Chapter 2
Signs of Communication in Chimpanzees

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Abstract Chimpanzees communicate with facial expressions, vocalizations, postures, and gestures. Vocalizations are of many types for both close and distance communication. Identity of individuals and groups is apparent in vocalizations. Vocalizations occur in specific contexts and there is evidence that some carry referential meaning. Gestures occur in a variety of modalities and chimpanzees vary the modality appropriately with the attentional state of the partner. Communities of chimpanzees have specific repertoires of gestures and the same gesture among communities varies in form. In cross-fostering research chimpanzees acquired American Sign Language. One young chimpanzee acquired signs from his mother and other signing chimpanzees. In a remote videotaping procedure the chimpanzees signed to each other using a variety of signs in a variety of contexts. Other studies have examined chimpanzee communication using artificial languages. Chimpanzee communication shows flexibility as partners navigate through interactions and gestures are acquired through social learning.

1 Introduction

Chimpanzees are in the order of primates. Organisms in this order tend to be social, live in groups and have parallel adaptations in physiology and behavior to facilitate communication. This includes hairless faces with many muscles and high visual acuity. Chimpanzees communicate using vocalizations, facial expressions, postures, and gestures (Goodall 1986). They live in groups of 20–100's of individuals with fluid

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subgroupings. Community members have complex and long lasting relationships characterized by close communication such as during grooming bouts, as well as long distance communication between members at separate locations.

2 Facial Expressions

Like humans, chimpanzees possess a variety of facial expressions that contribute to the overall meaning or message (Parr 2004). Humans and chimpanzees share similar facial anatomy and similarities between the two species in emotional expression occur indicating that facial expressions are an important avenue for chimpanzee communication. Using a ChimpFACS coding system researchers found more than 250 facial expressions in chimpanzees. (Burrows et al. 2006; Parr et al. 2007). Chimpanzee facial expressions are tied closely to vocalizations but can be produced both in their absence and in combination with them.

3 Postures

Chimpanzees use a variety of postures, which communicate information about the signaler (Goodall 1986; McCarthy et al. 2012). For example a bipedal posture occurs in a highly aroused chimpanzee. It is often accompanied by pilo erect hair, also a sign of high arousal. A submissive chimpanzee displays a crouching posture. Chimpanzees present body parts to other chimpanzees to solicit grooming. The presents also are postures.

4 Vocalizations

Acoustic communication is closely adapted to environmental conditions and the function of the signal. Low-frequency vocalizations are required in dense vegetation and other sounds must be able to travel over long distances. Chimpanzee vocalizations are no exception.

Vocalizations are necessary for long distance communication. Geographic ranges of chimpanzee communities can cover large distances such as 25 km^2 (Lehmann and Boesch 2002) so members may be separate and traveling alone. Although, as social beings chimpanzees often travel together in subgroups. Vocalizations are a way to maintain contact with community members over long distances and they also occur in behavioral contexts with close proximity, such as play and grooming. A calm chimpanzee is very quiet, yet in times of emotional arousal a chimpanzee can be quite loud. Overall chimpanzees spend proportionally much of their time in silence, unlike a bird.

Chimpanzees produce many types of vocalizations which include pant hoots, screams, barks, grunts, pants, whimpers, squeaks, cough grunts, and laughter and mouth sounds (see Goodall 1986; Slocombe and Zuberbühler 2010 for review). Some vocalizations are loud reaching all community members while others are quiet and only reach members in the subgroup.

Pant grunts are a series of submissive noisy grunts joined together by voiced inhaled elements (Crockford and Boesch 2005; Goodall 1986). A subordinate when approaching or approached by a higher-ranking individual produces pant grunts. Pant grunts help to maintain friendly relations between members of the community. Greetings between friendly individuals will result in a soft pant grunt; however, if the subordinate is apprehensive, the pant grunt is louder matching the level of apprehension.

The hoo is a distinctive part of a whimpering sequence (Crockford and Boesch 2005). Produced by both infant and mother when physical contact needs to be re-established, the chimpanzee repeats the hoo several times. An adult also produces a hoo vocalization, often with pouted lips, when begging for food or grooming. If this vocalization occurs in rapid succession, rising and falling in pitch, it grades into a whimper (Goodall 1986).

The whimper, most commonly occurs in infants, reflects distress and need; however, whimpering can also occur in subordinate, older individuals when refused food by a higher-ranking individual. Whimpers can grade into screams (Crockford and Boesch 2005; Goodall 1986; Slocombe and Zuberbühler 2010).

In response to threats subordinates will produce a short, shrill squeak (Crockford and Boesch 2005). As fear increases, squeaks can grade into screams, which again grade back to squeaks when the subordinate becomes less agitated (Goodall 1986).

Chimpanzee laughter is a soft, repetitive, breathy, guttural sound of low intensity produced through repetitive sequences of air being drawn into the lungs and then exhaled (Ruch and Ekman 2001). Laughing occurs more often in infants and juveniles and results most frequently during tickling encounters, but also in other physical contact play, such as wrestling or play biting (Vettin and Todt 2005; Slocombe and Zuberbühler 2010).

Panting consists of rapid, shallow breathing, and occurs during greeting, groom, and feeding excitement. Typically, an open mouth presses against the body or face of the partner. Copulation pants can be mistaken for laughing; however, a sound spectrograph analysis reveals that not only are copulation pants more rapid, but it lacks the voiced inhalation phase of laughter (Goodall 1986; Slocombe and Zuberbühler 2010).

Chimpanzees produce a variety of grunt vocalizations. Community members use soft grunts when traveling or foraging together. The extended grunt occurs during rest sessions. The nest grunt is produced when an individual is looking for a suitable nest area, making a nest, or settling down for the night. Soft food grunts occur during the first minutes of feeding on a highly desired food item (Goodall 1986; Slocombe and Zuberbühler 2010).

The huu vocalization is an alarm call and occurs in situations of surprise, slight anxiety, or puzzlement. Small snakes and unknown sources of sounds can elicit the

huu vocalization, even when the chimpanzee is alone (Slocombe and Zuberbühler 2010). Sounding much like the hoo vocalization, the huu does not have the characteristic pouting lips (Goodall 1986).

Chimpanzees make loud sounds that are audible over long distances. Of these pant hoots are the most studied. Chimpanzees pant hoot most often in the morning and overall pant hoots increase with a rise in the numbers of males per party, and high ranking males call more often than low-ranking males (Wilson et al. 2007). Pant hoots occur when arriving at a new food source, when two parties meet, during travel, after returning from patrolling the territorial boundaries, during social excitement, spontaneously during feeding, and at night during nesting (Slocombe and Zuberbühler 2010).

High pitched, loud screams, emitted most often in a series occur when an individual is highly stressed, fearful, frustrated, or excited (Crockford and Boesch 2005; Goodall 1986). Screams travel long distances and may serve to solicit help from other members of the community to troubled individual. Screams occur in three subtypes: victim scream, tantrum scream, and copulation scream. The victim scream, produced when the caller is attacked, is harsh and prolonged and is accompanied by the sounds of the actual beating (i.e., hitting and stamping sounds). Infants rejected during weaning or adults indecisive if they should retaliate after an attack, emit a tantrum scream. Females emit a copulation scream during mating, which consists of a clear, high pitched sound of variable length (Goodall 1986).

Barks, usually produced in long sequences, are loud and sharp, varying in pitch. Waa barks are loud and are produced by participants or observers of agonistic encounters. After an attack, the victim's screams will change to waa barks, if he receives support from allies. A soft bark or cough threat is a grunt made with a slightly open mouth by a high ranked individual to a low ranked individual, serving as a mild warning to not approach or to prevent an unwanted action (Goodall 1986). Alarm calls, consisting of a long drawn-out wraa occur when a chimpanzee encounters a potential dangerous animal or abnormal behavior in a community member. Wraa serves as a distant call, alerting other members of danger, and also to intimidate the dangerous intruder (Goodall 1986).

When approaching a desirable food source or feeding, large parties of chimpanzees emit pant hoots, barks, grunts, and a loud, high pitched sound called the loud aaa (Crockford and Boesch 2005; Goodall 1986). The loud aaa occurs only in the context of feeding and most commonly by males.

5 Other Sounds

Chimpanzees produce other sounds that are not vocalizations since there is no voicing. Captive chimpanzees produce unique sounds such as bronx cheers, lipsmacks, and pants in interactions with humans (Hopkins et al. 2007; Bodamer and Gardner 2002). Free-living males drum tree buttresses, which is audible up to 1 km and is often accompanied by pant hoots. Chimpanzees will use this when traveling in large

mixed-sex parties. In the Tai Forest, Ivory Coast drumming indicates differences in travel direction and resting periods (Boesch 1991). Differences in patterning of drumming occur between communities of chimpanzees (Arcadia et al. 2004) and between individuals within a community (Arcadia et al. 1998).

6 Individual and Community Differences

Vocalizations provide information about the vocalizer and community. Individual identity is apparent to listeners and appears in spectrograph analysis (Marler and Hobbett 1975). In a captive experiments chimpanzees recognized other individuals by hearing pant hoots (Kojima et al. 2003). In the field arrival pant hoots contain information about the status of the signaler in the hierarchy (Clark and Wrangham 1993). Screams indicate whether the signaler is the victim or aggressor in a conflict (Slocombe and Zuberbühler 2005a). In a playback experiment researchers (Herbinger et al. 2009) played recordings of pant hoots from chimpanzees in the neighboring community, a distant community from 70 km away, and community members. The listening chimpanzees pant hooted in response to the pant hoots of neighbors, but screamed in response to pant hoots of strange chimpanzees. They responded the least to pant hoots of community members.

Members of a free-living community have pant hoots more like each other than those of neighboring communities and this difference is not explained by genetic similarities (Crockford et al. 2004). This is supported by a captive finding in which there were differences between the pant hoots of two groups (Marshall et al. 1999). These findings suggest that communities of chimpanzees have vocal dialects (Slocombe and Zuberbühler 2010).

7 Meaning in Vocalization

Do vocalizations portray the signaler's internal state or information about external events? Seyfarth and Cheney (2003 for review) developed a playback method in which they played recordings of alarm calls, which are acoustically distinct, to vervet monkeys. Monkeys gave specific responses to specific types of calls. For example when monkeys heard the eagle alarm call they looked up and ran for cover. When monkeys heard the snake alarm call they stood bipedally and looked around. These experiments provided strong evidence that vervet monkey alarm calls contained referential information; they contained information about the specific type of predator. The playback technique now has been used with numerous species, including chimpanzees (Slocombe and Zuberbühler 2005b).

Some chimpanzee vocalizations show acoustical variation and occur in specific situations. Pant hoots provide information about the quantity of food. Additionally pant hoots vary depending up the chimpanzees' activities such as arrival at a food

source versus traveling (Notman and Rendall 2005). Barks vary as a function of the context; hunting snakes versus the presence of a snake. When chimpanzees combined these barks with other behaviors, their specificity increased (Crockford and Boesch 2003). Although these two studies found acoustical differences, they do not include the playback component that confirms if listeners perceive the differences in vocalization and use the information within them to gain information from the environment.

In playback experiments with captive chimpanzees (Slocombe and Zuberbühler 2005b), vocalizations carried information about food value. Highly valued foods were ones that the chimpanzees preferred. Also vocalizations carried information about food type; they were specific and consistent to bread and bananas. In another experiment, one chimpanzee used vocalizations to gain information about the location of food.

8 Gestures

Gestures are "discrete, non-locomotor limb and head movements, regardless of the receptive sensory modality (sight, sound, touch) that occurred when [chimpanzees] were in proximity and engaged in social interaction immediately before, after, or during the movements" (Tanner and Byrne 1999, p. 216). Some researchers include intentionality in definitions of gestures. Intentionality includes checking the partner. For example the signaler must look at the recipient or wait for a response from the recipient (Hobaiter and Byrne 2011; Pika and Mitani 2006). Gestures occur in one or more of three communicative modalities: visual, auditory, and tactile (Goodall 1986). Thus some gestures make sounds such as a handclap, some are silent such as an arm wave, and some involve contact between two individuals such as a tap.

Tomasello et al. (1994) created a comprehensive ethogram of captive chimpanzee gestures. They recorded 259 occurrences of gestures in captive juvenile chimpanzees. Two gesture combinations occurred in 90 instances and three gesture combinations occurred in 11 instances. Hobaiter and Byrne (2011) reported that a free-living group of chimpanzees in Budongo, Uganda used 4,397 instances of gestures in 120 h of video footage. There were 66 distinct gesture types which occurred in a broad range of behavioral contexts.

Gestures are used from an early age and develop over time into a reliable communication system in chimpanzees and other ape species as well. Social gestures such as begging are present in infant chimpanzees between the ages of 9 and 12½ months. Following the use of the begging gestures infants begin to use other gestures to initiate tickling or grooming sessions (Plooij 1984). The grooming handclasp is a gesture used in grooming interactions. It appears at about 4 years of age with mothers molding the gestures. As juveniles develop they begin to use the gesture with other members of the community (Nakamura and Nishida 2013). This shows evidence for social learning of gestures.

If gestures are learned through social processes, there should be differences between the gestural repertoire of various communities. In a seminal study researchers working at nine different long-term chimpanzee field sites collaborated and developed a list of 65 behavior patterns (Whiten et al. 1999). The behaviors were classified in terms of their local frequency of occurrence. There were 39 behaviors including gestures that the researchers determined were cultural variants since they were absent in some communities and customary or habitual in others. It included gestures such as leaf clipping, rain dance, knuckle knock, and grooming hand-clasp.

The grooming hand-clasp gesture is when grooming partners hold each others' hand and groom with the other hand. The hand-clasp occurs customarily in some communities of chimpanzees such as Kalinzu and Kibale in Uganda, and Lope in Gabon and is absent or rarely seen in others (Nakamura 2002). There are differences in the use of the hand-clasp among chimpanzees in western Tanzania. The Kasoge chimpanzees use this gesture however it is absent in the nearby Gombe chimpanzees (McGrew and Tutin 1978). In Gombe grooming partners instead grasp an overhead branch. Among the communities within Mahale there is variation in form of the hand-clasp. The M group uses a form in which partners' palms face each other. The K group uses this palm-to-palm form in addition to a non-palm-to-palm form, which involves support at the wrist (McGrew et al. 2001). Chimpanzees at Chimpfunshi, an African sanctuary, used varying forms of the hand-clasp which were specific to their group. Of the four groups, two never used the hand-clasp, and one used palm-to-palm (Van Leeuwen et al. 2012). De Waal and Seres (1997) reported the propagation of the hand-clasp as new social custom in a group of 20 captive chimpanzees. The gesture originated from a single female individual and she initiated the use of the hand-clasp mostly with immediate adult kin spreading it to other individuals. This body of evidence strongly suggests that gestures are socially transmitted.

During interactions, for communication to be successful partners must make adjustments to each other or the audience. Free-living chimpanzees attenuate vocalizations in response to the audience. For example chimpanzees pant grunt in greeting and individuals only produce it in interactions with higher ranking individuals. Females produced more pant grunts to other individuals when the alpha male was absent (Laporte and Zuberbühler 2010). Free-living chimpanzees were more likely to emit an alarm call in the presence of others who were unaware of the predator than those who were aware (Crockford et al. 2012). Females were less likely to produce a copulation call in the presence of a higher ranking female (Townsend and Zuberbühler 2009). During attacks victims changed the acoustic structure of screams based on the ranking of bystanders in relation to the aggressor (Slocombe and Zuberbühler 2007). This variation in vocalizations in relation to the composition of the audience shows flexibility in the production of sounds. Although, chimpanzees show vast more flexibility in the use of gestures.

Several experiments show that captive chimpanzees adjust sounds and gestures depending upon the state of the partner. In captive settings chimpanzees used mouth sounds such as bronx cheers or produced noise such as cage banging or handclap

when human caregivers had their back turned. Then chimpanzees made gestures (Hostetter et al. 2001; Leavens et al. 2004) such as points or signs of ASL (Bodamer and Gardner 2002) when caregivers turned to face them. In interactions with conspecifics chimpanzees were less likely to use a visual gesture if the partner was inattentive. When partners failed to respond, a chimpanzee was more likely to persist with a subsequent gesture (McCarthy et al. 2012; Liebel et al. 2004; Roberts et al. 2012a).

Like vocalizations, gestures themselves carry referential meaning. Roberts et al. (2012b) found that within the same group of chimpanzees reported above, individuals were able to understand the meaning of gestures even when they were not associated with a context. Recipient's responses depended upon the particular gesture even when it occurred outside of its usual context. These findings are supported by sign language studies with chimpanzees in which chimpanzees acquired human gestures of American Sign Language (ASL).

Ethologists use the procedure called cross-fostering to study the interaction between environmental and genetic factors by having parents of one species rear the young of a different species. Primate cross-fostering projects date to the 1930s, when Kellog and Kellog (Kellog 1968) raised the infant chimpanzee Gua for a period of 9 months with their son. In the 1950s, Hayes and Hayes (Hayes and Nissen 1971) cross-fostered the chimpanzee Viki while attempting to teach her to talk. After 4 years she was able to say four words, "mama", "papa", "cup", and "up". This research demonstrated that chimpanzees cannot speak, leading to the search for other means of testing the language and other cognitive abilities of apes.

Gardner and Gardner (Gardner et al. 1989) cross-fostered the infant chimpanzee Washoe and immersed her in ASL. In teaching ASL to Washoe, caregivers imitated human parents teaching human children in human homes. For example, they called attention to objects, expanded on fragmentary utterances, and molded Washoe's hands into the shape of new signs. In a second project, the Gardners' cross-fostered four more chimpanzees, Moja, Pili, Tatu, and Dar. All of these cross-fosterlings acquired and used signs in ways that paralleled human children. The size of their vocabularies, appropriate use of sentence constituents, number of utterances, proportion of phrases, and inflection all grew robustly throughout the 5-year cross-fostering process.

In 1979 at the University of Oklahoma Washoe adopted a 10-month-old chimpanzee son, Loulis. Human signing was restricted in Loulis' presence to test whether he would learn ASL from other chimpanzees rather than from humans. Loulis began to sign in 1 week, and at 73 months of age had a vocabulary of 51 signs (Fouts et al. 1989). As adults Washoe, Loulis, Dar, Tatu and Moja signed to each other and to themselves (Bodamer et al. 1994). They initiated conversations (Bodamer and Gardner 2002) and maintained topics with humans. When human interlocutors feigned a misunderstanding, the chimpanzees adjusted their responses appropriately (Jensvold and Gardner 2000; Leitten et al. 2012). The chimpanzees' patterns of conversation with human caregivers resemble patterns of conversation found in similar studies of human children.

In August 1983 during a 15-day period video cameras remotely recorded the chimpanzees with no humans present. Every day during the study period the video

Table 2.1 Frequency of Chimpanzee-to-Chimpanzee signed interactions

	Initiator						
		Washoe	Moja	Tatu	Dar	Loulis	Total
Receiver	Washoe	–	7	21	8	12	48
	Moja	1	–	0	2	3	6
	Tatu	0	0	–	6	12	18
	Dar	0	1	1	–	27	29
	Loulis	0	7	28	53	–	88
	Total	1	15	50	69	54	

cameras were recorded for two 20-min periods between the hours of 9:00 a.m. and 5:00 p.m. Forty-five recording periods were scheduled so that each hour of the day was sampled randomly without replacement either five or six times. Loulis initiated 451 interactions, both signed and non-signed, with the other chimpanzees. Forty percent (181) of those interactions were directed to his male peer, Dar. Loulis used 206 signs in his interactions and 114 of those were directed toward Dar (Fouts 1994).

For each signed utterance on the videotapes the observer recorded the context, the initiator of the sign, the recipient of the sign, the sign gloss and the description of its form, and the number of times signs occurred within the utterance. From this record we now report the other chimpanzee-to-chimpanzee signs on the videotapes. Washoe, Moja, Tatu and Dar initiated 134 chimpanzee to chimpanzee interactions. Table 2.1 shows the frequency that each chimpanzee initiated a signed interaction. The data for Loulis is from Fouts et al. (1989, Table 9.2). The chimpanzee initiated 188 signed interactions. The total for receivers is 189 because Dar directed one interaction to both Loulis and Tatu. Loulis initiated the most interactions and Washoe initiated the least. Dar received the most interactions and Moja received the least. Dar and Loulis were the most frequent dyad with 167 signed interactions and Loulis and Tatu were the second most frequent dyad with 76 signed interactions. Most of the interactions occurred in the Affinitive Social (33 %) and Play (38 %) contexts.

Table 2.2 shows the variety of signs that were used by Washoe, Moja, Tatu, Dar and Loulis. The data for Loulis is from Fouts (1994, Table 3). The chimpanzees used 36 different signs and there were 369 chimpanzee to chimpanzee signs on the videotapes. The chimpanzees also combined signs. For example on 7/31/83 at 14:11:30 Dar hung above Loulis and signed to him FRIEND MORE CHASE MORE. Loulis then played with Dar.

Cianelli and Fouts (1998) found that the chimpanzees often used emphatically signed ASL signs during high arousal interactions such as fights and active play. For example, after separating Dar and Loulis during a fight and with all the chimpanzees still screaming, Washoe signed COME HUG to Loulis. He signed NO and continued to move away from her. The signs were recorded as emphatic because they were large. Emphasis occurs by making signs larger or faster just as emphasis in speech is loud or more rapid speech. These results indicate that the chimpanzees' signing is very robust indeed and is a regular part of interactions.

Table 2.2 Signs used in Chimpanzee-to-Chimpanzee interactions

Sign	Frequency
Ball	2
Blanket	1
Brush	3
Can‘t	1
Catch	2
Chase	5
Clean	1
Come	29
Dar	3
Drink	7
Eat	1
Food	9
Friend	1
Gimme	3
Go	1
Good	14
Groom	11
Gum	3
Hat	1
Hug	3
Hurry	155
Me/Mine	17
More	10
Out	5
Peekaboo	5
Person	3
Pretty	1
Shoe	3
Tatu	3
That	4
Tickle	42
Time	2
Toothbrush	1
Want	4
Washoe	5
You	8

Terrace et al. (1979) claimed to have replicated the Gardners' cross-fostering project with a chimpanzee named Nim. The young chimpanzee spent 6 h each day in a classroom while a string of teachers drilled him with questions and demands for signing. If he wanted something, the teachers withheld it until he named it. Terrace found that Nim made few spontaneous utterances and often interrupted his teachers. This procedure differed greatly from the Gardners' cross-fostering project, in which the young chimpanzees were treated like human children. Terrace's failure to create a comparable environment for language acquisition led to Nim's failures. Later studies showed Nim made more spontaneous utterances and interrupted less in a conversational setting than in a drill setting (O'Sullivan and Yeager 1989).

9 Artificial Communication

In the 1970s the Gardners' research sparked research using artificial systems to examine grammatical skills in chimpanzees. Premack used plastic tokens which varied in shape and color to represent words. The chimpanzee Sarah learned rules for their order and used them to answer simple questions about attributes of objects (Premack and Premack 1983). Rumbaugh tested a chimpanzee's grammatical ability using Yerkish, a system of individual symbols (known as lexigrams) each representing a word, and rules for their ordering. Lana used lexigrams to generate sentences to ask for goods and services. Later Savage-Rumbaugh attempted to train a bonobo, Matata, to use lexigrams. While Matata failed to use the lexigrams, her infant son, Kanzi, who was present during training, did use them (Hillix and Rumbaugh 2004). Devoid of face-to-face interaction, these artificial systems reveal little about conversational behavior, but they do demonstrate apes' capacities to use syntax.

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