Gestural phrases and gestural exchanges by a pair of zoo-living lowland gorillas*

Joanne E. Tanner

Previous study of the spontaneous gestural communication of the great apes has been primarily of individual gestures and their sequels. Such analysis gives only a partial picture of the quality of gorilla interaction. The repertoire of gestures of a pair of gorillas at San Francisco Zoo has been described by Tanner and Byrne (1993, 1996, 1999). These gorillas often used gestures in continuous sequences or *phrases*. Both single gestures and phrases were used in *exchanges* between gorillas. Phrases included a variety of syntactic functions, and exchanges seemed to negotiate matters such as location, initiator, and type of play. Both single gestures and phrases could be modified by "negative' gestures. Detailed transcription of gorilla communicative events show that gestures are continually being modified and varied by the communicative partners, rather than being ritualized elements of a finite repertoire.

The electronic edition of this article includes audio-visual data.

Keywords: gorilla, gesture, communication

Analysis of animal communication in terms of discrete actions of signaler and respondent has considerable limitations. Without looking at complete sequences composed of many different behaviors both audible and visible, and actions that are sometimes simultaneous between partners, study of individual gestures or vocalizations and what follows them gives an incomplete picture of ape communication (Chadwick-Jones, 1991; Johnson, 2001; King, 2002; King & Shanker, 2003; Shanker & King, 2002). Though previous analysis of the communication of the gorillas who are the subjects here provides an accurate summary of what kind of gestures occurred and what these gestures' sequels were (Tanner & Byrne, 1993, 1996, 1999), it simplifies the complexity of the

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behavior that transpired. In this paper I set forth some illustrations of the complexity and interactive nature of gorilla communicative sequences. As well as demonstrating the quality of interaction when gestures are exchanged between partners, I want to illustrate the elaboration possible in a single gorilla's utterances when the gorilla uses phrases of several gestures.

In previous analysis by Tanner and Byrne specific correlates of individual types of gestures were recorded: whether visual attention was present or absent in the receiver, whether the gesture resulted in contact, whether a playface was present or absent in the signaler. The results were calculated individually for each gesture on a pass/fail basis. Whatever most frequently took place in a specified interval following a particular gesture was considered to be a consequence related to the gesture, regardless of other gestures occuring in close proximity before or after the gesture in question. An exception was the study of a "hide playface" gesture (Tanner & Byrne, 1993) in which the hiding of the playface with a hand was found to modify future activity, regardless of other previous gestures. Also, facial expressions and other body postures and activities that did not fit into the designated working definition of a gesture were not reported in analysis in earlier publications.

Combinations or sequences of actions may be worthy of much more study than has previously been given to them. Very recently, Crockford and Boesch (2003) have published a study of context-specific calls or "signals" in wild chimpanzees in the Tai forest in West Africa. Interestingly, six of eight of the "call" types discerned in these chimpanzees are phrases or combinations, sometimes multi-modal, combining different kinds of barks, grunts or drumming. Several of these combine as many as three different elements. Each different grouping appears to give a different meaning to the phrase. These sequences are found in specific relationship to different contexts of *hunt, snake, neighbour (hear chimpanzees from different community), contact (hear separated party from same community), travel,* and *aggression.*

Another example of the importance of looking at combinations of signals is found in a study of two four-year-old gorillas at the Berlin Zoo. Weber and Niemitz (in preparation) analyzed not only single gestures but also combinations of gestures as well as other elements of communication, in terms of the behavior that followed. Each combination was treated as a single "gesture" for purposes of analysis. Two combinations, of *chestbeat* with *run-away/look-back* or *object use* with *run-away/look-back* most frequently had the result of social play. This was different from the consequences of *chestbeat* alone or *object use* (throwing an object at partner, or slapping an object or surface) alone, which resulted in

visual attention from the partner but not in a significant amount of play.

Recent research on monkey vocal communication has also shown the importance of studying combinations of signals rather than a single signal. Playback experiments, again in the Tai Forest, considered the reactions of Diana monkeys to alarm calls of Campbell's monkeys that are known to refer to specific predators. Results showed that when an alarm call is preceded by a "boom" sound, it devalues the alarm call and indicates the monkey is uncertain of the nature of the predator, but still wants to alert its companions (Zuberbuhler, 2002).

Attentional factors, both of gaze and hearing, are of the utmost importance in receiving and acting upon another ape's or human's utterance. Visual contact must first be gained in order to convey a gestural message, unless it is a purely tactile or auditory one. An I/you mutually attentive relationship in communication between two individuals may be established through the locations to which visual attention is directed (Savage-Rumbaugh et al., 1977; Gomez, 1990, 1991, 1994, 1996). Gomez' studies of human interaction with young gorillas emphasized the importance of eye contact in a gorilla's success in making requests without any forcible manipulation of the human. Facial expression certainly may also be important in shaping gorilla partners' responses to each other. A lack of facial expression in gorillas as compared to chimpanzees has been posited by some scholars (Hauser, 1996), but my own observations have been that gorillas have extremely expressive faces; playfaces, pouts, pursed or drooping lips, tongue motions and extensions, varying degrees of hidden or bared teeth, and much more, are frequently seen in the video I have collected.

Scholars specializing in human sign language have made the observation that gesture in itself contains the basic elements of what is commonly called syntax (Armstrong, Stokoe, & Wilcox, 1995). In iconically portraying a motion, a gesture moves from a starting point to an ending point. These locations, in both human and ape gesture, are often an actor (agent) and a recipient of action (object, or *patient* in some studies). A gesture can begin with arm extended first to a communicative partner, then continue with motion moving toward the gesturer; or motion can begin from the gesturer's body, perhaps hand touching body first, and then move to the partner and drop. Or attention may first be directed by gesture to an object or location in the environment rather than an actor or partner.

Greenfield and Savage-Rumbaugh (1990, 1991) attempt to show that the bonobo Kanzi has a preferred "word order" in his utterances, many of which combine spontaneous gesture and taught lexigrams. A preferred order of

gestures in gorilla phrases has not been discerned. However, a regularity in word order is not a necessary element of a natural syntax, nor even in ordinary human speech. The phrases "You come here", "come here, you", and "Here — you come", all convey the same idea with slightly different emphasis. And of course different human languages have differing customary orders of subject, object, verb and modifiers ("Kommen sie her"). Gesture order is important in the gorilla gestural phrases discussed here only in that it *orders the attention.* A previously described gesture/phrase of the young male silverback Kubie, *tap other, armswing under-touch self* might in English approximate "you come here", but *armswing under-touch self* has also been observed without the *tap other* (Tanner & Byrne, 1996). As in humans, "you" can be conveyed by directing the gaze, rather than verbalizing the word "you".

What comprises a single gesture or a single class of gesture is a question needing more exploration. Between the beginning and ending points of a gesture, many forms of motion that can depict activity anticipated from the gesturing gorilla are possible: downward, upward, sideways, or even rapid shaking. But "up", or "down", for instance, do not always follow a precise trajectory at a right angle to the ground, and can have a wide degree of variation. The beginning or ending point of gesture can be one of potentially many different locations on the gesturer's body, a partner's body, an inanimate object, or open space. Descriptions of gestures attempt to "lump" them into clear categories in order to do numerical analyses, but in reality there is great variation in begining and ending points and the motion between these, and in size, forcefulness and number of repetitions.

The working definition of gesture used by Tanner and Byrne (1996, 1999) did not include actions that used physical force or lacked directional motion, thus excluding a number of actions that other researchers consider to be gestures, such as *grab, touch,* and *peer* (in Pika, Liebal & Tomasello, 2003). Also excluded were actions upon or with objects, which are considered to be gestures in other work (Pika et al. 2003; Tomasello, George, Kruger, Farrar & Evans, 1985; Tomasello, Gust & Frost, 1989; Tomasello, Call, Nagell, Olguin & Carpenter, 1994). In looking more broadly at entire sequences of communication, such actions may be important parts of the communicative event, whether strictly defined as "gestures" or not. In this paper, however, I will stick to Tanner & Byrne's (1996, 1999) original definition of gesture (see below in *Definitions* section), for the sake of efficient exposition of data. Nonetheless, it is my goal here to present a broader, more inclusive look at communicative events between gorillas than has been previously published.

Method

Subjects and setting

The primary subjects of the author's longterm observations were 13 year old male lowland gorilla Kubie and 7 year old female Zura (ages at the time of the data presented here, during 1988–1989). They were members of a stable social group, all of whom had spent nearly all of their lives at this zoo. The group included first- and second-generation descendants of the wild-caught founder, Bwana, who had been at the zoo since 1958. Kubie is Bwana's son. An elderly wild-caught but human-reared female, Pogo, grew up at the zoo with Bwana. Two young females whose early rearing was by humans in zoo nurseries, Bawang and Zura, joined the group in 1981 and 1982 respectively, after the death of two older females, one of whom was Kubie's mother Jackie. In 1989 Kubie and Bawang's first of three offspring was born. The most extensive interaction between Kubie and Zura, including much gesturing, took place during the period when Bawang was pregnant with, then nursing and caring for, her first infant, Shango, and was thus unavailable to Kubie. Zura was just entering maturity and Kubie was much larger than she, thus she was hesitant about fully cooperating with him in play interactions.

The San Francisco Zoo's present gorilla enclosure has been the group's home since 1980. It has an outdoors area of 2300 square meters, or 38 by 50 meters at maximum parameters. It is covered with grass and other vegetation and contains large, climbable live trees as well as several dead trees, large stumps, and two artificial rock "hills" including arches and cavelike areas. The enclosure is below ground (viewer) level, except for one windowed viewing area where gorillas and humans can interact face to face. The lack of fencing or other barriers at eye level allows good visibility for videotaping gorilla activity.

Definitions

As in earlier work (Tanner & Byrne, 1996, 1999), a gesture here is defined as a non-locomotor limb or head movement that occurred when gorillas were in proximity of each other, and where the gorillas engaged in social interaction before, during or after such movements. Such gestures were thus presumed to be potentially communicative and social. The gesture could be received through sight, sound, touch, or a combination of these. A gestural motion that was repeated consecutively without pause was counted only as a single gesture.

A "phrase" is defined here as a continuous sequence of two or more gestures by an individual, performed after no gestures have occurred previously for 2 seconds or more, where the gestures within a phrase follow upon each other without any pause longer than 1 second. A pause is timed from when the arm (or head or foot, in a few cases) comes to rest after a gesture or the motion of a gesture stops, to the time a limb begins a new motion. "Phrase" here refers to the gestures of one individual, though gestures from another gorilla may or may not occur simultaneously.

A gestural "exchange" is defined as a continuous sequence of two or more gestures where the gestures are performed, usually alternating, but sometimes simultaneously, by more than one gorilla. As in a phrase, the gestures in an exchange follow upon each other without pauses longer than 1 second. (Some gestures have a duration longer than a second themselves, so notated timings of gesture onset may be more than 2 seconds apart and still meet criteria.)

Procedure

I examined the catalog of gestures of Kubie and Zura previously analyzed in other publications (Tanner & Byrne, 1996, 1999). This contained data from 30 different zoo visits, each of approximately 3 hours duration, during an eleven-month period between October 31, 1988 and September 20, 1989. I picked out all the gestural sequences that qualified as phrases under the definition above. Many of these phrases were part of longer exchanges involving both gorillas; I also extracted these. Listed below is the corpus of gestures that make up these phrases and exchanges, with explanation of gesture functions within phrases. I next provide detailed examples of phrases and exchanges, transcribed directly from videotape.

Results

Phrases and phrase length

More than half of the gestures Kubie performed during the study period were part of phrases; during the approximately 90 hours of observation he performed 109 phrases with a total of 316 gestures used in phrases; Zura performed 81 phrases containing 183 gestures within the phrases (see Table 1). Kubie's phrases varied in length from 2 to 8 gestures (see Table 2); Zura's phrases varied

Table 1. Gesture phrases

Gorilla name	Number of phrases	Total gestures used in phrases	Length of phrases
Kubie (male)	109	316	2 to 8 gestures
Zura (female)	81	183	2 to 4 gestures

Table 2. Gesture phrases

Kubie		Zura	
Number of gestures in a phrase	Phrases with this number of gestures	Number of gestures in a phrase	Phrases with this number of gestures
2	59	2	62
3	27	3	17
4	8	4	2
5	10		
6	2		
7	1		
8	2		

in length from 2 to 4 gestures. Please note that a single gesture repeated consecutively was counted as more than one gesture *only* if followed by a pause of 1 second before the next gesture.

Since there is little published information on phrases or phrase length by other untaught apes it may be of interest to compare the findings here with the length of phrases or "utterances" reported in some captive enculturated apes, though the number of vocabulary items the signing ape has to choose from is far greater than that of the zoo subjects and signs may not be fully comparable to gestures as defined here. Data on mean utterance lengths of Koko, a female gorilla (Patterson & Linden, 1981), Kubie, Zura, and a signing chimpanzee, Nim (Terrace, 1979), are shown in Table 3. I have been unable to find a definition by Terrace of what he considered a single utterance. Patterson (personal communication) confirms that her definition of an utterance is virtually the same as mine for a phrase. In addition, we can note that wild chimpanzees regularly use phrases of at least 3 different elements, whose meaning can be discerned dependent on the combination and order of these elements (Crockford & Boesch, 2003).

Patterson reports that Koko's vocabulary quantity and utterance length fluctuated according to social and physical events in her life (loss of a teacher she was attached to, illness, moving the project to a new location), with a

Table 3. Phrase lengths of apes

Subject	Age sampled, sex	Rearing environment	Mean phrase length	Range of phrase length
Kubie gorilla	13 year old male	Zoo, mother reared for two years until mother's death	1.5	1 to 8 gestures
Zura gorilla	7 year old female	Zoo born, early rearing by humans, then introduced to zoo gorilla troop	1.2	1 to 4 gestures
Koko gorilla	5 year old female	Zoo born, a few months mother rearing, human reared with sign language teaching from age 1 year	2.2	1 to 8 signs
Nim chimpanzee *Pan troglodytes*	between 3 and 4 years old male	Human reared with sign language teaching from age 2 weeks	1.5	1 to 16 signs

significant drop in quantity when a disturbing event occurred (Patterson & Linden, 1981). This was also the case for Kubie. There was a large drop in overall amount of gesturing during study periods other than the one reported here, when there were external environmental or social disturbances (see Tanner & Byrne, 1999, p. 223).

Phrase components

Most gestural phrases can be broken down into functional elements (Table 4). Some gestures may be included in more than one functional category. A gesture type was not necessarily limited to a single function, as function was closely bound to the context in which it was used.

The following list is not exhaustive, but includes gestures used most frequently. A discussion of each category follows.

1. Attention getters/attention directors, incicators:

Examples: *chest beat, body beat, slap surface, knock, head nod, tap other, chest pat, armshake*

Which of these is performed depends to some degree on the attentional state of the recipient. The first four examples above are audible and are likely to be used if the recipient is not looking (Tanner & Byrne, 1996). The "attention getter" may announce the gesturer's request for focus on a forthcoming visual message

Table 4. Gestures and functions (A list of gesture descriptions is provided in the Appendix)

Gesture functions	Some specific gestures
Attention getters and/or attention directors	*chest beat, body beat, slap surface, knock, head nod, tap other, chest pat, armshake*
Motion depictors	*tactile gestures, armswing under, away, come, down*
Indicators of location/ destination	*tap other, pat chest* (and other body locations), *knock* (on object or surface), *slap surface*
Negatives	*hide playface, away, pat off, backhand, wrist glance*

or sometimes draw attention to a location. Some silent attention getters indicate the gesturer: *Head nod* draws a visual path toward the gesturer's body, leading attention directly to the gesturer. *Chest pat* and *body beat* also indicate the gesturer. Choice of attention getter also may be mediated by availability of hands and proximity of recipient. *Head nod* was found to be used rather than other gestures made with the hands and arms when Kubie had an object in his hand, was in quadrupedal locomotion, was already gesturing with his hands, or Zura was too far away to touch (details in Tanner, 1998). *Tap other* requires the other gorilla to be in arm's reach.

Head nod was not only Kubie's most frequent gesture (Tanner & Byrne, 1996) but also the most frequent starter of phrases; it began 25% of Kubie's 109 phrases analyzed here, second to *tap other* and *armshake* (each opened 11% of phrases). A variety of tactile close gestures began 10% of phrases. Interestingly, audible gestures of any kind only started 9% of phrases. It would seem that when extended visual communication was initiated, the great majority of the time it was when the visual channel was already engaged. Visual attention was already present in 88% of cases when *head nods* were performed (Tanner & Byrne, 1996).

2. Motion depiction

Examples: *tactile gestures, armswing under, armshake, away, come, down*

These gestures draw "pictures" of motion, that is, they are iconic. Ape anatomy allows a great deal of rotation in three dimensions, providing means to depict just about any kind of movement, whether through touch on another's body or by gestures in space.

Tactile gestures were made by Kubie's touching Zura's body when the two

gorillas were within easy arm's reach of each other, seated close together or with one or both gorillas standing quadrupedally, or tripedally when gesturing. These gestures were not forcible enough to move the other gorilla unless it desired to cooperate. An example can be viewed in video clip 1; here Kubie attempts unsuccesfully to get Zura to turn her rear to him in mating play. Note the facial expressions that are also an important element of the communication. (In this and the other video examples, sound has been removed. The gorillas did not make vocalizations audible to the camera, and there was a great deal of distracting conversation and noise from human zoo visitors near the camera.)

Movie # 1

Tactile gestures indicated direction by such means as:
A hand or arm moving down the recipients body (back, side or other location)
Patting downward (on the head, back or bottom)
Pushing the head down gently
A hand or arm moving across the recipient's waist or back, toward the gesturer
Lightly tapping, poking, or knocking on a body part (thigh, elbow) in a certain direction (down, away, up)
Pushing away gently
Holding, then releasing, a body part (arm, hand, foot) to stop motion
Pulling gently on a body part (hand, foot), then releasing it, indicating motion toward the signaler
Holding and shaking a body part, presumably to indicate movement is desired of the recipient

Other (non-tactile) gestures of this class were made in space in front of the gesturer's body, usually with eye contact with the partner. (For details on frequencies of eye contact and other features associated with each gesture, see Tanner & Byrne 1996.) *Armshake*, listed both as an attention getter and motion depictor, was a gesture shared by both gorillas and sometimes performed in synchrony in immediate response to the other's *armshake* (12 times during the study period). It appears to show a state of motor activation that is a prelude to further action. Kubie's *armshakes* were most frequently followed by contact between the gorillas; Zura's *armshakes* were not. Zura performed *armshake* in a greater variety of contexts than did Kubie (details in Tanner, 1998), and this

may explain why her *armshake* gestures did not always have the same outcomes as Kubie's.

3. Location/destination
Examples: *tap other, chest pat (and other body locations), armswing under, knock, slap ground*

These were also listed above as attention getters or motion depictors; they can function as such but at the same time may point out a specific locus of attention. This can be the self, another gorilla, or an object in the environment. Kubie would knock on a tree or rock and Zura would often then come to exactly that spot, even if Kubie had moved away.

Some location gestures seem to be a gorilla version of pointing. Many gorilla actions meet criteria for definition of pointing: gaze alternation between object and other gorilla, arm extension, and attention getting behaviors indicating intentionality of communication. It is in fact the inclusion of these elements that distinguish these gestures from their use, at times, as mere attention getters. It is functionality, not anatomy, that defines pointing (see Leavens et al., 1996, Leavens & Hopkins, 1998, 1999). For the gorilla subjects here, these gestures involved actual touching of an object, whether the self (as in *armswing under,* which ended touching the area between the legs, a salient area for sexual play), another gorilla, or a feature of the environment, and with a whole hand (either open or fist; finger tips, knuckles or palms may make contact in different cases) rather than the extended index finger.

Pointing through sound rather than vision is also a possibility. Some of Kubie's gestures *knocking* or *slapping* objects included sound that may or may not have been the primary communicative medium. Communication with sound through *chestbeating*, *clapping*, and *slapping* or *pounding* on the ground or objects, takes place in the dense vegetation of the natural habitat of both gorillas and chimpanzees and perhaps serves the same function there (Schaller, 1963; Fossey, 1983; Mori, 1983; Fay, 1989; Boesch, 1991; Crockford & Boesch, 2003). Percussive sound is probably more efficient, both energetically and in sonic projection, than vocalization in many cases. Humans in the same habitats have discovered this; West Africans have used drumming for long distance communication for all of their known history.

4. Negatives
Examples: *hide playface, away, pat off, backhand, wrist glance*

These gestures may change or negate a message conveyed by other gestures. I

tested this by hypothesising that phrases of gestures that, unlike the majority of phrases, resulted in no contact, would contain at least one gesture I suspected to be "negative", or be interrupted by a negative from the other gorilla more often than those phrases resulting in contact.

I sorted Kubie's gestural phrases from Period 1 into those that resulted in contact and those that did not result in contact. For the "no contact" cases I dropped any with obvious contextual reason for no contact: for instance, when phrases of gestures were part of a display series performed high up on the rocks when the gorilla at whom the gestures were aimed was down below; this game was one where contact was not possible. I then counted the number of Kubie's gestural phrases in each grouping (contact or no contact) that contained a negative gesture by Kubie or contained an interjection of a negative gesture by another gorilla during Kubie's utterance. There was a significant association between the presence of a negative gesture in a phrase and a consequence of "no contact" (Table 5). Besides gestures, of course, other factors such as facial expression may also modify a message; bared teeth or a tense face, for instance, might suffice to discourage play. Nor do all negative gestures result in no contact; one gorilla may still choose to over-ride the other's negative and attempt to play.

Table 5. Negative gestures

Sequel of phrase	**phrase includes negative gestures**	**phrase does not include negative gestures**
Contact follows	11	67
No contact follows	21	10

$\chi^2(1) = 15.1$, $p > .0001$

The gesture *hide playface* has been described in detail by Tanner and Byrne (1993). See an illustration of the use of *hide playface in* video clip 2. This scene was transcribed in writing in the 1993 study but without video available to the reader. In this scene Zura and Kubie are interrupted in their play by the senior male, Bwana. Both show a visible desire to continue playing, with armshakes and playfaces, but both repress this urge; Kubie by knocking away a *bite finger* gesture made by one hand, with his other hand, and Zura by hiding the irrepressible emotional expression of her playface.

Movie # 2

Examples of gestural phrases and exchanges

I here present specific examples of gestural exchanges that were performed by gorillas Kubie and Zura. With the assistance of what has been learned in previous studies about specific gesture types of these gorillas and their functions (Tanner & Byrne, 1993, 1996, 1999), I interpret some of the gorillas' exchanges and the gestures and phrases of which they are composed. Through these exchanges, Kubie and Zura negotiate the nature of the play in which they will engage. Though both gorillas gesture, each has a different idea about body movements, location, and type of play. As was typical in their interactions, Zura is hesitant about cooperating fully with Kubie in these examples and he reshapes his messages according to her reactions. The term co-regulation (from Fogel, 1993) might appropriately be used in this regard. After several seconds of gestural exchange along with other communicative movement and facial expression, play proceeds.

I notate the gestures and a contextual description along a timeline. This is followed by a narrative transcription that will employ the principle that some of the gorillas' gestures can be interpreted as iconic (Tanner & Byrne, 1996). Iconicity may be a key that can bring us closer to understanding ape communication, thus it seems worthwhile to attempt to apply an iconic interpretation even for gestures that did not have a sample size large enough to analyze in previous work. For example, *bite* (on finger) was used by both Kubie (16 times during the study period analyzed) and Zura (14 times during the same period). I have observed this gesture to be a play signal in other captive gorillas and on video of mountain gorillas in the wild (Diane Fossey's film archived at National Geograpic, Washington D. C.) It always occured in situations where the gorilla was inhibited from actually biting a potential play partner. For Kubie and Zura, in the majority of cases real biting on the other's body followed after a *bite finger*. In several of the cases where biting did not follow, there were obvious inhibiting factors, such as the presence of Bwana, the older male. Therefore I interpret *bite finger* as a depiction, involving both tactile and visual elements, of real biting.

Exchange Example 1, May 3, 1989 (see video clip 3).

Movie # 3

Context immediately preceding the example: Kubie and Zura sit facing each other on the rocks, then Zura stands up and begins armshaking. Her rock perch is above Kubie so her foot is near his face level:

Time on video	Kubie's gestures	Zura's gestures	Context and comments	Possible gesture function
00.10		*armshake*		attention getter
00.12		*down*	Kubie gets a playface	motion depiction
00.13		*tap foot*	Kubie makes and holds eye contact with Zura	indicates location
00.14			Kubie begins to pull Zura down by her foot but she turns away, struggling from his grasp	
00.15	*around*		With his tactile gesture *around*, Zura returns her gaze to him	motion depiction
00.16	(partly obscured) *bite finger* (or *come*)		making eye contact with each other	motion depiction
00.17	*knock fists*	*bite finger*		motion depictions
00.18	*extend hands*			invitation
00.19			Contact, with wrestling and biting play, follows	

Possible interpretation: With an armshake, Zura calls Kubie's attention to her desire to engage in play activity; he responds to her approach with a playface. Zura, standing on the rocks while Kubie watches intently, makes a *down* gesture, ending by tapping her foot, thus drawing Kubie's attention to her foot. Kubie takes hold of her foot and begins to pull her down; but she then changes her mind and turns away to struggle from his grasp. When he makes a tactile *around* gesture on her body, she returns her gaze to him. When they make eye contact Kubie indicates his own play intention with a hand moving toward his

mouth (may be an obscured finger bite), then knocks his fists together (iconically, a "coming together"), and hesitates with eye contact with Zura. She bites her finger with a hand motion like his previous one toward his mouth, and Kubie extends his hands to her. Contact follows in wrestling and biting play.

Exchange example 2, May 31, 1989 (see video clip 4).

Movie # 4

Context immediately preceding the example**:** Kubie and Zura have been playing by some trees. Play has paused before this exchange, with Zura sitting by a tree and Kubie arranging his nest of burlap bags nearby.

Time on videoclip	Kubie's gestures	Zura's gestures	Context and comments	Possible gesture function
00.07	*hands behind back*	*armshake* (right hand) *slap surface* (left hand, on tree trunk)	Zura stands bipedally by tree	Kubie: self location indicator Zura: attention getter and motion depiction, location indicator
00.08 00.09	*head nod* *head nod*		Kubie, facing Zura, has open mouth playface	Kubie: self indicator
00.10	*hands behind back*	*hide playface*	Zura hides playface with one hand, other hand on tree	Kubie: location indicator Zura: negative
00.11	*armswing under*	*down hide playface*	Zura removes left hand from tree with the down motion, other hand continues to hide playface	Kubie: motion depiction, indicates location on self Zura: motion, negative
00.12	*tap other armswing under*	*hide playface*	Kubie knocks Zura's hands from her face, but she resumes hiding her playface	Kubie: indicator of other and motion depiction Zura: negative

00.13	*tap other*	*hide playface*	Kubie touches Zura at face level	Kubie: indicator Zura: negative
00.14	*armswing under*		Zura's hands move away from her face, seemingly fending his hands away	Kubie: location indicator
00.15	*head nod*		At Kubie's nod and lowering of his body, Zura approaches and they begin sparring play	Kubie: self location indicator

Possible interpretation: Zura proposes a new start of play with an *armshake*, indicating the tree as location by *slapping* it. Kubie urges her to approach and play with him on the ground. She *hides* her *playface* and stays by the tree, rejecting Kubie's request. Kubie performs a series of inviting gestures and finally, after Zura's moves her hands away from hiding her face, she approaches to participate in sparring play.

Exchange example 3, January 24, 1989 (see video clip 5).

Movie # 5

Context immediately preceding the example: At a rock formation where they often play, Zura leaves the table-like rock where she has been sitting opposite Kubie. (There is a brief jump where video was paused just before this episode starts.)

Time on videoclip	Kubie's gestures	Zura's gestures	Context and comments	Possible gesture function
00.24	*pound*		on table-like rock, with playface	Indicates location
00.25	*chest pat*		(after these first two gestures, 3 second pause while Zura retreats)	Indicates location (self)
00.30	*body beats*		on his stomach; Zura watches	Indicates location (self)
00.32	*pound*		on rock, as she turns head and vision away	Indicates location
00.33		*bite finger*	Zura looks toward Kubie again, runs to the rock	Depiction of motion
00.33	*pound*		on table - like rock, as Zura approaches	Indicates location
00.35	*pound*		on rock indicated earlier, as Zura arrives at the rock and climbs up on it	Indicates location
00.36	*head nod* (twice)	*armshake*	as play starts; then begins to play bite Zura's stomach	Depictions of motion; head nod indicating self as location
00.37		*hide playface*	resisting Kubie's play biting	negative (cancels facial play signal)

Possible interpretation: Kubie drew attention to two locations: the rock where Zura often sat for play (*pound*), and himself (*chest pat*), in particular his stomach (*beats stomach)*. When Zura turned her gaze away his audible gesture, *pound,* recaptured her attention. She responded with a gesture representing an action, *bite*. Zura moved to the play location on the rock; Kubie's *head nod* moved the visual pathway to himself, and he performed the previously signaled action, *bite,* on a location on Zura that he had drawn attention to, the stomach. Zura expressed activation with an *armshake* but shrunk from the biting play Kubie initiated, indicating her reluctance by *hiding* her *playface*.

Discussion

Kubie and Zura's use of gestures conveys more than re-emphasis of a single message promoting the achievement of contact in play, an interpretation that might be gleaned from earlier analyses of these gorillas' gestures. Rather, decisions on when, where and how to play evolve gradually in the course of interaction. Negotiations or co-regulation (term and sense from Fogel, 1993) between partners through their active exchange may sometimes result in cooperation in a specific kind of play, or sometimes result in no play at all. A particular kind of gesture will not always have the same outcome because of all the variables of context, prior activities and influences, and changes in group dynamics.

Why should a gorilla express in gesture proposed activity that could be engaged in by the partner gorilla, when other contextual and expressive elements might suffice? Because gesture does "intend" beyond immediate context and reactions. Gesture is by definition and usage a physical representation rather than a forceful action or irrepressible emotional expression. A gesture is not simply a signal that elicits a response, but a statement of a plausible intention that can, however, be reshaped by the other gorilla's activity.

In the case of the San Francisco Zoo gorillas, there were many environmental and social factors not likely to be exactly replicated in a different zoo. There were two mature males in the group. The older male tended to interfere with any noisy play or commotion in the group, thus silent gestures would allow Kubie, the younger male, to better succeed in negotiating playful interactions with females. There were also several easy escape routes for the females if they did not want to be with the males (a door to the inside rooms kept open to a width where only the females could enter, and outdoors, large trees to climb where heavier males would not be safe). Gestures were more likely to be useful than forceful actions like grabbing, hitting or chasing when it was possible for the females to depart from an interaction entirely.

Consideration of these gorilla interactions may give us some insight into the evolution of joint attention and understanding of the other as an intentional being. These are important elements of human cognition (Tomasello, 1999), whose underpinnings should be discernable in our primate relatives. Kubie's gestures often directed the attention of the other gorilla to both objects in the environment (trees, rocks) and his own body parts. Zura would often move to an object Kubie drew her attention to rather than to Kubie himself regardless of whether Kubie remained there (as in Example 3 above).

The differences found between the repertoires of the gorillas at the San Francisco Zoo and two groups in European zoos studied by Pika, Liebal and Tomasello (2003) might be explained, regarding *process*, by the term "ontogenetic ritualization". What leads to these differences between groups must first be shaped, however, by the totality of influences at each different zoo. Gorillas' gestures are extremely adaptive, in an immediate sense, to their environment, to the daily social situation, and to the immediate circumstances of another gorilla's proximity and mood. Awareness of visual attention and of constantly changing facial expression is part and parcel of their communication. All these factors would be important in any group of gorillas, but the complex and differing web of social and environmental factors in each zoo situation will certainly result in different ways of communicating in each zoo. In some cases shared items of communication have been found to be peculiar to a certain zoo (Tanner, 1998; Pika, Liebal & Tomasello, 2003). Discerning the actual cognitive processes involved in learning these unique shared ways of communicating is best left to further studies of social and imitative learning in apes.

Process aside, it will not be possible to fully understand the communication of the great apes without looking at a whole picture including past and present social contexts. Why might one ape respond to a particular gesture from another ape, yet not respond to the same "signal" made by a different individual? Past social history, perhaps unknown to the observer, must certainly come into play. An example is the role of Bwana, the senior silverback, in suppressing rough play in the younger gorillas. Only in this context is the development of Zura's unique *hide playface* illuminated (details in Tanner & Byrne, 1993). Thus, even when all present contextual elements and communicative media are considered in viewing an ape exchange, past history may be necessary for interpretation. The unique social history of each individual can be inferred in the immediate complexity and unpredictability of observed exchanges between gorillas, but only long term observation of the same small groups of individuals will make more accurate interpretation possible. To do observation of this quality will be necessary for the next generation of ape communication research.

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Though much of the content of this paper was in my doctoral dissertation (Tanner, 1998) and visually presented at a meeting of the American Society of Primatologists in Boulder, Colorado in 2000, there has been much reshaping here. For new ideas that led to the writing of this particular paper, and much time discussing and reading it, I thank Barbara King.

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Appendix: Gesture descriptions

Key to gesture descriptions:
P = place (location on body, or location in space)
C = hand configuration or shape
M = motion (direction, force) of gesture
(after Stokoe, W.C., Casterline, D.C. & Croneberg, C.G., 1965. *A Dictionary of American Sign Language on Linguistic Principles.* Washington D.C.: Gallaudet College Press)

armshake
P: space in front of or at sides of the body
C: one or both relaxed, open hands
M: arms and hands shaken loosely; may vary from prolonged motion of entire upper body to minimal motion of hand(s) shaken from wrists

armswing under
P: space in front of body, ends between legs at crotch
C: open hand or both hands
M: arm(s) swings from space in front of body, back to body between legs

away
P: in front of body
C: extended arm
M: arm moved quickly away from body toward recipient, may or may not touch other gorilla

backhand
P: any environmental surface
C: fist
M: back of hand hits surface forcefully, usually audible

bite
P: mouth, between front teeth
C: extended finger, thumb or side of hand
M: finger or hand held briefly between teeth

body beat
any location on body except chest beaten with alternating open hands or fists. Often audible but not as resonant as real chestbeating

chest beat
chest is slapped with alternating open palms, audible effect

chest pat
P: chest
C: one cupped hand
M: hand taps chest lightly, no audible effect

come
P: space in front of body
C: open hand
M: hand extended, palm up, toward other gorilla; may be held still, or quickly move out from and then back to body

down
P: space in front of or next to body
C: open hand
M: extended arm moves downward

head nod
head moves abruptly downward and then returns to vertical position

hide playface
P: open mouth
C: open, curved hand
M: hand covers mouth

knock (or *pound)*
P: any environmental surface
C: fist
M: knuckles or side of hand hits surface, sometimes audible

slap surface
P: any environmental surface
C: open palm
M: palm contacts surface forcefully, usually with audible effect

pat off
P: other gorilla's body
C: open hand
M: flat hand contacts body and then is pulled sharply away

tactile close gestures
touching of the recipient's body with directional indication but short of force to actually move the body; includes hand moved down the back vertically, or across horizontally; patting, gentle pulling of a hand, pushing away, and others

tap other
P: body of other gorilla, most often head or chest
C: open hand, or fingers bent at knuckles
M: fingertips or knuckles contact body of other gorilla then quickly move back

wrist glance
P: space in front of body
C: relaxed hand, palm down, wrist flexed slightly toward face
M: hand suspended in space, visual attention directed at wrist

Author's address

Joanne E. Tanner
3071 Dover Drive
Santa Cruz, CA, 95065
USA
email: gorilvr@pacbell.net

About the author

Joanne E. Tanner received her Ph.D. in Evolutionary Psychology from the University of St. Andrews, Scotland, in 1998. She has observed and videotaped the gorillas at the San Francisco Zoo regularly since 1988, and has also been a volunteer companion to the signing gorilla Koko since 1981. Tanner has lectured at the University of California at Santa Cruz, teaching Primate Behavior. Her first academic degree was in music performance, from Oberlin College, Ohio, in 1965, and she continues to be an active teacher and performer on the violin.