recorded. Recording began after the assigned starting time and only when a chimpanzee was present in the enclosure. This meant that during some sessions the experimenter had to wait to begin recording. If the chimpanzee(s) vacated the enclosure area after the start of recording, then the observer was instructed to wait 30 seconds. If a chimpanzee had not returned to the enclosure, then they were to stop video taping and wait until a chimpanzee re-entered. Observers followed this procedure until the daily total of 12 minutes of chimpanzee behavior had been recorded.

During videotaping, the normal daily routine was followed except that humans were prohibited from entering Enclosure 1 and the surrounding hallway. Humans were free to interact with the chimpanzees in the other enclosure areas as long as they were not within visual range of Enclosure 1 during recording.

analysis

In the analysis of the 56 hours of videotape, Furrow's (1984) definition of private speech was used to identify private signing. Furrow classified the instances of private speech into twelve mutually exclusive functional categories. All of Furrow's categories were used in this study except the "Incomprehensible" category. This category was not used because it was impossible to reliably discriminate between a nonverbal gesture and a sign that is incomprehensible. To avoid this problem, a sign criterion was used to discriminate between a nonverbal gesture and a sign. The observer who scored the videotapes had 20 years experience with signing chimpanzees and ASL.

Sign Identification

For a gesture to be classified as a sign it had to be used in the citation form or be a commonly modulated form of the sign in question. Each sign in ASL has a basic citation form which can be described according to its PCM. PCM refers to: the place on the body or space around the signer where the sign is made, "P"; the configuration of the hand, "C"; and the movement of the hand, "M" (Stokoe, Casterline & Croneberg, 1965). Each of the chimpanzees' signs has a citation form PCM (Gardner, Gardner & Nichols, 1989; Fouts, Fouts & Van Cantfort, 1989).

Identification of private signing

After a gesture was identified as a sign, Furrow's (1984) definition of private speech was used to determine whether the signed utterance was private or social. Furrow identified instances of social speech using two criteria. The first criterion was whether eye contact occurred any time from 2 seconds before until 2 seconds after an utterance. These chimpanzees also use eye contact during their social interactions when signing (Van Cantfort & Rimpau, 1982). The second criterion was whether any social indicators occurred between the child and the adult during the 2 seconds before or after an utterance. Furrow defined social indicators as any behaviors that involve another person; such as physical contact, approach, extension of arms, attraction of the other person's gaze, or if the utterance contained a vocative. If one of these behaviors was associated with an utterance, Furrow did not consider it private. Most of these behaviors are common components of chimpanzee social interactions (Goodall, 1986) and were easy to identify in our analysis. Because chimpanzee eye contact is difficult to determine on black and white videotape, a more stringent criterion than Furrow's was used in the present study. If the chimpanzees displayed any reciprocal face (head) orientation during the sign or the 2 seconds before or after the sign, then it was not classified as private signing. In addition if the chimpanzee was oriented toward an area occluded from the cameras while signing and if the location of all the other chimpanzees could not be determined during the two seconds preceding and following the utterance, then the sign was not counted as an instance of private signing.

Classification of private signing

Each instance of private signing was classified according to Furrow's (1984) definitions of functional categories. Furrow used the following guidelines to determine the functional category: (1) Intonation Contour, (2) Specific Utterance Content, (3) Relationship of Utterance to the Environment. Please see Table 2 and 3 for Furrow's classification guidelines and category definitions.

Furrow's first guideline, Intonation Contour, was adapted in this study for the visual modality of ASL. Most languages use devices such as inflection, markers, and word order to modulate meaning. In a vocal language, such as English, the simple declarative utterance, "time to eat", can

TABLE 2 - Definitions of Functional Categories

Functional Category	Definition	Examples
Instrumental	an utterance refers to the child's wants, and/or an utterance is whined	"I want it".
Regulatory	an utterance refers to an event that might be immediately carried out; another person is the specified agent, or there is no agent and the child does not perform the action him or herself	"Go there"
Self-regulatory	an utterance refers to an event that might be immediately carried out; the child is the stated agent or there is no agent and the child performs the action him or herself	"I put that there".
Attentional	an utterance refers to a sensory event that is ongoing or might be immediately carried out	"Look"
Interactional	utterance content is a conventional greeting	"Hi"
Expressive	utterance content is an evaluative opinion, an expression of an internal state, or a stock phrase that expresses feeling	"I love you"
Referential	an utterance refers to a present object or a present event that does not involve the child	"That"
Describing Own Activity	an utterance refers to an ongoing or just completed event in which the child was involved	"Putting it"
Question	utterance intonation contour resembles adult rising question intonation and/or an utterance is syntactically a question	"What that?"
Imaginary	an utterance is sung, is word play, or represents a transformation of real objects or events, whether present or not	"That hat (referring to wooden block on head)"
Informative	an utterance refers to a non present object or event.	"Daddy at work"

be made into an interrogative utterance by using a rising intonation on the word, "eat". Sign languages use analogous devices to modulate meaning (Klima & Bellugi, 1979) except they are adapted to the visual mode. Examples of modulators are: establishment of loci (signing outside the standard region in ASL); facial expression; repetition for emphasis; and sign order (Van Cantfort & Rimpau, 1982, pp. 35-42). Rather than using Intonation Contour, we used the gestural "Modulation Contour" to determine some of the functional categories.

The chimpanzees in this study have been observed to use a variety of modulators in their signing (Mendis, 1985; Van Cantfort & Rimpau, 1982; Rimpau, Gardner & Gardner, 1989). For example, the chimpanzees can change the utterance TIME EAT into a declarative, an imperative, or an interrogative utterance depending on the modulators used. Tatu makes a declarative utterance in ASL by signing, "TIME EAT", which is equivalent to the English, "It is time to eat". The

TABLE 3 - Classification Guidelines

Guideline	Functional Category
A. Modulation Contour Questioning Modulation Whining Modulation Singing Modulation	Question Instrumental Imaginative
D. Specific Utterance Content "I want" or demand Evaluative opinion or statement of feeling Question syntax Standard greeting Sensory verb	Instrumental Expressive Question Interactional Attentional
C. Utterance content and relationship environment	
Utterance involving:	
(Objects (and Locations not current or immediately involved)	
Present Absent Transformation (present or absent)	Referential Informative Imaginative
Events (action sequences and Locations if currently involved in)	
Temporal relatedness + Speaker the agent (?)	
Distant past	Informative
Just occurred (prior 2 sec)	yes... Describing Own Activity no... Referential
Ongoing	yes... Describing Own Activity no... Referential
Following 2 sec.	yes... Self-regulatory no... Regulatory
Capable of immediately occurring	yes... Self-regulatory no... Regulatory
Distant future	Informative
Unreal or fanciful	Imaginative

declarative is characterized by the citation form of the sign. Tatu was observed to turn this utterance into the imperative by using the modulator of repetition as in, "TIME TIME EAT EAT EAT" which is equivalent to saying, "It is time to eat, now!" in English. Speed of signing can also be used to express the imperative. Tatu was observed to use the interrogative, "TIME EAT?" by modulating her signs with raised eyebrows, prolonged eye gaze, and holding the last sign in the utterance in place for a long duration. These are common interrogative modulators in ASL (Baker-Shenk, 1985) and are equivalent to saying "Is it time to eat?" in English. The use of repetition, duration, and facial expression can give the same two signs quite different meanings.

Consideration of Modulation Contours plays a critical role in categorizing instances of private signing into the Instrumental, Question, and Imaginary functional categories. An English vocal example of Furrow's Instrumental category would be "I really want to be tickled", the words, "really want", are emphasized to convey a strong desire on the part of the speaker to be tickled. An analogous ASL example is WANT TICKLE WANT, in which the emphasis of the desire to be tickled is demonstrated by repetition of the sign WANT. This can also be modulated by changing the normal speed of the sign; such as signing abruptly or forcefully. It can also be modulated for emphasis by signing very slowly and deliberately.

As mentioned above, an utterance in ASL can be modulated to form the interrogative by using facial expressions, raising the eyebrows, and holding the sign in its final position. If any of these modulators were seen in the chimpanzees' utterances, then it would be classified as a Question. For example, signing FOOD, raising the eyebrows, and holding the sign while staring at a picture would be classified as an example of the Question functional category. The absence of modulation contours would result in this single sign utterance being classified into another functional category.

Modulators can also be used to express the song-like intonation that Furrow used to identify the Imaginative category. Flowing and elaborate gestures are some of the modulators used to express song-like quality (Klima & Bellugi, 1979). The chimpanzees in this study were observed to use some signs in this manner.

The second classification guideline, Specific Utterance Content, requires a consideration of the signs or sign order used in an utterance while the first classification guideline would require question modulators to be present to classify an utterance as a question, the second guideline requires the presence of a sign such as "what", "who", or other explicit signs used for questions. Likewise, while an utterance could be classified as Instrumental due to modulation contours such as repetition, this second guideline requires a specific sign such as "want" or "gimmie" to occur in the utterance. The classification of an utterance into the Expressive, Interactional, or Attentional category depends entirely on content of the utterance. For example, Expressive requires the chimpanzee to express an evaluative opinion or a statement of feeling. Signs used by these chimpanzees that meet this classification are HUG/LOVE, SMILE, CRY, and DIRTY. Interactional utterances are conventional greetings. Examples of these types of utterances used by the chimpanzees are PERSON/HEY and COME HUG. The Attentional category requires a sign that refers to a sensory modality such as LOOK or LISTEN.

Furrow's third guideline considered the relationship of an utterance to the environment. This guideline was used to classify utterances into the Referential, Informative, Imaginary, Self-regulatory, Regulatory and Describing Own Activity categories. It required the determination of whether the utterance involved (a) an object, (b) an event, or (c) a location.

If the utterance involved an object, then it could be classified as either Referential, Informative, or Imaginative. The utterance was classified as Referential if it referred to an object that was present and it was classified as Informative if the object was not present. Finally, the utterance was classified as Imaginative if it represented a transformation of either a present or absent object. For example, the utterance, HAT, was classified as Referential if a hat was present. The same utterance was classified as Informative if no hat was present. Finally, if the chimpanzee held or looked at a wooden block and signed HAT, this utterance was classified as Imaginative.

If the utterance involved an event, then two things were considered to determine the appropriate category: (a) the temporal relationship of the event to the utterance, and (b) whether the subject was active in the event. The utterance was classified as Self-regulatory if the utterance referred to an event that just about to occur or potentially could occur and the subject was the stated agent, and/or the subject immediately carried out the action. These types of utterances were classified as Regulatory when the subject was not the stated agent and did not carry out the action. If the utterance referred to a more distant future or past event, then it was classified as Informative. An utterance that described an event that was occurring or had just occurred and involved the subject as the agent was classified as Describing Own Activity. If the utterance did not involve the subject, it was classified as Referential. If the utterance described an unreal or fanciful event, then it was classified as Imaginative.

For example, the single sign utterance, CLEAN, could be classified in several ways depending on when it was made and whether the chimpanzee engaged in the activity. If a chimpanzee

igned CLEAN and then began scrubbing with a scrub brush, the utterance would be classified as Self-regulatory. If a chimpanzee signed CLEAN shortly before the usual scheduled time for laboratory personnel to clean the enclosures, then the utterance would be classified as Regulatory. The occurrence of this when cleaning time was not near and no cleaning was occurring would be classified as Informative. If the chimpanzee scrubbed with a scrub brush and signed CLEAN, then the utterance would be classified as Referential. If the chimpanzee scrubbed the floor with a wooden block and signed CLEAN, then the utterance would be classified as Imaginary because this was a transformed use of the block.

If the utterance involved a location, it was treated either as an utterance that involved an event or an utterance that concerned an object and classified according to the above. If the location utterance was, or immediately became, involved in the subject's behavior then it was treated as an event utterance otherwise it was treated as an utterance involving an object.

Inter-observer Reliability

Two measures of inter-observer reliability were used in this study. The first was a measure of the consistency in identifying instances of private signing. The second was a measure of the percentage agreement of the categorization of instances of private signing into the functional categories.

Results

Signs Observed in Private Signing

A total of 368 instances of private signing were observed during 56 hours of videotape. There were 59 different signs used and 91 different utterances.

Corpus of Utterances Across Functional Categories

The instances of private signing were categorized into nine of Furrow's (1984) 11 functional categories. Table 4 shows that the frequency within a given category ranged from 4 to 218 instances. Across the chimpanzees, instances of the Referential category occurred the most often, accounting for 59% of the instances of private signing. This prevalence of the Referential category was found with each of the three chimpanzees, Washoe, Moja, and Tatu, who accounted for 92% of the instances of private signing. The Informative category accounted for 12% of the instances of private signing and no other category had more than 8% of the total instances.

Table 4 lists the entire corpus of private signing and indicates which chimpanzee signed the particular utterance by listing his or her first initial in parenthesis. If the utterance was observed on more than one occasion, the corresponding numerical notation was placed after the chimpanzee's initial. Washoe used 23 different signs in 30 different utterances in her 84 instances of private signing. The sign, FLOWER, occurred in 33 (39%) of her instances of private signing. Moja used 23 different signs in 28 different utterances in 91 instances of private signing. The sign, PEEKABOO, occurred in 17 (19%) of Moja's instances of private signing. Tatu used 28 different signs in 42 different utterances in her 163 instances of private signing. The indicative sign, THAT, occurred in 80 (49%) of her total instances of private signing. Dar used 8 different utterances in 8 different instances of private signing. Loulis used 13 different signs in his 14 different utterances in 21 instances of private signing.

Differences Across Months, between and Within Chimpanzees

The chimpanzees produced instances of private signing in each of the 15 months of this

TABLE 4 - Corpus of utterances across functional categories

CATEGORY	TOTAL	PERCENT	UTTERANCE/CHIMP/FREQUENCY
INSTRUMENTAL	31	8%	APPLE (T) (D) BANANA (T2)(D) BOOK (M2) CHASE (D) CRY (M) DRINK (L) FLOWER (W7) FOOD (M2)(L) GROOM (T2) (D) GUM (W) MORE (T) NUT (T) ORANGE (T) OUT (W) SANDWICH (M) TIME (L) WANT (L)
REGULATORY	7	2%	CLEAN (T4) OUT (D) WIPER CLEAN (T2)
SELF-REGULATORY	0	0%	No examples observed
ATTENTIONAL	4	1%	LISTEN (T3) LISTEN THERE (T)
INTERACTIONAL	8	2%	COME (W) (M) (L) COME HUG (W) HURRY (L) HURRY COME (W) (L2)
EXPRESSIVE	10	3%	DIRTY (W8) PERSON (W) STUPID (T)
REFERENTIAL	218	59%	APPLE RED BANANA (T) BIRD (W2) (T2) BIRD PERSON (W) BLACK (W2) (T8) BLACK THAT (T4) BLACK THAT BLACK (T2) BOOK (W7) (M8) BUG (T6) BUG BOOK (M) BUG LOOK (M) CARROT (T) CAT (W) (M3) COW (D2) FLOWER (W15) FOOD (W2) (M2) (L) FRUIT (M) IN (M) LIPSTICK (W) LOOK (T) LOOK BLACK (T) MILK (T2) MINE (W) (L) MY BOOK (W) ORANGE (T) PERSON (W3) RED CRY FUNNY (M) SHOE (M)

CATEGORY	TOTAL	PERCENT	UTTERANCE/CHIMP/FREQUENCY
			THAT (W) (M12) (THU) THAT APPLE (T) THAT BLACK (T5) THAT BLACK THAT (T5) THAT BLACK THAT BLACK THAT (T) THAT BOOK (W2) THAT CAT (M3) THAT FLOWER (W) (T) THAT FOOD FLOWER (W) THAT GUM RED (W) THAT ICE CREAM THAT (T) THAT MILK (T7) THAT PAINT LISTEN (T) THAT POPCORN (T) THAT POPOCORN MILK (T) THAT RED (W) THAT SHOE (W) (M2) THAT THAT (T) THAT THAT BLACK (T) THERE (T)
DESCRIBING OWN ACTIVITY	29	8%	DRINK (T) FOOD (M) LOOK (L) MASK (L) PEEKABOO (W) (M17) (D) (L5) TOOTHBRUSH (M)
QUESTION	0	0%	No examples
IMAGINARY	17	5%	CAT (M) FLOWER (M) FUNNY BLACK FOOD (M) GUM (D) PAINT (T) PEEKABOO RED (M) QUIET RED FOOD CRY SANDWICH (M) RED (M9) SWEET (M)
INFORMATIVE	44	12%	BANANA (T2) BERRY (T) BIRD (M) BOOK (W) BUG (T) CARROT (T) CAT (M) COME FOOD (W) DEBBI (W) DOG (L) DRINK (M) DRINK FLOWER (M) FLOWER (W11) (M) (L) FLOWER FOOD (M2) FLOWER FRUIT (W) FOOD (M) (T) (L) FOOD RED LOOK (M) GRAPE (T) MEAT (T3) NO (L) PERSON (W) POPCORN (W) RED (M2) (T) SODA POP (M)

experiment. At least one instance of private signing was observed in 87 of the 280 days in which video data was collected (31%). The number of instances of private signing each month and the number of days in which private signing were observed each month were used to look for changes in the frequency of occurrence of this behavior. Both of these measures showed that this behavior stayed relatively constant over the course of the experiment.

Tatu was observed to sign to herself at least once in 14 of the 15 months of data collection. Washoe was observed to sign on at least one occasion during 12 of the months and Moja had instances of private signing in 11 of the months. Loulis and Dar, who both had relatively few instances of private signing recorded in this experiment, were observed signing privately on at least one occasion in 9 and 4 months respectively.

Tatu not only displayed the most total instances of private signing but she also signed in the greatest number of sessions. She had the greatest consistency of private signing throughout the experiment as measured by the number of instances of private signing each month and the number of days of private signing each month. She had the most or tied for the most instances of private signing in 11 of the 15 months. Tatu also averaged the most or tied for the highest number of days in which private signing was observed in a given month in 8 of the 15 months.

Frequency of Categories used by the Chimpanzees

As can be seen in Table 5 the analysis for use of functional categories across and between chimpanzees showed that the Referential category was the most commonly observed category.

This category was used by four of the five chimpanzees and was the most frequently observed in the three female chimpanzees.

Camera Four and Private Signing

The addition of camera four on 6/8/87 allowed for the videotaping of an additional 15% of the chimpanzee's enclosure. Twenty instances of private signing were recorded using this camera. This was 13.1% (20 of 153 instances) of the total instances of private signing recorded during the second half of this study.

Reliability

Fifteen percent of the total videotape sample (43 segments) was analyzed by a second independent observer to determine interobserver reliability for the identification of instances of private signing and classification of utterances into Furrow's (1984) functional categories. The first measure of interobserver agreement was 94%. The second measure was 78%.

Discussion

In the analysis of 56 hours of remote videotape recordings it was found that this group of five signing chimpanzees would sign to themselves. We were able to classify these instances of private signing into nine of Furrow's (1984) functional categories. The high number instances of private signing identified demonstrates the effectiveness of this remote videotaping procedure as a method to record and analyze this behavior.

We found the chimpanzee's private signing to be a robust phenomenon with a total of 368 instances observed. All five of the chimpanzees evinced instances of this behavior. Bodamer (1986) also found that all five chimpanzees signed to themselves and he observed private signing in the two categories we did not observe in this experiment (Self-regulatory and Question), which

TABLE 5 - Frequency of Functional Categories by Chimpanzee

CHIMPANZEE	CATEGORIES	11/6/86 - 1/21/88
Washoe	Referential	46
	Informative	16
	Expressive	9
	Instrumental	9
	Interactional	3
	Describing Own Activity	1
		<u>84</u>
Moja	Referential	38
	Describing Own Activity	19
	Imaginary	15
	Informative	12
	Instrumental	6
	Interactional	1
		<u>91</u>
Tatu	Referential	130
	Informative	12
	Instrumental	8
	Regulatory	6
	Attentional	4
	Describing Own Activity	1
	Expressive	1
	Imaginary	1
		<u>163</u>
Dar	Instrumental	4
	Referential	2
	Regulatory	1
	Describing Own Activity	1
	Imaginary	1
		<u>9</u>
Loulis	Describing Own Activity	7
	Instrumental	4
	Interactional	4
	Informative	4
	Referential	2
		<u>21</u>

is another indication of the robustness of this phenomena. The chimpanzees displayed individual variations in the frequencies with which they signed and in the functional categories used.

The chimpanzees used 59 different signs in this experiment. This relatively large number of different signs reflects the diversity of this behavior. Tatu displayed the most diversity in her private signing, using 28 different signs.

We were able to compare the similarities and differences of chimpanzees private signing to studies examining human private speech (Furrow, 1984) and signing (Raymond, 1990). Private signing appears to be very similar to private speech in children in several ways. The similarity of function of the private signs was demonstrated by the fact that we were able to classify the 368

instances of private signing into nine of the 11 functional categories used by Furrow (1984) with human children. Another similarity was the finding that a few categories accounted for the majority of the instances of private signing. This was found in Furrow's study on hearing children (1984) as well as Raymond's (1990) study on signing deaf children. In the present study the Referential and Informative categories accounted for 71% of the instances of private signing. None of the other categories accounted for more than 8% of the total instances. Furrow found that the Referential, Describing Own Activity and Self-Regulatory categories accounted for 55.8% of the instances of private speech. Raymond found that the three categories, Referential, Questioning, and Self-Regulatory, accounted for a majority (76%) of all instances of private signing.

This similarity between children and chimpanzee private signing becomes more evident when individual categories are examined. Fifty-nine percent of all signing instances were classified as Referential. This category was also observed the most frequently in Furrow's (1984) and Raymond's (1990) studies where it accounted for 29% and 20% respectively. The Referential category was observed most often in all the chimpanzees except for Dar, for whom it was the second most frequently observed category. The Referential category occurred nearly five times more often than the second most frequently observed category, Informative.

A difference between the chimpanzees and Furrow's human children was noted in the frequency of the Informative category. As previously stated this category was used to classify private utterances that referred to objects not present in the immediate environment. For the chimpanzees it ranked second in terms of frequency (12%). This category accounted for only 1.7% of the children's private speech utterances in Furrow's (1984) study and 4.7% of the private signing in Raymond's (1990) study. While this difference may be attributed to species differences, it may also be due to developmental differences. Pellegrini (1981) found that in the private speech of children under seven years of age there was an increased probability of encoding words denoting objects that were present as opposed to objects that were absent. With this evidence one would expect to find a higher incidence of Referential utterances compared to Informative utterances in younger children and chimpanzees. Furrow and Raymond supported these findings with children. Bodamer (1986) also supported this finding in that the youngest chimpanzee Loulis was the only one with a higher incidence of the Referential category than the Informative. In the present study, however, four out of Loulis' 21 instances were classified as Informative and only two were classified as Referential. This reversal was consistent with the age of the children in the Pellegrini study. Contrary to Pellegrini's findings, it was also found in this study that the older chimpanzees, Washoe, Moja, and Tatu, displayed a higher incidence of Referential private signing than Informative. It should be noted that these older chimpanzees still displayed a much higher proportion of Informative utterances (ranging from 19% to 7%) than the 1.7% found in Furrow's two-year-old children. Future studies may reveal more clearly whether there is a higher preponderance of the Referential category as opposed to the Informative in younger chimpanzees.

The third most frequent category in the present study, Instrumental (8%), accounted for less than 1% in Furrow's (1984) and 1.6% in Raymond's (1990).

The fourth most frequent category, Describing Own Activity, also accounted for 8% of the chimpanzees' utterances. This category accounted for 16.5% of the children in Furrow's study and 10.9% of Raymond's.

There were few instances of the Expressive category (3%) in the present study. This is comparable to Furrow (1984) (6.8%) and Raymond (1990) (7.8%), but quite different from Bodamer (1986) where 29.7% of the same chimpanzees' private signing were in this category. The oldest chimpanzee, Washoe, accounted for over 80% of the instances of Expressive private signing seen in Bodamer's study. Rubin (1979) found that the Expressive function accounted for a large portion of school-age children's private speech and that instances of the Expressive

function increased with age. This offers a possible explanation for the low incidence of expressive private speech seen in the two-year-old children in Furrow's study as well as the younger chimpanzees of this group. However, the observation that the second oldest chimpanzee, Moja, had no instances suggests factors other than age may be important. Individual differences as well as age may influence expressive private signing.

Each of the other categories accounted for less than 7% of the total instances of private signing. In fact five of these categories accounted for not more than 5% of the total.

An apparent difference between our study and human private speech is that we did not find a decrease in private signing as a function of age. Likewise, Vygotsky's (1962) analysis of the Self-Regulatory function of private speech found an initial increase followed by an eventual decrease except in circumstances where an adult was placed in intellectually challenging circumstances. It should be noted that Vygotsky's analysis of the function of private speech forced him to arrange his experiments in such a way that his subjects were required to perform a task. The difference between the above studies and this study may be the result of procedural differences rather than species differences. Other researchers who studied the natural occurrence of private speech in unstructured free play contexts have not found a decrease with age (Klien, 1964; Pechman, 1978; Rubin, 1979). In contrast to Vygotsky, the chimpanzees were not required to perform any tasks but were given the opportunity to interact with various objects as they would during a typical day. Under these conditions a decrease in the amount of private signing with age was not seen. In fact the oldest chimpanzee, Washoe, accounted for 23% of the total instances of private signing. She also had the most instances of private signing in the Bodamer (1986) study.

One final difference between the present experiment and Vygotsky's (1962) research was that he focused on Self-Regulatory private speech whereas we did not; as a result we found multifunctional use. These chimpanzees, like the humans in the research of Berk (1986), Berk and Garvin (1984) and Flavell (1964), displayed a wide variety of communicative functions in their private signing.

The occurrence of private signing in signing chimpanzees is no longer a matter of incidental observation. This study systematically confirms the early observations that this behavior occurs in each of these chimpanzees (Gardner & Gardner, 1974; Bodamer, 1986). As with the previous research on these chimpanzees by the Gardners (1969, 1971, 1973, 1974, 1978, 1984, 1985) the present research demonstrates once again that the proper question is not "Can a chimpanzee acquire a human language?", but rather "How do these chimpanzees use their signs?" This research provides us with another means for a comparative analysis of intelligence. Piaget saw private speech as a "window to the mind" and Vygotsky referred to private speech as "thought spoken out loud". As the work of Piaget, Vygotsky and others has shed light on the development of humans, so too might the continued evaluation of chimpanzee private signing provide a glimpse into hitherto uncharted areas of chimpanzee mentality.

This research also provides us with a model from which to form conjectures about the communication and mentality of our earliest hominoid ancestors. For example, the common notion that animals, other than humans, only refer to things in the present (e.g. out of sight out of mind) is thoroughly disproved by the robustness of the chimpanzee's private signing in the Informative category. The robustness of this category also suggests that our early hominoid ancestors were able to think about things absent from their immediate environment, and thus were most probably able to mentally manipulate these ideas in a fashion we call planning. This mental ability would have played an important role in the survival of our early ancestors. These results and the variety of categories of private speech evinced by these chimpanzees indicate that they, as well as our early hominoid ancestors, most probably had a rich private mental life.

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