The Mentalities of
Gorillas and Orangutans

Comparative Perspectives

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The development of spontaneous gestural communication in a group of zoo-living lowland gorillas

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When zoo-living gorillas perform communicative physical motions that seem to resemble those of signing gorillas, what does it mean? What are the processes involved in developing these gestures? What communicative behavior is universal for the species and what is individually learned? Though some gestures are shared by all gorillas and others are unique to individuals, such a simple dichotomy does not really tell the whole story. We have found that, in the gorilla group at the San Francisco Zoo, "species-typical" expressions such as slapping, clapping, pounding, and chestbeating develop quite differently in each individual. Individuals also create gestures, some of which have not been described for other gorillas. Other gestures are shared by a few, but not all, individuals in a group. Gestural repertoires of different individuals at the same ages vary both in type and quantity. There is variation in individual gorillas' usage of gestures over time and in accord with changing social conditions. The purpose of the present research is to describe this variation, explore the diverse physical and functional properties of these gestures, and learn why and how they have developed in this particular captive group of gorillas.

Before beginning the observations at the San Francisco Zoo that are described here, the first author (JT) had worked for 8 years with the signing gorillas Koko and Michael of the Gorilla Foundation, developing a particular interest in untaught signs and "natural" gestures of sign language tutored gorillas (Patterson, Tanner, & Mayer, 1988; Patterson & Tanner, 1988). When JT visited the zoo as a casual observer after having worked with signing gorillas, she was struck by the amount of gestural communication used by the zoo gorillas, some of which resembled untaught gestures or even taught signs used by signing gorillas. The iconic nature of some of the gestures used by the zoo gorillas as well as the sign-instructed gorillas seemed to be a feature held in common. Some zoo gestures had physical properties that appeared to depict activity desired or intended by the gesturing gorilla. For the sign-instructed gorillas, gestural inventions often seemed to outline physical features of objects or locations which were brought to their attention or to which they wished to draw attention. Exploration of this iconic aspect of gorilla gesture has been another of the aims of study.

SUBJECTS AND SETTING

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 × 50 m 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 cave-like areas. The enclosure is below ground (viewer) level, except for one windowed viewing area where gorillas and humans can interact face to face.

The subjects, the gorillas at the San Francisco Zoo, are members of a stable social group and all have spent either most, or the entirety, of their lives at this zoo. The group at present includes the son, Kubie, and grandsons, Shango and Barney, of the wild-caught founder, Bwana, as well as unrelated individuals. A wild-born but human-reared female, Pogo, grew up at the zoo with Bwana; and two younger 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. Bawang is the mother of Kubie's offspring, Shango and Barney. Further information about each of the gorillas in the group during the study is given in Table 11.1 (and see Parker, chapter 18, this volume). Though they interact daily with keepers and observe zoo visitors, none of these gorillas has had any intentional human instruction in gestural communication.

The two senior gorillas, Bwana and Pogo, had important roles in the group though they gestured very little. Until his death Bwana was a strong leader, continually watchful and alert to every event. The coexistence of two silverback males is unusual in zoos, and the interaction between Bwana and his son Kubie influenced the dynamic of the whole group. Though frequently challenged by Kubie, Bwana was himself rarely the instigator of display or aggression. On a one-to-one basis, Bwana usually retreated from Kubie unless severely provoked, but the rest of the group would rally with Bwana and take aggressive action to subdue Kubie if he harassed a youngster or female.

Pogo, the oldest female, who has never mated, has consistently repelled male advances over the years, though she would often teasingly court male attentions. Recently, a medical examination ascertained that she had a constriction in her vagina. Until the birth of Bawang's babies, Pogo spent a lot of time in the trees or on the periphery of the social group, trying to avoid harassment from Kubie in particular. She was extremely interested when Bawang's infant, Shango, was born and tried to get near him for months, but Bawang did not allow contact until Shango was 6 months old. After that, Pogo gradually became a preferred playmate and frequent "baby-sitter" for Shango. She has also played with Barney, but not as much, because Barney has older brother Shango as play partner. Pogo, like Bwana, rarely gestured, though once in a while in the course of play she would engage in a surprising burst of communicative activity.

GENERAL METHODOLOGY

Beginning in October 1988, observations were made one morning each week for approximately 3 hours when the gorillas were outdoors (conditions permitting).

Table 11.1 *Gorillas of the San Francisco Zoo*

Name	Sex	Age in March 1989	Age in March 1996	Birthplace and rearing	Parents
Bwana	male	31	deceased 1994	wild born, Cameroon	unknown
Pogo	female	31	38	wild born, human reared in Cameroon	unknown
Kubie (Mkubwa)	male	13	20	captive born, mother reared in San Francisco	Bwana and Jackie
Bawang	female	8	15	captive born, nursery reared in Cincinnati	Ramses and Amani (Cincinnati)
Zura	female	7	14	captive born, nursery reared in Columbus	Oscar and Toni (Columbus)
Shango	male	born March 1989	7	captive born, mother reared in San Francisco	Kubie and Bawang
Barney (Ike-ozo)	male	born October 1993	2.5	captive born, mother reared in San Francisco	Kubie and Bawang

Regular observations have continued to the time of this writing, except for one 6–month hiatus in the study from September 1989 to March 1990. Videotaped records were chosen as the only adequate way to study gestural communication; tiny variations in physical form of motions and direction of gaze are important elements for study and cannot always be instantly perceived nor adequately described in the form of written notes; further, any aversion of an observer's gaze to write may mean loss of data.

The research team has consisted of both JT and the camera operator, her husband Charles Ernest (CE), throughout the study except for 9 months in 1992–1993 when in their absence a team of trained students followed the same videotaping procedure JT and CE had established: the principal researcher (JT) scans the activity taking place and suggests to the camera operator the most relevant area to film. The camera follows a given social interaction continuously wherever possible (sequence sampling). For the first few years of the study, the choice of subjects was easy because virtually all of the gesturing occurred during play sessions between a young silverback, Kubie, and a young adult female, Zura. Very little gesturing took place in agonistic contexts or between other gorillas, and none in feeding situations. Later in the study, when play sometimes occurred simultaneously between two of the older gorillas and between an infant and older gorilla, the camera continuously followed the interaction thought most likely to contain gestural communication. If no apparent interaction was occurring and the gorillas were all resting, eating, or spatially separated, the camera was turned off. This procedure has resulted in approximately 200 hours of videotape used for the various analyses described in this chapter. (On average, a 3–hour visit would yield an hour of usable videotape.) The videotaped records are time coded, date and time stamped, and often include verbal commentary about context or behavior of other members of the gorilla group while the camera was focused on a single ongoing interaction. Further, JT took diary-style written notes about any events affecting the gorillas' activity that the camera was unable to record (such as annoyance from zoo visitors, airplanes or construction noise causing distraction, or information from the zoo-keeper about events during the previous week).

Each videotaped instance of gesture was catalogued on the Filemaker Pro database computer program. Only gestures clearly visible on the videotape were included. If the same gesture was rapidly repeated consecutively several times it was counted only once. Most gorilla vocalizations were too quiet to analyze and are ignored here, but bodily gestures which produced sound are included.

GROUP HISTORY AND STUDY PERIODS

The data analyzed here is divided into six "study periods" of roughly equal duration. A "period" was delineated on the basis of the occurrence of important social events or changes in group composition. Such changes often seemed to affect social communication. A brief social history explains what events and changes demarcated study periods (see Table 11.2).

Table 11.2 *Study periods and social history of group*

Study Periods	Duration	Age of juveniles	Social conditions and activity
Period 1	October 31, 1988–September 20, 1989 (Then a 6–month break in data collection occurred.)	from beginning of observations until Shango's age is 6 months	Kubie plays exclusively with Zura; Bawang is pregnant, then stays continually with newborn Shango.
Period 2	March 19, 1990–June 17, 1991	Shango, 1 to 2.3 years	Noise stress from nearby construction causes some decrease in play (Gold & Ogden, 1992); Kubie plays with both Bawang and Zura; Shango plays with everyone.
Period 3	July 1, 1991–September 22, 1992	Shango, 2.3 to 3.5 years	Kubie begins to pursue and guard Bawang, presumably from his father Bwana. Kubie does not play at all. Shango plays with all the females; this is the only play in the group.
Period 4	October 2, 1992–June 24, 1993	Shango, age 3.5 to 4.3 years	Kubie's pursuing and guarding of Bawang continues until mating and into the first few months of her pregnancy (February 1993). He does not engage in play. Shango plays with the females.
Period 5	July 14, 1993–September 1, 1994	Shango, 4.3 to 5.6 years; Barney, birth to age 11 months	Reappearance of play on Kubie's part; this period extends from the latter part of Bawang's pregnancy, through Barney's birth in October 1993 to his age 11 months. Kubie's play is nearly all with Shango; Shango plays with everyone. This period ends with Bwana's death.
Period 6	September 6, 1994–January 26, 1996	Shango, 5.6 to 6.10 years; Barney, 11 months to 2.3 years	This period begins right after Bwana's death; Barney is becoming independent; Kubie plays with both youngsters; they play with everyone and particularly each other.

DEFINITION OF GESTURE

Gesture has been defined in many different ways. For animals, gesture frequently refers to bodily motion or facial expression that is "ritualized" to some degree. For human behavior, gesture can mean almost any intentional and voluntary kind of nonverbal communication. Because an aim of study has been to focus on the degree to which signs and signals distinct from ordinary whole body action are used by gorillas, here body postures and locomotory gaits have been excluded from categorization as gesture.

As a working definition, the term *gesture* is here used for *all discrete, non-locomotor limb and head movements, regardless of receptive sensory modality* (sight, sound, touch), *that occurred when gorillas were in proximity and were engaged in social interaction immediately before, after, or during the movements*. We presumed these gestures to be communicative, in the sense of attempting to influence other gorillas' behaviors, and then examined the data to see if such gestures in fact were consistently responded to with particular behaviors by others.

In *tactile* communication, gestures may be defined as different from ordinary motions in that they involve transformations of purposive behaviors so that they are no longer forceful enough to be mechanically effective (Bretherton & Bates, 1979; Goldin-Meadow & Mylander, 1984; Gómez, 1990). For example, lightly brushing a hand downward on another's body to indicate a desire for downward movement on another's part would be a *tactile gesture*, as opposed to the direct *action* of forcefully pushing the other down. A purely *visual gesture* with similar function would be performed by a downward motion of the hand and arm in the space in front of the signaler's body while having the visual attention of the other.

CLASSIFICATION OF GESTURES

All gestures by the gorillas, whether visual, tactile, or auditory, were catalogued. Table 11.3 provides a descriptive list of all the gesture types specifically referred to in this chapter, with comparisons to similar gestures in other ape species.[1] The gestures in Table 11.3 are only part of the San Francisco gorillas' actual repertoire; other gestures did not occur with enough frequency to provide sample sizes sufficiently large for analysis.

[1] These comparisons were difficult because in many sources a careful physical description of gestures was not given. For instance, terms such as patting, poking, tapping, hitting, and swiping may have been interchangeable in ethograms from different zoos. Therefore the comparisons in Table 11.3 are not exact, and in some cases guesses. Many gestures and other behaviors that have not been observed in San Francisco are listed for gorillas in other zoos, but likewise some San Francisco gestures are not reported elsewhere. Some gestures used socially in San Francisco are listed only as solitary or stereotyped behavior in other zoos. The number and type of behavioral elements in ethograms for the same species also vary tremendously from one to the other, perhaps because of the individual goals and observational focus of the studies they were for, but probably also because behaviors differ from zoo to zoo and in the wild.

Table 11.3 *Some social gestures of the gorillas at the San Francisco Zoo*

Gesture type and class; gorillas who used that gesture[a]	physical description	usual context at S. F. Zoo	similar gesture in other gorillas in zoos or wild?	similar gesture in other apes?
armshake silent visually received Kubie, Zura, Bawang	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	play, sometimes warning	several zoos, also called wave or hand shake; solitary or sterotyped only in some gorillas, 1	bonobo: nervous request or threat, De Waal, 1988 chimpanzee: wristshaking, threat, Goodall, 1986; warning, approach invitation, De Waal, 1988, Plooij, 1984
armswing under silent visually received Kubie, Zura	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	male–female play		chimpanzee: beckoning?, Goodall, 1968b; stretch over, Van Hooff, 1973, Plooij, 1984 bonobos: ? Savage-Rumbaugh et al., 1977
backhand pound audible Kubie, Zura, Shango	P: any environmental surface C: fist M: back of hand hits surface forcefully, usually audible	play, agonistic display	frequent at zoos, 1; in wild, 2	chimpanzee: "hitting away" (threat), Goodall, 1968a
body beats audible Kubie, Zura, Bawang, Shango, Barney	any location on body except chest beaten with alternating open hands or fists. Often audible but not as resonant as real chestbeating	play	frequent at zoos, 1; in wild, 2	

Table 11.3 *Continued*

Gesture type and class; gorillas who used that gesture[a]	physical description	usual context at S. F. Zoo	similar gesture in other gorillas in zoos or wild?	similar gesture in other apes?
chest beat audible Kubie, Zura, Bawang, Shango, Barney	chest is slapped with alternating open palms, audible effect	play, agonism, display	species typical: details on use in mountain gorillas, 2	
chest pat silent visually received Kubie	P. chest C: one cupped hand M: hand taps chest lightly, no audible effect	play	at several zoos, 1; in wild, 3	bonobo: De Waal, 1988
clap audible Kubie, Zura, Bawang, Shango, Barney	flat hands, palms contact in space in front of body. Audible effect	play	frequent in zoos, 1; in wild, 3, 4, and Fay, 1989	bonobo: Ingmanson, 1987, De Waal, 1988, Thompson 1993
head nod silent visually received Kubie	head moves abruptly downward and then returns to vertical position	play	in wild, 3	chimpanzee: inviting approach, De Waal, 1988; also Savage in Fouts unpublished and undated training material
hide playface silent visually received Zura	P: open mouth C: open, curved hand M: hand covers mouth	avoiding play		
knock/pound audible Kubie, Zura	P: any environmental surface C: fist M: knuckles or side of hand hits surface, sometimes audible	play	frequent at zoos, 1	
slap (surface) audible Zura, Bawang, Shango, Barney	P: any environmental surface C: open palm M: palm contacts surface forcefully, usually with audible effect	play	frequent at zoos, 1; in wild 2, Mori, 1983	chimpanzee: frequent in wild and captivity
tactile gestures tactile close Kubie, Zura, Bawang, Shango, Pogo	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	positioning, mating play	probably at other zoos, described as push, brush, or nudge, 1; in wild 2	bonobo: Savage-Rumbaugh et al., 1977 chimpanzee: Kohler, 1925, Yerkes, 1943
tap other silent visually received Kubie, Zura, Shango	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	play	at several zoos, may be called poking, tagging or touch with hand, 1; in wild 3	bonobo: punching? Savage-Rumbaugh et al., 1977, De Waal, 1988 chimpanzee: poke? Van Hooff, 1973

References for comparisons to other gorillas: 1. Ogden & Schildkraut, 1991; 2. Schaller, 1963; 3. Robert Campbell films at National Geogographic, viewed by J. T., 1991; 4. Fossey, 1983.

[a]"used" means gesture was observed to be performed at least 5 times in at least one study period by the listed gorilla(s)

P = place (location on body, or location in space)

C = hand configuration or shape

M = motion (direction, force) of gesture

(PCM system as by Stokoe et al., 1965)

KUBIE'S GESTURES

The young silverback male Kubie, in his play with the female Zura, had the largest repertoire of gestures of all the gorillas during Period 1. The first classification project undertaken was an analysis of Kubie's gestures during this period. A corpus of over a thousand gestures performed during interaction with Zura, gleaned from 22 hours of videotape, was used for this analysis (Tanner & Byrne, 1996). Three main classes of gesture were discerned:

(1) *Tactile close* gestures trace or mime on the body of the receiver movements that the gesturing gorilla apparently desires the other gorilla to make. In the majority of cases these gestures do not require visual attention of the receiver.
(2) *Silent visually received* gestures are usually made when the signaler has the recipient's visual attention. They invite further attention, elicit activity, or promote contact (*armshake, armswing under, head nod, chest pat, tap other*).
(3) *Audible* gestures elicit the receiver's attention through sound as well as motion. They often are performed without the receiver's visual attention (*chestbeat, knock, pound*).

Each class of gestures had consistent, but different, communicative effects: *Tactile close* gestures usually resulted in movement of Zura's body in the direction indicated by Kubie's gesture; *silent visually received* gestures resulted in a high rate of bodily contact in play activity. These first two classes of gestures are not regularly seen in all gorillas and have properties that we consider iconic or deictic. (For further discussion of iconicity see Tanner & Byrne, 1996, and the general discussion at the end of this chapter.) *Audible* gestures, which are species-typical, resulted in a low rate of subsequent physical contact, but did frequently result in redirection of the attention, or alteration of the locomotion, of the recipient gorilla.

The frequency distributions of these different classes of gestures varied in different kinds of play sessions between the gorillas. Their frequencies corresponded to differing degrees of physical proximity and visual access of the gorillas to each other. For instance, *tactile close* gestures were most frequently used in sessions of play involving positioning for sexual inspection and mating play; *silent visually received* gestures were most frequently used for a game of tag around a tree and for a tug-of-war game where both players were within a few feet of each other; *audible* gestures were most frequently used in a long-distance "king of the mountain" game with one gorilla on top of a rock formation and the other below on the grass, repeatedly trading places.

A further finding in this study of Kubie's gesture (Tanner & Byrne, 1996) was that playfaces (open-mouthed faces), as used by Kubie, were not *signals* promoting play, but always responses to imminent contact by Zura. Visually received gestures, on the other hand, were useful in promoting play contact in the face of resistance or reluctance on the part of Zura. Recent work by Pellis & Pellis (1996) reanalyzing the "playface" argues that the open mouth of the playface is a preparation to fend off the "attack" of another animal by biting, not a metacommunicative "play signal"; Kubie's usage seems to fit this interpretation.[2]

ZURA'S *HIDE PLAYFACE*

Zura, Kubie's play partner, also had a large repertoire of gestures, some of which have yet to be analyzed. One gesture that was unique to Zura, however, seemed to call for closer study. This was Zura's behavior of hiding her playface with a hand or both hands during interactions with Kubie. (See Figure 11.1: Zura *hides playface* while Kubie performs *head nod* and *hands behind back*, a possibly deictic inviting gesture; and Figure 11.1e: Zura again *hides playface* as Kubie completes *armswing under*.) The *hide playface* was found to be significantly associated with postponement or nonoccurrence of play and to take place in several contexts: when the older male, Bwana, was in proximity or directly interfering with play, where play with the larger Kubie was getting particularly rough, and in situations where she may have hoped to deceive Kubie about her play motivation (Tanner & Byrne, 1993). Zura's behavior is similar to that of a chimpanzee who hid his fear grin with his hands (De Waal, 1982). This is the only other report of an pe manually concealing a facial expression.

A reinterpretation of the playface by Pellis and Pellis (1996) as a response rather than signal (on the face-maker's part) fits well with our conclusion that Zura was concealing her play motivation to prevent the occurrence of play in situations in which it would cause trouble. Zura restrained her presumably automatic and involuntary playful response, apparently aware that after her open-mouthed playface contact play was imminent. This playface-hiding took place in Kubie's view in 21 of 22 cases where line of sight was detectable on the video. Therefore, though perhaps the playface was not an intentional signal by Zura, it may have functioned as a signal to Kubie. Zura behaved as if she was aware of this by producing a canceling signal. She may have anticipated that the onset of contact play would cause interference from Bwana or cause her to get rough treatment from Kubie. Zura was, in essence, fashioning a simple negative by separating a signal from its referent, a first step toward some of the properties of human language (Bateson, 1968).

GESTURAL REPERTOIRE OVER THE LONG TERM

We now turn to the larger picture of change in gesturing over the longer term for the entire group. Some of the changes in number of gestures both within and between

[2] For comparison to chimpanzees, see Goodall (1968a) who observed that the playface was used to *initiate* play by only one individual among the entire troop at Gombe. For others, the playface only became evident during the play session: "the full play face was in fact usually displayed as soon as contact play (wrestling, tickling, etc.) became at all vigorous" (Goodall 1968a, p. 258). The "play walk," a ritualized rolling gait, was used by adolescent and older males to initiate play; for juveniles and females, often a simple approach and reach initiated play. In later writing about play initiation, Goodall (1986) does not mention the playface as a play initiation at all, but discusses additional play invitations such as "finger wrestling," "back present," or approach with a "play twig" in the mouth or brandished in the air for the invitee to attempt to snatch.

a 25.25
Zura *slaps* tree+*armshake*
Kubie *hands behind back*

b 25.28
Zura *hides playface*
Kubie *head nod, hands behind back*

c 25.30
Kubie *tap other*

d 25.31
Kubie *armswing under* (come...)

e 25.32
Zura *hide playface*
Kubie *armswing under* (hand arrives between legs), *headnod*

f 25.33
Kubie and Zura make contact and wrestle

Figure 11.1 Series of gestures by Kubie and Zura, Study Period 1 (time on videotape in minutes and seconds).

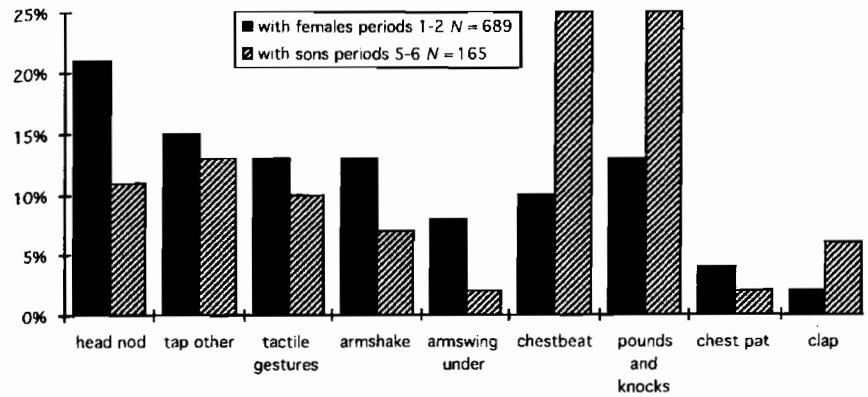

Figure 11.2 Kubie's most common social gestures during periods with different play partners, with percentage of each gesture type used per period (for this comparison, Periods 1 and 2 were combined and Periods 5 and 6 were combined; Periods 3 and 4, when Kubie did almost no gesturing, were not included).

individuals from period to period were so drastic that, even without statistical analysis or strictly equal observation times, they call for explanation. The most striking changes in quantity of gesture over time were clearly related to social circumstances (see Table 11.2). The number of gestures Kubie was observed to use during Periods 1 and 2 when he was playing regularly with Zura was 100 times greater than the number he was observed to use in Periods 3 and 4, when he stopped playing and spent a great deal of time pursuing Bawang.[3] Kubie's observed gestures increased again by about 14 fold during Periods 5 and 6 when he again began to play, this time with his sons. As gestures are found predominantly in play contexts, the cessation of play behavior by Kubie for Periods 3 and 4 meant virtual cessation of his communicative gesture.

Change in gestural repertoire with different social partners

Whether a gorilla's type of gestures might differ in interaction with different individuals seemed worth investigating, since we had already found that gestures used vary according to style and setting of play. There was, indeed, a difference in distribution of types of gestures observed to be used by Kubie at different times with different play partners (Figure 11.2). For analysis, Periods 1 and 2 were combined into an "early" period, and Periods 5 and 6 into a "late" period. During Periods 1 and 2, the early period, Kubie's play was with females; during Periods 5 and 6, the late period, his play was almost exclusively with his young sons. Proportions, within each period, of the nine most frequent gesture types observed for Kubie varied very significantly overall between the earlier and later periods ($\chi^2[8, N = 854] = 67.26, p < 0.0001$). (Here, and in

[3] An earlier lesser drop in Kubie's gesturing from Period 1 to Period 2, when he still played regularly, may have been related to the occurrence of noise stress from nearby construction; an overall decrease in play in the group at this time was documented (Gold & Ogden, 1992).

all succeeding analyses, N is the total number of Kubie's gestures rather than, as normally the case, the number of individuals contributing data. Note that for this reason statistically valid conclusions do not generalize to all gorillas.) In order to investigate whether this variation was particularly associated with certain gestures, we examined each gesture separately, in comparison to all other gestures pooled. Thus, for each gesture type, we constructed a 2×2 table in which the frequency of that gesture was compared with that of all others combined, for each of the two observation periods, early and late. Some gestures did not show significant variation relative to the whole set: *tap other* ($\chi^2[1, N = 854] = 0.67$, $p > 0.4$), *tactile close* gestures ($\chi^2[1, N = 854] = 1.10$, $p > 0.3$) and *chest pat* ($\chi^2[1, N = 854] = 2.11$, $p > 0.1$). All the other gesture types did show significant variation in proportion of use from earlier to later periods. There was relative decrease in the later period of the silent inviting gestures *head nod* ($\chi^2[1, N = 854] = 9.28$, $p < 0.01$), *armshake* ($\chi^2[1, N = 854] = 5.03$, $p < 0.03$), and *armswing under* ($\chi^2[1, N = 854] = 7.99$, $p < 0.005$), but increase in *chestbeat* ($\chi^2[1, N = 854] = 28.32$, $p < 0.0001$), *knock* and *pound* ($\chi^2[1, N = 854] = 12.97$, $p < 0.001$) and *clap* ($\chi^2[1, N = 854] = 8.85$, $p < 0.01$).

The gestures *head nod, armshake, armswing under* (see Figure 11.1 b, c, d and e) were used extensively by Kubie during Period 1 to get and direct visual attention and encourage approach during play with females (Tanner & Byrne, 1996). These gesture types were used less by Kubie when he played with his young sons in Periods 5 and 6, probably because, in play with Kubie, older son Shango was usually the initiator. The gestures that increased for Kubie in Periods 5 and 6 were typical audible male displays (*chestbeat, knock*, and *pound*), plus *clap*, which was a frequent gesture of Shango's. It might seem odd that *tactile close* gestures were observed in the same relative frequency in Kubie's play with his sons as in play with Zura and Bawang, because that type of gesture was associated with positioning for mating play. Kubie, however, sometimes engaged in mounting behavior and anal inspection with his sons, and *tactile close* gestures also functioned to adjust location in ordinary play when the gorillas were already in close contact.

Finally, the number of Kubie's gestures with his sons during Periods 5 and 6 was far less than during Periods 1 and 2 with the females, even though observation time was greater for Periods 5 and 6. Perhaps the females required greater persuasion to participate in interactions than the rambunctious youngster Shango. Shango often actively tried to initiate play, and used gestures to do so, even when Kubie initially showed no interest. (Number of gestures observed of Shango during Periods 5 and 6 was roughly double the number of observations for Kubie.) For Kubie's gestures in Period 1 where the sequels were contact, on the other hand, Zura initiated the actual contact 70 to 80% of the time; it seems that Kubie's gestures were important in influencing her choice to take part in contact interaction. These differences in Kubie's usage of gesture in differing social situations (interaction with females vs. young males) support the finding in our earlier work that gestures function as specialized communicative elements and vary according to context.

Individual differences in gesturing in brothers at the same age

In order to discover what kind of differences might appear in the development of gesture in gorillas of the same age and sex, a comparison was made of the gestures that brothers Shango and Barney each were observed to use socially when aged 12 to 27 months (Figure 11.3). Barney seemed to use a larger overall number of gestures than his older brother Shango did at the same age; though observation time was not strictly equal, Barney still was observed to use nearly 3 times as many social gestures. For both, the most frequent gestures were primarily *slap* (on surfaces in the environment such as the rocks, ground, and trees), *clap*, and *chestbeat*, all typical in gorillas as a species (see Fay 1989 regarding clapping as species-typical for lowland gorillas). Barney also performed a substantial number of *armshakes*. The four gestures seemed interchangeable in function; all were used the large majority of the time when in front of another gorilla in fairly close proximity and therefore can be considered to be communicative. Proportions of these four gesture types observed within the matching age periods varied significantly overall between the two brothers ($\chi^2[3, N = 287] = 28.13$, $p < 0.0001$). Further analysis did not show variation in the frequency of *chestbeat* by each brother for the matching age periods, relative to other gestures ($\chi^2([1, N = 287] = 2.09$, $p > 0.1$). However, Barney was seen to use *clap* ($\chi^2[1, N = 287] = 11.13$, $p < 0.001$) and *armshake* ($\chi^2[1, N = 287] = 6.57$, $p < 0.01$) relatively more than Shango, and *slap* ($\chi^2[1, N = 287] = 18.85$, $p < 0.0001$) relatively less. Barney also used *clap* in nonsocial ways not seen in Shango (these instances are not included in the numbers above for *clap*, which are for social, communicative gestures only).[4]

Two young hand-reared male gorillas studied by Redshaw and Locke (1976) also varied from our subjects in their gesture usage. Both strongly preferred slapping, like Shango, at a similar age (1.10 to 2.2 years) to our subjects. Clapping was rare, and at this age their subjects did not use chestbeating in a friendly social context. Slapping was always followed by the approach of the other gorilla for Redshaw's subjects; this was not the case for Shango or Barney, perhaps because their slaps were often performed in front of the older gorillas, who frequently did not choose to play. Redshaw's subjects had only each other as companions.

At times Barney also performed *claps* and *chestbeats* in immediate response to claps or chestbeats by other gorillas (or zoo visitors); this was never observed in Shango during the same age period. Parker (1993, and chapter 18, this volume) reports imitative response by Kubie to his own older brother's chestbeating and slapping between age 2 and 3 years. However, Barney developed an *armshake* gesture that was never a part of

[4] Barney, unlike Shango, seemed to use *clap* as a "marker"; he would frequently clap just *before* jumping off an object such as a tree trunk, rock, or ledge, or clap immediately *after* accomplishing some physical feat such as stripping the bark off a stick, jumping off something, or climbing up and balancing on top of an object like a tree trunk, tub, or large pile of branches. *Chestbeat* also was performed several times prior to jumping, but *slap* was not, perhaps for anatomical reasons. This aforementioned "marker" usage did not seem to be an attention-getting device and did not appear to be communicatively directed toward others; it might be similar to expressions used by very young children to encode success (called non-nominal autoprotodeclaratives by Gopnik [1982]), such as *"there"* upon placing a block or puzzle piece successfully.

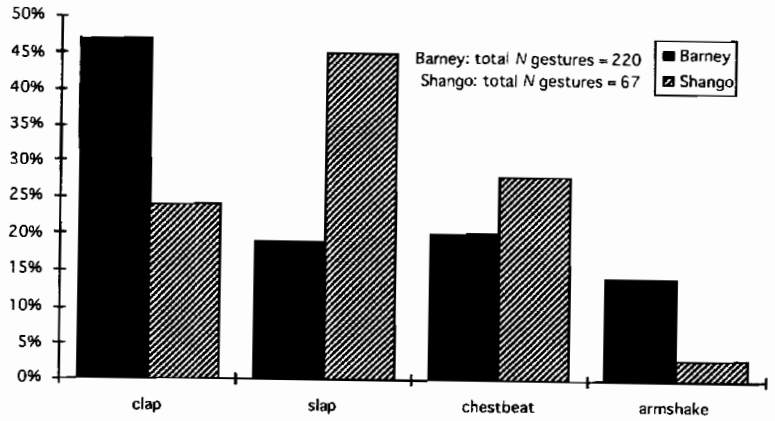

Figure 11.3 Most frequent gesture types (social) between ages 12 and 27 months in two young male gorillas, as percentage of total repertoire of each gorilla.

Shango's standard repertoire despite his frequent exposure as a youngster to its usage in play between Kubie and Zura. Barney seemed to discover *armshaking* in solitary situations, a few weeks later extending it to social usage. Parker reports similar progression of development of *armshake* in Kubie, and also lists twice as many types of play "enticements" used by Kubie as for his older half brother, Sunshine (now at another zoo). Perhaps the greater quantity and variety of gesture use seen for Barney and Kubie, the younger brothers, were some kind of "sibling effect" resulting from early exposure to an older brother's gestures, or were simply because the younger sibling tends to be less controlled by the mother and has more motivation to initiate play when an older sibling is available as playmate.

Developmental changes in gesturing in the individual

To learn about development in gesture use from juvenile period to maturity in an individual gorilla we followed the usage of gestures by the young male Shango across time from age 1 year to age 6 years 10 months (Figure 11.4). Proportions of observations of *slap, clap*, and *chestbeat* within five different Study Periods varied very significantly overall ($\chi^2[8, N = 465] = 134.53, p < 0.0001$). With increasing age, Shango not only was observed to use a larger number of gestures, but showed a change in preferred types of gestures. After age 5 years 6 months (Period 6) Shango played not only with his father, Kubie, but increasingly actively with his younger brother Barney. During this period there is a relative decrease in both *clap* and *slap* and a sharp increase in *chestbeat* compared to the earlier Period 5. Comparison of the frequency of observations of each of the three commonest gestures against the other gestures pooled, in 2×2 tables, showed significant variation in Shango's proportion of use of each gesture between Period 5 and Period 6: for *clap*, ($\chi^2[1, N = 305] = 22.96, p < 0.0001$); for *slap*, ($\chi^2[1, N = 305] = 9.68, p < 0.01$); for *chestbeat*, ($\chi^2[1, N = 305] = 61.04, p < 0.0001$). Period 6

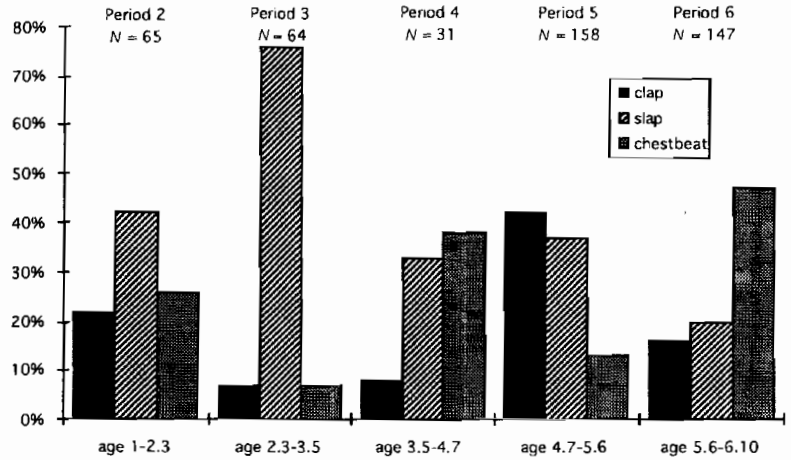

Figure 11.4 Shango's most common social gestures over a 5–year span (Study Periods 2–6) with percentage of most frequent gesture types out of total gestural repertoire for each period.

also saw the new appearance of *backhand* and an increase in *tactile close* gestures (not shown in Figure 11.4).

As Shango matured, his gesture use began to approximate that of his father, Kubie: he was seen to perform *chestbeat, backhand*, and *tactile close* gestures more frequently, and *clap* and *slap* were performed less frequently. Perhaps *clap* and *slap* are "baby" gestures, gradually dropped with increasing maturity; similar dropping of earlier gestures in maturity was found by Tomasello et al. (1989, 1994) for chimpanzees. However, this may be different for females; the preferred gestures of Bawang, Shango's mother, at the age of 9 (when Shango was between age 1 and 2.3 years) were *slap, clap*, and *body* (other than chest) *beating*; she rarely *chestbeat*. The same gestures remained prevalent for Bawang at age 14 (when her younger son Barney was between 1 and 2.3 years old), though Bawang was observed to gesture less overall at the later age. There may be functional reasons for females to use audible gestures other than chestbeating. Chestbeating is not an anatomically comfortable behavior for a lactating female, as Bawang has been during most of the duration of this study; clapping would serve far better as auditory communication during lactation. Zura, a female without young, chestbeat frequently at the same ages when Bawang did not. The fact that, in the wild, clapping has been observed only in females and young (Fay, 1989) seems to support this idea.

The two oldest individuals in the group, Bwana and Pogo, did very little gesturing at all. Until we can follow other individuals to the same age it will be impossible to know whether reduced gesturing is related to age, and perhaps available energy, or is a matter of individual differences. Much of the gesturing done by the other gorillas is performed bipedally, and the oldest gorillas rarely assumed a bipedal stance.

DEVELOPMENT OF GESTURES: GENERAL DISCUSSION

The questions posed at the beginning of this chapter are really one question. How does an animal born with a certain set of typical species behaviors move from these to creation and comprehension of unique ways of communicating through movement and sound? It is apparent from these zoo observations that this creative potential is present in the untutored ape, and we see its furthest development in the innovative signs of apes taught sign languages and other symbol systems. We discuss three aspects of the development of gestures: first, how and why iconic gestures might develop; next, the stages when different classes of gesture may appear (and sometimes disappear) in the development of individual lifespans; and, finally, the extent to which there seem to be differences in the kind of gestures developed by zoo-living and symbol-taught apes, and what this indicates we might find in wild populations.

The development of iconic gestures

The anatomical element that unifies the gestural abilities of all the great apes is the complete rotational movement of their joints. Though individual digit control evolved earlier, only the apes can produce movement in all directions from wrist, elbow, and shoulder joints. This locomotory adaptation that allows movement through trees also makes possible subtle gestures of the hands and limbs (Morbeck, 1994, and see Chevalier-Skolnikoff, Galdikas, & Skolnikoff, 1982; Povinelli & Cant, 1995, for diverse ideas regarding the effect of ape locomotion on cognitive ability). We propose that the ability to function in three dimensions underlies a shared emergent ability of the great apes to depict motion iconically with the limbs. With these fine rotational movements, a single gesture type can vary in configuration, direction, size, and forcefulness on a continuous scale according to the circumstances of its use. Though to produce mimetic gesture the necessary anatomy must be supplemented by an adequate level of cognition, feedback to the brain from the results of use of the brachiator's distal anatomy would certainly have facilitated development of iconic gesture like that which we observe in the great apes.

The importance for the history of humanity of the development of the ability to depict actions and objects iconically has often been noted; whether or to what degree apes share this ability with humans has been a topic of debate (Donald, 1991; Burling, 1993; Mitchell, 1994). Our zoo observations may help to show how an iconic faculty might have developed in its earliest manifestations in our hominoid ancestors; signing apes demonstrate this faculty a step or two further in advancement (Miles & Harper, 1994).

For sign language, Klima and Bellugi (1979) consider a sign to have an iconic relationship to its referent when 'elements of the form of a sign are related to the visual aspects of what is denoted" (Klima & Bellugi, 1979, p. 21). Because we have not observed our zoo subjects to depict objects, here we limit our definition to the depictions of action that these gorillas do produce. We also limit the concept "iconic" to gesture representing action inferred to be desired by the signaler of the recipient.

Though iconic gesture could certainly also depict a signaler's own intended action, in practice such gestures in animals cannot be distinguished from automatic "intention movements," or incipient action (Savage & Rumbaugh, 1977) unless employed deceptively (see Mitchell, 1994).

In our study, therefore, we call a gesture (by hand, arm or head) *iconic* when its motion path in space, or on another animal's body, follows a path of movement, or form of an action, that we infer to be desired by the gesturing animal of another (remembering that, as defined earlier, a gesture lacks the physical force to actually move or change the activity of the recipient, unlike a simple social action). We can infer that a gesture (for example, in open space, moving an outstretched arm down from above the head) may be depicting intentions regarding others' actions, rather than being an "intention movement," when the depicted act itself (in this example, moving the body down) does not come to be performed by the signaler; further, the gesture may be quite discrete and different from the action itself (for instance, an arm motion as opposed to a whole body motion).

The finding that Kubie's communications included gestures that are in our definition iconic (Tanner & Byrne, 1996) is similar to results of Savage-Rumbaugh, Wilkerson, & Bakeman (1977). They found that pygmy chimpanzees expressed intent for different types of sexual positioning with iconic gestures, both tactile and in space. Observations in the wild of pygmy chimpanzees dragging branches to indicate proposed direction of movement (Ingmanson, 1996), the possibility of directional trail-marking (Savage-Rumbaugh, Williams, Furvichi, & Kano, 1996), and, in common chimpanzees, the representation of direction and duration through sound placement in drumming (Boesch, 1991), provide further support for the presence of an ape faculty to plan future movement and represent proposed movement iconically. There has been no study of the gestures of uninstructed common chimpanzees or orangutans specifically in terms of iconicity, though observers such as Köhler (1925), Crawford (1937), Yerkes (1943) and Van Hooff (1973) discerned the mimetic character of the gestures of the chimpanzees they watched. In their study of young chimpanzees, Tomasello and colleagues have described some chimpanzee gestures that appear to be similar to those we have classified as iconic, but did not discuss that aspect of young chimpanzees' gesturing (Tomasello, Gust, & Frost, 1989, Tomasello et al., 1994) . For untutored gorillas, both wild and captive, any study of gesture other than the anecdotal has been of species-typical actions (Redshaw & Locke, 1976; Schaller, 1976 [1963]; Fossey, 1983).

For both Kubie and Zura, development of novel silent forms of visual communication, including the iconic, may have been promoted by social and physical conditions in their particular group. The presence of Bwana, another mature male, at times may have meant a need for silence. Gorillas in the wild have been observed to suppress normal vocalizations in mating situations when other more dominant males are nearby (Byrne & Whiten, 1990), and chimpanzees have been found to suppress sound in numerous situations (Goodall, 1986). Captive gorillas have been observed to use distractive manual activities to achieve interaction (Mitchell, 1989, 1991). At the San Francisco Zoo, an additional factor was a physical environment that permitted female choice as to proximity with males. During the first several periods of our study, the door to the

gorillas' indoor quarters was usually kept open to a narrow width that allowed free entry and exit by the two younger females and infants but was too narrow for the males and the older female to be able to come back inside, once released outdoors in the morning (see Kerr, 1993). Another escape route was the large trees in the enclosure that the females readily climbed, but the mature males rarely did.

It might seem likely that Kubie and Zura developed their usage and comprehension of *tactile close* and other silent gestures through a process of "conventionalization" or "ontogenetic ritualization." This process was posited for chimpanzees by Tomasello (1990) and Tomasello et al. (1989, 1994). A similar progression was described by Savage-Rumbaugh et al. (1977) for pygmy chimpanzees, whose gestures showed two kinds of extensions from the ordinary social action they represented. These were (1) gestures gently touching the partner's body and (2) gestures in space, with both versions of a gesture meant to attain the same goal, such as ventro-ventral sexual positioning. In a study with a young gorilla, Muni, as subject, Gómez (1990) reports a related process. The gorilla first used a human companion as a physical object to climb upon or manipulate in reaching a goal, then later began communicating intent, through gaze and gesture, to the human in order to influence the human to collaborate in reaching the goal (Gómez, 1990). For all these apes, depictions of activity desired from partners may have developed from force or whole body motions into gentle directional touches, then into arm or head motion in space, "shaped" by the responses of the recipient.

For an example of how a conventionalization process might work, let us look at Kubie's frequent gesture *armswing under*, which was usually preceded by the gesture *tap other* (see Figure 11.1; c, d, and e). Kubie would tap Zura without force (Figure 11.1c), presumably gaining her attention as subject of activity (a deictic gesture), then, having her visual attention, would swing his arm toward himself (Figure 11.1d; an iconic depiction of the motion desired from Zura), moving his open palm to a final position between his legs (deictic, Figure 11.1e). This might have developed as follows: when Kubie wanted Zura to come to him he might first have pulled Zura to him; when co-operative, Zura might move toward him if his arm only brushed down her body then towards himself (tactile gesture), then eventually simply the motion of his arm swinging toward himself would carry the same message (visually received gesture in space).

On the other hand, longitudinal data on Kubie's development argue against this "conventionalization" or "ontogenetic ritualization" interpretation. In addition to the studies described earlier in this chapter illustrating the similar repertoire Kubie employed with different individuals in diverse time periods, we are fortunate to have a bit of information about Kubie at an even earlier period. A 20-minute piece of film (Sandra Keller, *Friends of the Zoo*, 1984) shows Kubie at age 8 with the older female Pogo, attempting to get her to raise her bottom for copulation and/or estrus checking. The film has 83 gestures by Kubie, and only 4 by Pogo. With Pogo, Kubie utilized many of the same gesture types (including many *tactile close* gestures) frequently used with the similarly uncooperative Zura five years later. This implies that if conventionalization was the process by which Kubie's gestures were established, he went through a similar process three different times with three different females and later again with his sons.

We have no evidence that this happened; on the contrary, there is evidence that it did not. It is quite possible that Kubie might generalize his gestures to use with other individuals, but, unless he repeated the whole conventionalization process with each new partner, *the other (receptive) half of the communicative equation would not be able to function*; the other females, and later his sons, *would not understand* his gestures. Though Kubie's earliest use of his gestures with each female occurred before the beginning of this study, we did observe Kubie's early usage of gestures with each of his young sons. Gesture types used earlier with females were performed in finished form with the sons. It is unlikely that with our weekly observations we would totally have missed observing some of a presumably extensive shaping process, had it been taking place.

Was observational learning involved on the part of the younger females, then? This also seems unlikely; Zura was not in the group when Kubie originally developed his gestures, though as a youngster she perhaps had opportunity to observe Kubie using gestures with the older female, Pogo. A simpler explanation might be that *comprehension* of the motion depicted in gestures is biologically encoded for primates, thus eliminating the need for conventionalization on the receiver's side of the interchange (Perrett et al., 1989). It is also possible that actions of the signaler other than the gestures help the receiver read his intentions; but then, why gestures?

None of the above explanations for development of iconic and deictic gesture completely satisfies. In Kubie's case as well as that of Savage-Rumbaugh's pygmy chimpanzee subjects and Gomez's young gorilla, it seems that something like the process of conventionalization led not simply to a learning of a gradually more finely shaped association of stimulus and response, but to an understanding of the partner in communication as an intentional and responding being. Whether the receiving partner was a human or another ape, the signaling ape made sure that visual contact was established (except for *tactile close* gestures), and seemed to understand both the other's potential actions and what the partner might, in turn, understand from his (the signaler's) performance of gestures. The *tactile close* gestures performed by Kubie support this explanation; these gestures varied so greatly in type and size and force (being performed in a three-dimensional space on the body of another gorilla) that an individual conventionalization of each gesture would seem an unwieldy process. The understanding of iconic motions on the body and in space may instead be a normal part of great ape development when conditions make such gestures useful. Even the far more complex symbols of human language are often learned, after all, not by a gradual process of shaping or careful teaching and demonstration, but by active integration into contexts of daily action where the experienced language-user and the child, or student, commonly interact. This "untaught" learning of language or symbols systems has been pertinently described for the symbol-adept pygmy chimpanzee, Kanzi (Savage-Rumbaugh, 1984).

Development of gestures over the life of an individual

Though we have no observations of the first emergence of gestures for Kubie because JT's regular observations began after he was a mature adult, we are fortunate to have observations by Parker (1993 and this volume) that tell us about Kubie's development

during the first 3 years of his life. Parker's observations of Kubie document his increasing awareness between ages 2 and 2.9 years of the communicative significance of his behaviors, as evidenced by his watching of other animals' responses to his displays and provocations. Parker suggests that trial-and-error learning regarding the relative success of various sorts of play enticements was effective in the building of a repertoire of displays. Kubie's play repertoire as listed by Parker, including behaviors we define here as gestures, is very similar to that of Shango's and Barney's at the same ages. Parker does not report *tactile close* directional gesture for Kubie at this age, nor was it commonly observed in either Shango or Barney at age 1 to 2.3; those few instances tentatively recorded were directed to much larger gorillas where "force" applied by a small gorilla would have been ineffective. Nor were silent directional gestures in space, self-indicating gestures, or gestures indicating location observed in any youngsters during their first two years. After age 3.5 years, Shango began to use some *tactile close* gestures, but has not yet, at age 6, been observed to use *silent visually received* gestures in space nor silent self-indicating deictic gestures as Kubie does. This may imply that a certain level of cognitive development over the course of maturation is necessary for a gorilla to employ iconic and deictic gestures. The ages at which an ape reaches certain levels of cognitive development may, of course, be subject to individual variation (as for mirror use in apes; see Parker, Mitchell, & Boccia 1994), probably depending on a combination of genetics, environmental input, and degree of human influence.

We hope soon to follow Shango through the adolescent "blackback" stage. For now, information for adolescent male gorillas comes from different individuals, but can perhaps still help bridge this age gap in the observations. In two different cases, extensive gesturing by an adolescent male gorilla was directed toward an unco-operative female who was considerably larger and older; this age and size difference was also the case for the pygmy chimpanzees whose gesturing was described by Savage-Rumbaugh et al. (1977). Our gorilla evidence comes from the 1984 film, described above, of adolescent Kubie with the older female Pogo; and from video collected at the Rio Grande Zoo in Albuquerque, New Mexico by the first author (JT) in 1992 (transcribed in detail in Tanner, 1993). The Rio Grande video is a record of a "sneak" mating by a 7-year-old male and a 27-year-old female. Many silent gestures, both *tactile close* and *silent visually received*, were used by the young male and also the older female, and were seemingly of a similar iconic and deictic quality to those recorded in our San Francisco observations, though not identical in type. Gestures by the 7-year-old and the female seemed not only to promote an actual copulation, but also first to serve to elude the 27-year-old silverback male, and then to reach agreement upon a meeting out of sight in the enclosure's deep dry moat.

Only future observation can tell us whether such gestures will appear in the course of Shango's maturity, and whether they will appear only when Shango is confronted with uncooperative females. We have not yet observed extended attempts on Shango's part to interact with Zura or Pogo sexually. So far, much of Shango's play, including the sexual, is directed toward his mother Bawang, who quickly rebuffs most of his approaches or turns them into wrestling play.

Gorillas in the wild, zoo gorillas, signing apes, and humans: differences and similarities in gesture use

All human children introduce nonverbal symbolic activity into object play around age 13 months (Bates, 1979). Deaf children exposed to no sign language create iconic gestures for both objects and actions in order to communicate (Goldin-Meadow & Mylander, 1984). Such activities exceed what has been observed of apes untaught by humans. Symbolic play and creation of iconic gestures for both objects and actions is not, however, beyond apes who have intensive interaction with humans and/or have been taught symbol systems by humans. Why, then, is symbol use for objects, and symbolic play, not found in gorillas in zoos or in the wild? Iconic gestures as representations or simulations of motions and shapes seem closely related to mimetic ability. But the fact that repertoires of non-species-typical gestures were not shared among all members of our zoo study group implies that imitation of particular gestural forms is not a common method of transmission.[5] The "imitation" that takes place in the production of an iconic gesture is a reproduction of previously experienced, and imminently desired, functional body motion. Imitation of another's *gestural* motion is removed from "real" activity, and perhaps this second order of detachment is where untutored apes have difficulty. Imitation of gestures as well as more complex activities are, however, frequent in signing or intensely human reared apes (Hayes & Hayes, 1952; Gardner & Gardner, 1971; Patterson, Tanner, & Mayer, 1988; Tomasello, Savage-Rumbaugh, & Kruger, 1993; Custance & Bard, 1994; Miles, Mitchell, & Harper, 1996). Free-ranging rehabilitant orangutans exposed to human activities and interactions imitate complex sequences of people's activities, even without any encouragement from humans (Russon & Galdikas, 1993). Gorillas in the wild show evidence of the ability to imitate organization of action in the context of complex feeding techniques (Byrne & Byrne, 1993; Byrne & Russon, 1998). But it seems that, for apes to go beyond action-based simulation to imitation of gestural shapes made by others and to representation of object shapes, enculturation with human symbol systems and turn-taking interactions with humans are necessary, and may result in a different kind of learning process (Bard & Vauclair, 1984; Savage-Rumbaugh, 1984; Tomasello et al., 1993; Kranz, 1993; Call & Tomasello, 1996).

Still, symbol-taught apes, in spite of their expanded communicative vocabulary, do not lose, but rather elaborate upon "natural" or species-typical gestures. This fact has been seized upon by some as evidence that apes do not really learn human sign languages, but only perform gestures that they would "naturally" use anyway (Wallman, 1992; Pinker, 1994). This can, instead, be interpreted as an illustration of the universality of the ape and human capacity for iconic expression. The rapid shaking of

[5] One gesture that is not species-typical, though seen at low frequency in some other zoo gorillas (see ethograms in Ogden & Schildkraut 1991), *armshake*, is used by more than one individual in this group; Kubie and Zura both used *armshake* frequently and sometimes in synchrony. In earlier observations when Kubie was an infant, it was noted that *armshake* was performed by every member of the group (Parker 1993, and this volume). We have observed the emergence of armshaking by Barney (though it seems to have faded from his repertoire at the time of writing), but it was not observed in Shango, Bawang, Pogo, or Bwana during the present study.

an arm and hand can express urgent activity for an untutored ape and also can likewise express the concept of "hurry" in American Sign Language. Anyone familiar with signing apes knows that their gestural repertoire is much enlarged compared to untaught apes, not only with ASL signs that are unlike any "natural" ape gesture, but also with spontaneous inventions, many of which are iconic for some aspect of the actions or objects referred to (see Bonvillian & Patterson, 1993, and this volume, for discussion of prevalence of iconic signs in early sign acquisition by two gorillas). In addition to invented signs, taught signs are often modulated and performed consistently in ways that better suit ape hands and anatomy. Some innovations by the signing gorilla Koko even appear to be iconic for sound, involving cross-modal transfer of the sound of an English word for an already known sign, and using that sign for a different concept that has a similar sound in English, such as "knee" for "need," "witch" for "which," "brows" for "browse" (Patterson & Tanner, 1988; Patterson & Gordon, 1993). This is not a result of human reinforcement of chance novelty; these "acoustic errors" and other invented signs were generally not comprehended by Koko's human companions and were discouraged until repeated context made her meaning clear.

Apes trained in symbol systems other than sign language also employ many gestures to express themselves; it would be of great interest if the researchers working with these apes would describe the physical form of these gestures in more detail (Savage-Rumbaugh, 1986; Greenfield & Savage-Rumbaugh, 1990). The fact that symbol-taught (but non-signing) apes invent gestures and signing apes do not slavishly imitate human signs but rather adapt, change, and invent them, even in the face of human discouragement, would seem to be evidence that a process of real cognitive and behavioral assimilation is taking place (Patterson, 1980; Patterson & Linden, 1981; Patterson & Tanner, 1988; Gardner, Gardner, & Nichols, 1989; Patterson & Cohn, 1990; Miles, 1993; Miles et al., 1996).

With our present knowledge of the potential for iconic simulation in apes, we should not negate the possibility of some inventive use of gesture in the wild by gorillas and orangutans, though it might not necessarily be universal in the species or in every population (as in Van Schaik's report of orangutan tool use, this volume). There have been rare but telling observations of gorillas in their native habitats that hint at directional indications through sound and/or gesture. Beating the ground was associated with the starting or turning of group movement in eastern lowland gorillas in Zaire (Mori, 1983). Clapping by female and young lowland gorillas in the Central African Republic apparently indicated location to the silverback (Fay, 1989). In Gabon, a group of gorillas was observed crossing the savanna between two patches of forest. One gorilla, who appeared to be older and to have difficulty in walking, was closely accompanied by another younger gorilla, who sometimes walked backwards facing the older gorilla. When the older gorilla stopped, the younger gorilla faced him and waved one arm up in front him, appearing to urge the older gorilla on with a gesture that humans might interpret as 'come on' (personal communication 1993, C. Tutin & R. Parnell). An arm-lifting gesture by females, possibly related to female transfer, seemed to be directed at other groups in a clearing in the Mbeli Bai, Nouabale-Ndoki National

Park (Fay, 1994). In the Central African Republic, tree-slapping then chestbeating was performed by a female who was up a tree with her infant when she detected a human below, followed by the appearance a minute later of a silverback, who charged the human (personal communication, M. Goldsmith, 1996).

Great variability is now known to exist among gorilla groups in social composition as well as in ecological settings in their native habitats; it is evident that there are many different kinds of problems to be solved in group living, and perhaps as many different kinds of solutions. One of these may be the invention of gesture, as well as other forms of simulation, both in captivity and in the wild, to negotiate social relations and group cohesion.

SUMMARY

All gorillas share some species-typical communicative behaviors; but it seems that, with maturity and the appearance of certain social needs, further gestures may develop in some individuals. Some of these gestures have iconic or deictic properties. Individuals in the study group employed differing repertoires of gesture types which have remained stable over years, though the quantity of gestures used fluctuates over time relative to social situation and stresses in the environment. The fact that some zoo gorillas spontaneously develop iconic and deictic gestures helps explain the potential of gorillas, and all great apes, not only to acquire sign language and the use of other symbol systems with human instruction, but also to create further symbols of their own invention.

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