GESTURAL COMMUNICATION IN A GROUP OF ZOO-LIVING LOWLAND GORILLAS

Joanne E. Tanner

A Thesis Submitted for the Degree of PhD
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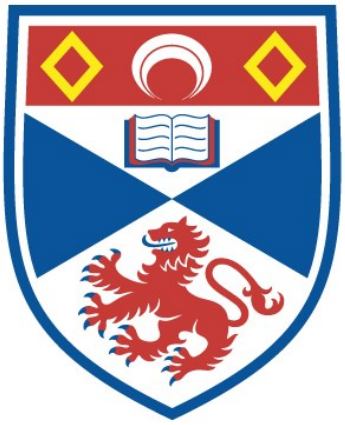
University of St Andrews



1998

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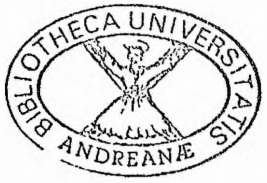
"Gestures are like thoughts themselves."

(McNeill, 1992, p.12)



Dissertation submitted by Joanne Tanner for the degree of Doctor of Philosophy

University of St. Andrews, Scotland, 1998

School of Psychology

Supervisor, Dr. Richard Byrne

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

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Declarations

I, Joanne Tanner, hereby certify that this thesis has been composed by myself, that it is a record of my own work and that it has not been accepted in partial or complete fulfillment of any other degree or professional qualification.

August 19, 1998 _____

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I was admitted as a M. Litt. student in October, 1992, and as a candidate for the degree of Doctor of Philosophy in October, 1993; the higher study for which this is a record was carried out under the auspices of the University of St. Andrews between 1992 and 1997.

August 19, 1998 _____

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I hereby certify that the candidate has fulfilled the conditions of the Resolution and Regulations appropriate for the degree for Doctor of Philosophy in the University of St. Andrews and that the candidate is qualified to submit this thesis in application for that degree.

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Abstract

Gestural communication in a group of zoo-living lowland gorillas

Videotaped observations of a group of zoo-living lowland gorillas collected over a seven-year period were used to study aspects of non-vocal communication. I discerned three classes of gesture: 1) tactile gestures, that depict motion paths iconically; 2) non-tactile silent gestures, some of which appear to be iconic and others deictic; and 3) audible gestures, that, unlike the other two classes, are species-typical gorilla behavior. The iconic gestures appear to represent activities desired of another gorilla. In addition, one gorilla developed a gesture that was regularly used to suppress the playface, a facial expression that was presumably involuntary. Certain social and environmental conditions, such as the presence of competing males and a physical environment that permits female choice as to proximity with males, may promote the development of such forms of visual communication.

I trace the development of gestures throughout the gorilla lifetime, and approach the acquisition of gestures from several viewpoints. "Ontogenic ritualization" and imitation are both found to have a limited explanatory value. One gorilla imitated human gestures, but there was no concrete evidence that these gorillas imitated each other. Repeated strings of gestures or other actions showed, however, that memory capacity exists in gorillas for reproducing complex sequences.

Finally, I compare the gestural inventions of my zoo subjects with those of a gorilla taught American Sign Language, finding continuity in styles of depiction from portrayal of pure action to description of stationary objects. Gesture, in portraying action as well as in its ability to depict object shapes, can be seen as a necessary foundation for the eventual development of language in the hominid line.

Acknowledgments

First and foremost, I am grateful to my supervisor, Dr. Richard Byrne, for endless patience and a sense of humor in helping me carry out the writing of this thesis, and for always being responsive and making time to assist me when I needed it. The fact that he and I share an interest in the same kinds of questions in science has been a great motivation for me, and that we often disagree in our responses to them only makes the learning process more lively and wide-ranging.

In a very different way, I am equally indebted to my husband, Charles Ernest, who has provided constant emotional as well as material support for my studies over many years. In addition, he has been an integral part of the process of data collection as video cameraman, and of its cataloguing by providing technical support in all computer and video areas. Without his encouragement, I could not have carried out this project.

For setting me on the path that has led to undertaking this study, I thank Dr. Francine Patterson, Dr. Ronald Cohn, and the gorillas Koko and Michael of the Gorilla Foundation. They made me aware of the potential of the gorilla mind and aroused my thought upon many questions about gorilla cognition. I also thank Dr. Patterson for reviewing the chapter comparing signing gorillas and zoo gorillas and for permission to reproduce photographs of Koko. Pushing me further along the path of inquiry, Dr. Adrienne Zihlman gave me the confidence that I could pursue academic studies at an age when some might rather be thinking about retirement, and gave me all the basic tools to do so. She then encouraged me to continue as far as I possibly could go. My friend and colleague Dulce Shafer has also been an inspiration, demonstrating that it is possible to carry out and publish important research independent of major institutions, grants, or career ambitions, simply for the intrinsic value of the knowledge gained.

For facilitating the execution of my study, I am much indebted to Mary Kerr, gorilla keeper at the San Francisco Zoo, who has provided a wealth of information on the lives of my gorilla subjects of which I otherwise would not have been aware. For

continuing data collection on video during the months in Scotland when I could not do so, I thank Jenni Meyer and Heather Quick. And for ongoing video data collection while I wrote this thesis, so that the study can continue beyond the seven years documented here, I am extremely grateful to Peter Rudiak-Gould.

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Chapter 1
Non-vocal communication in the great apes and its implications for cognition: a history of study

Introduction

A question that has intrigued researchers ever since great apes began to learn human-generated symbol systems in the 1960s and 1970s is this: If apes can learn from humans the appropriate use of numerous signs or symbols for objects, actions, and even intangible concepts such as emotions, what comparably complex system of communication might apes be using in their native environments in the wild? Is there something apes are doing that we have missed or do not understand how to interpret? Or does human intervention shape the development in apes of aptitudes that are neither needed nor utilized in the natural setting? These are questions that led me to study the ways in which a group of zoo gorillas communicate. Though in a captive setting the challenges of living differ from those confronted in gorillas' native African environments, the conditions of captive observation allow much more detailed data collection than currently possible in any setting in the wild. This is especially so for my particular interest, visual and non-vocal communication.

There are many reasons to believe that for the great apes visual communication and other forms of non-vocal signaling are just as important as vocal communication. Historically, however, the most detailed studies of communication in primates, both in the field and in captivity, have been of vocal communication (e.g. Fossey, 1972; Green, 1975; Marler, 1976; Marler & Tenaza, 1977; Seyfarth, Cheney & Marler, 1980; Snowdon et al., 1982). Great apes taught by humans readily learn to use visual but not vocal symbolic modes, regardless of whether these are manual sign languages or visual icons arbitrarily supplied by researchers (Premack, 1971; Rumbaugh, 1977). In addition to learning symbols taught to them, signing apes also commonly invent new signs or alter

taught signs in a purposeful way, indicating a productive gestural ability (Gardner & Gardner, 1971; Patterson, 1980; Gardner et al., 1989; Patterson & Cohn, 1990; Miles, 1993). When taught a non-gestural symbolic mode, apes still utilize limb gestures to amplify their messages (Savage-Rumbaugh, 1986).

Study of communication may have been biased toward the vocal for several reasons. Until recently, audio techniques have surpassed video in affordable cost and quality; elusive animals' sounds could be recorded even if they were not viewable; and the availability of playback technique and sonograms have enabled efficient analysis of vocal communication. This bias toward study of audible communication may result from the fact that the dominant medium of human communication is vocal. Human language, however, is not limited to speech (Klima & Bellugi, 1979), and even spoken language relies strongly on visual elements (Kendon, 1981; McNeill, 1992).

For gorillas, whose social organization consists of close-knit groups that remain together in their movements around the environment, some use of purely visual as well as auditory communication would seem practical. It has often been noted that as a species, the gorilla is relatively quiet unless disturbed, particularly in comparison to the chimpanzee. In mountain gorillas, relatively quiet "close calls" have been found to keep the group in contact in situations of potential separation, as well as to function as appeasement signals in potentially agonistic situations such as close contact in feeding (Harcourt et al., 1993). Other longer distance "hoot series," roars, or barks that function as display threats, as well as closer distance "cough-grunts", play chuckles and copulatory calls are well known. However, no specific information other than mood, emotional state, and location has been found to be conveyed by such context-bound vocalizations (Fossey 1972; Harcourt et al., 1993).

For gorillas in captivity, without barriers of dense vegetation, visual communication would seem especially useful. The relative importance of non-vocal communication in primarily ground-dwelling animals has been illustrated for a savanna-

dwelling monkey species, olive baboons (*Papio anubis*), in a study of this species at Gombe, Tanzania. Fourteen vocal signals, 38 visual signals, and 17 tactile signals were noted (Ransom, 1981). Visual communication can include facial expression, locomotion, whole body posture, and even intentional or unintentional alterations to the environment. Of course, even vocal communication, audible non-vocal communication (i.e., gorilla chestbeating), or tactile communication may be visually communicative when visual attention is directed to it, but these are not primarily visual signals because they can communicate without the visual faculty being involved.

Though Ransom (1981) and some other researchers clearly describe and delineate their subjects' repertoire, many primatologists mention the occurrence of "gestures" in apes without giving any physical description or other detail. This is the case in Hess' (1973) descriptions of gorilla behavior preliminary to mating, Kano's (1992) discussion of pygmy chimpanzees, and Rijksen's (1978) descriptions of orangutan behavior. In a captive situation, Menzel (1974) demonstrated the quality of information that apes can convey to each other nonverbally about location and desirability of objects, but could not elucidate exactly what the mechanisms for this communication were. Such reports imply that for all the great apes there exists a system of gesture and movement that conveys meaning, but the exact details of its operation seem to be difficult to describe precisely. Maple & Hoff (1982) stated the situation for gorillas, who have been least studied in this regard:

> The expression of emotions has not been adequately studied in the genus *Gorilla*. It is our impression that their communicative repertoire is composed of many subtle gestures which have not yet been properly classified. . . . We look forward to the acquisition of such data. (Maple & Hoff, 1982, p. 116).

More recent summaries of ape communication also lack information on gorilla non-vocal communication. Tuttle's (1986) review of the extant literature on the communication of gorillas and other apes confirms that with the exception of the chest-

beating display, the gestures, facial expressions and communicative postures of gorillas are not as fully documented, especially photographically, as those of common chimpanzees. In Noble and Davidson's (1996, p.48) table of "numbers of types of vocal and non-vocal communicative utterance in pongids and humans" the only absent entry in the table is for gorillas, in the column for non-vocal, postural elements.

In addition to the first step of defining the communicative repertoire of a species, research on any behavior requires attention to further questions of its development, function, and evolution (Tinbergen, 1963). In chimpanzees, communicative repertoire may show variation between individuals, between the sexes, and between populations within the species (Goodall, 1986; Mitani, 1996). This brings up questions of learning, culture, and cognition. For the great apes, it is not viable to study an individual's, or even a population's, behavioral characteristics as traits that automatically generalize to "the species" as a homogeneous unit. Behavioral variation and its causes, as in the differences between the behavioral expressions of wild, laboratory captive, zoo captive (and mother versus nursery-reared), and intensively human-reared apes, has become of primary interest to researchers today (Russon & Bard, 1996; Call & Tomasello, 1996; Matsuzawa & Yamakoshi, 1996).

The focus of my own research is the visible limb (and head) gesture of gorillas. Though whole body postures are important expressions of emotional state in the apes, and are most probably communications readable by other apes, I am primarily interested in learning what apes can express through motion of the hands and arms. The reduction of whole body motions to a more concentrated form begins to allow comparison to the actions of human sign languages. Thus in reviewing the history of research on communication in the great apes I will emphasize the relatively rare accounts of gorilla visual and non-vocal communication. I proceed in a roughly chronological manner, beginning with the earliest detailed records of gorilla behavior, observations of home reared gorillas. I continue with other types of studies such as

those in laboratory/experimental settings, in zoos and other captive colonies, "language" studies, and field studies. I introduce relevant early research with the other species of great apes: orangutan, chimpanzee and pygmy chimpanzee or bonobo. I set the 1960s as a dividing line between "early" studies and more recent times. This was the era when long term field studies as well as "ape language" studies began, and when primatology became an important area of study for biologists, psychologists and anthropologists alike. From this more recent era I review studies that have added to our knowledge of non-vocal ape communication, arranged by species for both captive and field studies. I conclude with information on general cognitive aptitude of the different ape species. In my own research, I will explore the aspects of cognitive capacities of apes that may be revealed in their use of communicative gesture.

Earliest studies of great apes

Early reports of home-reared gorillas

Records of lengthy and intimate relationships with individual gorillas by Alyse Cunningham, Maria Hoyt, and Gertrude Lintz are early sources of detailed information on gorilla behavior. The accounts by these perceptive women still bear reading today for their careful observation and reflection. They illustrate how ape behavior raised questions, even for these earliest observers, that led to investigations still being carried on at present.

Perhaps the earliest account of a home-reared gorilla is that of the remarkable adaptation to human ways of John Daniel, a young lowland gorilla acquired by Alyse Cunningham in 1918 and kept successfully in her home in London for three years. Cunningham's verbatim account is recounted in Hornaday (1923). John Daniel, besides acquiring table manners and performing all manner of other "human" behaviors, left us with an anecdote that seems to imply foresight and reasoned problem-solving. Miss Cunningham was with guests, ready to go out, when John Daniel wanted to jump into

her lap. Because she was wearing a clean dress she and the others discouraged him. He lay on the floor and cried like a child for about a minute, then got up, looked around the room and got a newspaper, spread it in Miss Cunningham's lap, and climbed up. Cunningham's account includes several other examples where John Daniel appeared to show understanding of causation of events or empathy toward human others: "John seemed to realize danger for other people in high places, for if anyone looked out of a high window he always pushed them away if he were at the window himself . . . if he was away from it he would run and pull them back" (Hornaday, p.97). John used to play with Miss Cunningham's 3-year-old niece, his favorite, for hours. "If she ever cried and her mother would not go and pick her up, John would always try and nip the mother, or give her a smack with the full weight of his hand . . ." (ibid. p.98). The young gorilla also displayed behavior that implied an understanding of humans as intentional agents (as in Gomez, 1990). When offered the less appealing portion of a food item, John would take the human's hand and move it to the preferred portion. Unfortunately, John Daniel soon grew too large for Cunningham to control and he died on his way to New York and the circus. William Hornaday, head of the New York Zoological Society and John Daniel's chronicler, notes that John Daniel also taught us that continuous social contact and playful exercise in captivity is absolutely necessary, not simply for health, but also in order to bring out the gorilla's true intelligence.

Maria Hoyt hand-reared Toto, a female lowland gorilla, from infancy in 1932 to age nine, and continued a close relationship with Toto even after giving her to Ringling Brothers, often traveling with her and the circus. Hoyt's (1941) book contains a wealth of information on Toto's development, including her methods of communication. Toto developed pointing gestures, among other methods, to communicate her desires. A portion of Hoyt's account follows:

> Whenever [Toto] discovered, with her marvelous eyesight, a ripe fruit that had escaped the gardener's attention, she would either go up the tree and pluck it or

> point it out to Tomas [her caretaker] for him to give to her. She knew that the thinner branches of a tree would not support her weight. . . . She would stand there, hold up her hand to show Tomas what she wanted and move her lips in what we had taught her as talking and make little grunting sounds until she had her way. If Tomas did not gratify her wish, she waited until I came into the garden, then immediately took me by the hand to show me where she had found the fruit. (Hoyt, 1941, p.134)

Pointing is again mentioned in a request by Toto for more cognac, which was given for a tooth removal. Toto would run to her caretaker Tomas and show him each loose baby tooth with her finger and then hold her mouth open for attachment of a string for removal. A hiding game originated by Toto also involved pointing. She would beg for Mrs. Hoyt's keys and immediately hide them, perhaps under an arm, between her legs, or in the grass. Then she would go through a routine of showing that she didn't have the keys, by calling attention to every part of her body except where they were. She might, for instance, hide them under her left armpit, then carefully lift her right arm, point to the inside of her elbows, open both hands, spread her legs and show the soles of her feet.

Toto got all the water she wanted "the same way she asked for everything that she wanted. She would look at a water faucet, point at it and make a rapid smacking motion with her lips" (p. 158). To indicate that she wanted to be tickled, Toto would take one of Mrs. Hoyt's hands and put it against the sole of a foot or against her ribs. For brushing, she would take Mrs. Hoyt's hand and place it against her back (p.184). The book contains photographs of Toto pointing out her head and blowing a kiss. Despite a lack of detail as to the exact configuration of some of Toto's gestures, it is clear that Toto developed many novel ways of communicating and understood and anticipated the ways her human companions were capable of helping her (Hoyt, 1941).

Gertrude Lintz spent years caring for two young male gorillas as well as numerous chimpanzees. She includes many descriptions of behaviors the apes acquired from

humans: scrubbing and cleaning, putting on makeup and hats, and exercising as taught. How such behaviors were learned is described by Lintz simply as "imitated" (and similarly so in many accounts in Hoyt). Today the topic of imitation by apes is yet a complex and debated issue. Lintz documented differences between chimpanzee and gorilla temperaments with observation of their contrasting reactions to new toys and new situations, and believed that gorillas "thought things through" more than chimpanzees (Lintz, 1942).

Early experimental investigation of the gorilla

The earliest published academic experimental investigation of gorilla intelligence was Robert Yerkes's experimental study of a young female mountain gorilla, Congo, estimated to be about 5 years old when captured (Yerkes, 1927, 1928). Congo died after two years in captivity. Yerkes found Congo to be slow in reaction and lacking in imitative skill, curiosity and facility with tools compared to the chimpanzees he had studied. The one exception regarding imitation was food-related "imitation," where Congo could be induced to try new foods only after observing others eat them, and used a spoon after observing its use. Congo also showed good memory skills in delayed response situations.

There is little mention of communication on Congo's part, but there is one pertinent episode: Yerkes introduced a mirror to Congo, who never seemed to understand it was her own image, but continued for weeks to be fascinated by the new companion in the mirror. She wanted to keep the mirror and have it to herself but this was not permitted, for fear of the danger of her breaking it. After many attempts to get the mirror away from the experimenter and drag it to another room, the gorilla took Yerkes by the arm, led him to the exit door and tried to push him out of the cage, while at the same time clinging to the mirror and evidently hoping to retain it (Yerkes, 1927). Yerkes states that he felt that this incident showed more foresight and problem-solving creativity than many of the planned situations that he provided. Here Congo's

communicative actions point to a topic of future study, use of humans as instruments to achieve a goal, a focus of research in Gomez's (1990) observations of a young gorilla.

Yerkes knew that he had only scratched the surface in understanding the gorilla. He remarked that individual and developmental differences and possibly the age and health of the subject affected results, and that broad generalization on gorilla intelligence because of his findings might not be proper. In retrospect, it seems that Yerkes's early characterizations of each ape species have nonetheless remained with us in spite of Yerkes's own caveats. Only recently has awareness of the range of variation in individuals, groups, populations and subspecies become an important part of behavioral study.

Earliest zoo study of gorillas

Belle Benchley, director of the San Diego Zoo, visited gorillas Mbongo and Ngagi (probably *G. graueri*) almost daily from when their approximate ages were five years (at acquisition in 1931), to death at age fifteen for Mbongo. Her account includes allusions to tactile and auditory non-vocal communication. She many times observed a quick warning touch (accompanied by a grunt) from the larger, older gorilla to the younger. She describes a tremendous variety of clapping and drumming play, often one gorilla "imitating" the other or patting the palms of the other like the child's game of pattycake: ". . . with maturity this childish response to each other ceased and we heard little beating except upon the doors and shelves and their chests" (Benchley, 1942, p. 260).

A more academic account of the same gorillas' natural behavior was made by Carpenter (1937/1964), who spent six weeks observing the gorillas daily. He mentions surprise at finding a smaller range of vocalizations in the gorilla compared to chimpanzees and monkeys he had studied. His conclusion was that "since vocalizations are very closely related to the higher mental processes and to emotional expression, such sounds should be indicative of the qualities of these processes" (Carpenter

1937/1964, p. 116), implying gorilla inferiority to chimpanzees. He comments that, on the other hand, for the gorillas "gestures, both fine and gross, contribute importantly in the social relations of the animals" (ibid.), but does not acknowledge that gestures might also have a relationship to mental processes.

Benchley (1942) discusses a series of unpublished experiments designed by Harold Bingham to test the intelligence of gorillas Mbongo and Ngagi at the San Diego Zoo. Bingham was a colleague of Robert Yerkes at Yale and an early visitor to mountain gorilla country (Bingham, 1932). Benchley states that an account of Bingham's work was never published because he considered it inconclusive, but she describes the experiments (suspended fruit, fruit on a pulley, slot boxes) herself in detail and explains how the gorillas arrived at successful solutions to all the problems posed to them.

Early work with other captive apes: chimpanzees

Yerkes and the institute he founded, Yale Laboratories of Primate Biology, stimulated much work on primate intelligence from the 1920's onward. During the first half of the century most of it was on chimpanzees (*Pan troglodytes*). Yerkes noted the importance of spatial relations and configuration for chimpanzees in solving memory tasks. Even if the visual appearance of an object changed radically after a delay between trials, the chimpanzees would often still look for the reward in its original position. This spatial memory seems related to the ability to use gestures in order to indicate desired locations and changes of location.

In observations over the years, Yerkes noted incidents of untutored communication that showed the readiness of chimpanzees to communicate gesturally. He describes an incident with a problem tooth that is similar to the gorilla Toto's request for help with tooth removal:

> Moos [a chimpanzee] had been ill, and we noticed that he was still refusing hard foods . . . a member of the staff entered the animal's cage and indicated that he wanted to make a dental inspection. . . . the observer failed to detect anything

> wrong. Satisfied with his examination he turned to leave the room, but Moos took hold of his coat, drew him back, and raising his upper lip with one hand pointed with a finger of the other hand to a spot on his upper jaw. There proved to be a slight swelling and subsequent examination revealed that a permanent canine was in process of eruption (Yerkes, 1943, p.192).

In an experimental task that required cooperation between two chimpanzees, the subjects used tactile gesture and beckoning gestures in space to solicit each other's help and to position each other. These gestures are described in detail in text and visually illustrated in a series of photographs of the young chimpanzees engaged in solving the problem set by the researcher (Crawford, 1937).

Another early chimpanzee colony was the one kept in the Canary Islands by Wolfgang Kohler. Among his many invaluable observations, one in particular describes the importance of gestural and tactile communication for the chimpanzee:

> A considerable proportion of all desires is naturally shown by direct imitation of the actions which are desired. Thus, one chimpanzee which desires to be accompanied by another, gives the latter a nudge, or pulls his hand, looking at him and making the movements of "walking" in the direction desired. One who wishes to receive bananas from another, imitates the movement of snatching or grasping, accompanied by intensely pleading glances and pouts. The summoning of another animal from a considerable distance is often accompanied by a beckoning very human in character. The chimpanzee also has a way of "beckoning with the foot," by thrusting it forward a little sideways and scratching with it on the ground. . . Rana, when she wanted to be petted, stretched her hand out towards us, and at the same time clumsily stroked and patted herself, while gazing with eager pleading. Another obvious method of invitation is for an ape to assume or indicate in his own person whatever movements he would perform in the activity he wishes the other to undertake. . . in all cases their mimetic actions are characteristic enough to be distinctly understood by their comrades (Kohler, 1925, pp. 319-20).

Though we might today want a more precise definition of "imitation," Kohler's chimpanzees apparently produced actions that clearly were "mimetic" to the observer,

anticipating current topics of debate as in Donald's (1991) discussion of stages of hominoid cognition.

The experiment of raising a chimpanzee like a human child, with the situation monitored by experts, was undertaken by the Winthrop Kellogg family in 1931 with the help of Yerkes. Such an experiment was inevitable, given scientific interest in relative effects of biology and environment on development, particularly in regards to the question of whether chimpanzees might speak, given suitable teaching. The project was abandoned after ten months because of lack of any success in getting the chimpanzee, Gua, to use speech. She did, however, communicate well manually; for instance, pulling a human's hand and placing it on an orange juice bottle she could not lift (Kellogg & Kellogg, 1933). Catherine and Keith Hayes undertook a similar project under the auspices of Yerkes's Orange Park, Florida, Yale Laboratories of Primate Biology, after the death in of Yerkes himself. This time the experiment was lengthier and more successful, lasting until the chimpanzee Viki's death at the age of six years. Catherine Hayes tells of incidents similar to those recorded for other home-reared apes: of Viki leading a human by the hand, or pulling and placing the human's hand; of Viki requesting specific activities by simulating those activities; and of Viki consistently indicating locations by using a "boo" vocalization and directed gaze (Hayes, 1951; Hayes & Nissen, 1971). As with Gua, an attempt to teach Viki spoken language was not very successful. She learned a few words, but with great difficulty.

Studies since 1965

Sign language and other symbol systems

It was Robert Yerkes who first mentioned the idea of using human sign language with apes:

> I am inclined to conclude from the various evidences that the great apes have plenty to talk about, but no gift for the use of sounds to represent individual, as contrasted with racial, feelings or ideas. Perhaps they can be taught to use their

fingers, somewhat as does the deaf and dumb person, and thus helped to acquire a simple, nonvocal, "sign language" (Yerkes, 1925, p.180).

It was 1966 when Yerkes's suggestion was followed. Robert and Beatrice Gardner began to raise a young female chimpanzee, Washoe, in an environment similar to that which a deaf child might experience. The experiment was phenomenally successful in that Washoe rapidly gained a large vocabulary of signs, which she used appropriately. At the present writing, over thirty years later, the reaction to Washoe's accomplishments has not ceased, nor has the controversy died over exactly what Washoe's achievements were. Washoe is still communicating with signs today at the Chimpanzee and Human Communication Institute of Central Washington University in Ellensburg, Washington, under the direction of Roger Fouts, one of her early teachers. She resides there with several other signing chimpanzees and has contact with many human companions.

To chronicle the history of sign language experimentation with apes as well as other methods of symbolic communication such as David Premack's plastic symbols (Premack, 1971) and the computer keyboard "language," "Yerkish," utilized by Duane Rumbaugh and Sue Savage-Rumbaugh (Rumbaugh, 1977), would require a volume in itself. Overviews of "language" studies with apes have already been done from several diverse critical viewpoints (Linden, 1974; Seidenberg & Pettito, 1979; Terrace et al., 1979; Sebeok & Rosenthal, 1981; Van Cantfort & Rimpau, 1982; Linden, 1986; Wallman, 1992) and I will not attempt my own analysis here. Projects similar to the Gardners' work with Washoe, using American Sign Language, were undertaken beginning in 1971 by Francine Patterson with a female lowland gorilla, Koko, and in 1978 by Lyn Miles with a male orangutan, Chantek. The project with Koko and a male gorilla, Michael, continues to this day; the study of Chantek lasted until 1986. These studies, plus Sue Savage-Rumbaugh's more recent work with pygmy chimpanzees (*Pan paniscus*) established the fact that all the four species of great apes can learn a large

symbolic lexicon from humans and use it in appropriate situations. Also established is that chimpanzees, at least, can learn manual signs and their appropriate use from other chimpanzees without human intervention (Fouts et al., 1989) and will use signs to communicate with each other when no humans are present (Fouts & Fouts, 1989). Any other conclusions (and for some, even the former statements) are subjects of heated debate: Is it language? Do the symbols really represent concepts or are they mere stimulus/response reactions? Are the signs really ASL or just awkward approximations that are actually "natural" ape gestures? Is there any sort of grammar in the apes' usage or are their "sentences" just random chains of responses? Would "grammar" make it language, or not? How do the apes learn? By simple reward and punishment, or by observation and imitation? The passing of psychology from a behaviorist paradigm to a cognitivist, and now a "cognitive science," computer-modeled outlook, has occurred during the thirty years of "ape language" history. This shift has moved goalposts and blurred and changed the questions asked and the answers considered appropriate.

I will avoid these issues for the moment. It is my own involvement in the sign language project with the gorilla Koko that has brought forth questions I wish to address regarding the cognitive processes involved in "natural" (i.e., not intentionally taught by humans) ape communication. As a part of my investigation of the visual communication of captive gorillas I will pursue the similarities of, and differences between, the communication of zoo-living gorillas and that of signing apes. I wish to look at both groups in terms of learning processes and cognitive implications, as well as more immediate function.

Spontaneous visual communication

In captive chimpanzees (*Pan troglodytes)*

About the same time that Washoe, Lana and Sarah were becoming adept in their human-taught communication systems and Koko the gorilla was learning her very first signs, several studies of the communication of untrained captive chimpanzees were published. These research concerns were undoubtedly influenced by the developments in the area of ape language.

Emil Menzel performed a series of experiments with a group of young chimpanzees housed a the Delta Regional Primate Center of Tulane University (Menzel 1971, 1974). Menzel's basic question was in regards to chimpanzee use of space: in a given space, where will chimpanzees go and why, and how is group movement coordinated? The latter part of the question is a question about communication. A series of experiments was done to observe the group's movement, exploration, or splitting processes, under varying imposed conditions with novel objects or food. A leader was given foreknowledge of a goal or object. The leader managed to convey information about the presence, direction, quality, quantity, or type of object to the other chimpanzees. This was done without vocalizations or gestures detectable by trained human observers. The leader's style of locomotion, glances and direction of attention, and knowledge of the existence of a probable goal, due to familiarity with the experiment, were sufficient to direct the group. Larger signals such as beckoning gestures were used only when the group lagged, as in the beginning of experiments or if a leader was too small and insecure.

A later addition to Menzel's experiments involved communication from researchers to chimpanzee leader about the food location under increasingly indirect and difficult conditions, such as pointing at the location from a great distance. Even under the most difficult conditions the chimpanzees still successfully led others to the

food (Menzel, 1974). Such efficient communication about the environment presumably also takes place in the wild.

In addition, an important piece of developmental information appeared:

> Obvious signalings . . . decreased as the tests continued and the animals grew older. It was as if the chimps unlearned their tapping, tugging, gesturing, grimacing, whimpering, tantrums, and other juvenile means of trying to induce a following and came instead to simply move out "independently" with an occasional glance backwards as most adult primate leaders do (Menzel 1974, p. 130).

For the mature ape locomotion, or purposive movement, seemed to be the medium and the message.

Around the same time Jan Van Hooff (1973) conducted observations of a semi-captive group of chimpanzees in a large open enclosure at a research lab in New Mexico. His intent was to create a structural analysis including all behavioral elements (locomotion, postures and gestures, body contact, facial displays and vocalization) and their temporal relationships to each other. Van Hooff's physical descriptions were done without the aid of videotape, yet he carefully recorded the form and details of any variation in the gestures he observed. He then speculated on their genesis and the cognitive processes that might be involved.

One gesture discussed was categorized as "hold out hand." Van Hooff discusses a number of variations on this beckoning movement, such as bending and stretching the wrist, palm up, and simultaneously bending and stretching the fingers rapidly. Another variation on "hold out hand" involves removal from, or ritualization of, the activity from which the gesture is apparently derived: the stretching of an arm over the back of a presenting female in preparation to mate. This "stretch over" was seen several times performed at a distance from the female, and also in the form of smooth downward waving movements, with both hands, of the male toward himself. In the latter case the

female proceeded to crouch-present and mating took place. Van Hooff discusses these gestures:

> In the chimpanzee it is especially tactile communication and the hand gestures that show an increasing variability. For, although learning has been shown to play a possible . . . role in the control of vocalization, it is especially the gestures that can be elaborately conditioned. In agreement with this is the high variability of the hand gestures observed in nature . . . that is also manifest in this study. The "down movement," a version of the "overstretch" described under *hold out hand*, is an instance of such a unique, but probably highly meaningful variant. This and other gestures may be gestural pictograms that owe their functionality to the contextual insight of both interacting partners (Van Hooff, 1973, p. 157).

Van Hooff also describes "hand leading," where the actor takes another animal's hand and gently places it in contact with his own body, as described earlier for Yerkes's chimpanzees (Yerkes, 1943).

Michael Tomasello and colleagues, in a series of publications derived from an ongoing study of the development of gestures in young chimpanzees (Tomasello et al. 1985, 1989, 1994), have confirmed Menzel's (1974) observation that as chimpanzees grew older, they gestured less. The Tomasello studies have also extended the work begun by Plooij (1978) on the development of gestures in one-year old chimpanzees. Tomasello's original study subjects were five captive infant and juvenile chimpanzees being reared by their mothers in a group including a male and other adult females and juveniles. For later study, other individuals were observed and compared to the original group. As the age of the chimps increased (though still juveniles) there was an increase in the number of gestures used, use with more group members, and increased importance of the direction of the gaze in supplementing gestures. "Response-waiting" on the signaler's part was considered an indication that a gesture was an intentional communication. Gestures seemed more important than vocalization for the juveniles; in fact juveniles rarely vocalized at all except when distressed. For the group, vocalizations

seemed more associated with affective states than were gestures. Tomasello's findings contradict the idea that young chimps gradually learn a repertory of adult gestures. Many juvenile gestures were not used by adults and were functional for situations not relevant to adults, like play and nursing. Gestures differed in individuals both within a group and between the study groups from different time periods, and each individual had at least one unique form of gestural communication not used by any other group member. Thus support was found for the idea that most gestures are established by "direct conventionalization" or "ontogenetic ritualization" rather than being genetically transmitted or learned by imitation.

Captive studies of captive chimpanzees not directed specifically toward the study of gestural communication have provided examples of such communication in social contexts. DeWaal (1982) studied a captive colony at the Arnhem Zoo, Netherlands. A chimpanzee's concealment of facial expression with a hand is an observation of particular interest because it presumably indicated the chimpanzee's awareness of his own involuntary emotional expressions and the ability to voluntarily redirect them. Another source of description of spontaneous gestural communication is Savage-Rumbaugh's (1986) book on computer-symbol trained chimpanzees Sherman and Austin, who nevertheless gestured extensively to direct their cooperative activities. Their interaction reminds the reader of Crawford's observations in the 1930's, where one chimpanzee would continually draw the less attentive chimpanzee back to the task at hand through gestures and gentle tactile directional indications.

Referential pointing has been found to be a common gesture for chimpanzees when a desired object is out of reach. Though ape pointing has been called "reaching" or "begging" because it is often performed with the open palm rather than one extended finger, recent studies have shown that all indicators of communicative pointing (attention getting, gaze alternation between desired object and the person being communicated to, and persistence to reward) are present. The captive subjects

were not language trained nor were they trained to point. Juvenile subjects were less likely to point and engage in joint attention than adults (Leavens et al., 1996; Leavens & Hopkins, 1997).

If specific gestural or vocal communication is often unnecessary for chimps (as in Menzel's studies), under what conditions *do* apes require such communication? Perhaps a clue can be found in the appearance of gestures in conditions where directional locomotion is not useful in solving a problem and locomotion cannot itself suffice as communication. Examples are Crawford's (1937) cooperative box-pulling experiment, Sherman and Austin's food-sharing situation (Savage-Rumbaugh, 1986), Van Hooff's (1973) description of gestures to invite sexual approach, and the use of pointing in situations where a goal cannot be reached by locomotion.

Spontaneous visual communication in captive *Pan paniscus*

The "other chimpanzee," *Pan paniscus*, the pygmy chimpanzee or bonobo, was not known to science to be a separate species of chimpanzee until perhaps 50 years ago. In recent years *Pan paniscus* has become a subject of intense study. The proposal that of all the great apes, *Pan paniscus* might resemble the human/ape common ancestor the most closely (Zihlman et al., 1978) has doubtless had an effect on scientists' interest in the species as a subject of study, as have findings in the field that *Pan paniscus* social organization and behavior differs greatly from that of *Pan troglodytes* (Susman, 1984; Kano, 1992).

Sue Savage-Rumbaugh and colleagues have established a long-term study of communication with a male *Pan paniscus,* Kanzi, as principal subject (Savage-Rumbaugh & Lewin, 1994). In addition to using a system of lexigrams similar to that used by earlier *Pan troglodytes* subjects, Kanzi's untaught vocal and gestural communication has been included in the study. Unfortunately, published material does not describe the actual form of Kanzi's gestures, instead calling them "his *go* gesture" or "his *chase* gesture." These gestures, in combination with lexigrams, have been cataloged

to illustrate rudimentary "grammatical" consistency in ordering of elements of utterances (Greenfield & Savage-Rumbaugh, 1990, 1991).

An earlier study of gestural communication in untaught *Pan paniscus* by Savage-Rumbaugh and colleagues (1977) is more informative as to the configuration of gestures. It describes spontaneous gestural communication between apes about sexual positioning. By establishing a statistically significant association between the form of certain gestures and resulting frequency of ventro-ventral versus dorso-ventral copulation, it was possible to discern the function of some of the gestures of the pygmy chimpanzee pair. There was also an extensive repertoire of other gestures between the pair besides those definitively categorized. Beyond function, Savage-Rumbaugh makes a further distinction between gestures according to level of detachment from the actual behavior desired by the signaler of the recipient. *Positioning movements*, the first category, are behavioral acts, defined by their effective physical force, and are not communicative gestures. *Touching, iconic hand movements* not exerting force, the second category, are gestures shaped from an incipient act. *Iconic hand movements in space,* the third category, depict the act desired from the recipient but are completely detached in space and time from that act: they mime a part of the act from memory. All three types can have the same function, for instance, to facilitate ventro-ventral positioning (Savage-Rumbaugh et al., 1977). Savage-Rumbaugh and Wilkerson (1978) compared the sexual behavior of the same *paniscus* subjects with co-housed *troglodytes* subjects and concluded that common chimpanzees use only one gesture in sexual solicitations, the *stretch-over*, or *arm-over,* discussed by Van Hooff (1973), but pygmy chimpanzees use many more.

An ethogram of the gestural communication of zoo captive *Pan paniscus* in San Diego was published by DeWaal (1988). DeWaal mentions some, but not all, the positioning gestures described by Savage-Rumbaugh et al. (1977), and does not refer to their work. Perhaps some of these positioning gestures did not develop in the differing

social context of the San Diego Zoo group. One of this group's auditory-visual gestures, clapping, has been subjected to closer study by Ingmanson (1987), who found it related to the onset of grooming behavior. A study by Thompson (1993) theorizes that clapping is a behavior spread by imitation, culturally transmitted from the San Diego group to other zoos by transfer of San Diego individuals to these zoos.

Spontaneous visual communication in captive orangutans

I am not aware of any captive studies of spontaneous gestural communication in untaught orangutans. A study of a male orangutan's (Chantek's) use of sign language documents gestural inventions and spontaneous use of referential pointing (Miles, 1990, 1993). Chantek, and another orangutan not taught sign language, were subjects of a comparative experimental study of their use of "pointing" and their comprehension of human pointing. Chantek's usage and understanding of pointing clearly and immediately exceeded that of the "unenculturated" orangutan, though with further training sessions this orangutan began to learn to perform efficiently (Call & Tomasello, 1994).

Spontaneous visual communication in captive gorillas

The study of gorilla behavior in captivity has been limited because gorillas were the last of the great apes to be successfully maintained in zoos and to reproduce in captivity. They have always been too rare, as well as expensive, to maintain as laboratory animals. Study of gorilla communicative behavior as well as cognitive development in general was made possible by increasing frequency of successful births in captive gorillas in the 1970s. Because of human caretakers' lack of confidence in the abilities of gorilla mothers to raise their young, nursery reared gorillas were available as subjects for intense observation and testing. A gorilla "baby boom" at the Jersey Wildlife Preservation Trust in the early 1970s provided the opportunity for a series of studies on early development. One study focused on the frequency of a number of social behaviors, particularly in play, of two young male gorillas of nearly the same age.

Common activities such as slapping, clapping and play biting were sampled, as well as behaviors labeled *swipe, reach, touch, push,* and *pull,* some of which might well be defined as gestures. Unfortunately, frequencies are the only precise information given about these activities. "Looking," or direction of the gaze, was recognized as an important communicative element for the young gorillas, from which one gorilla might read another's intention or focus of attention. Whether "looking" functioned intentionally as communication was not clear to the researchers (Redshaw & Locke, 1976).

The development of communication in a young female gorilla, who was nursery reared with much contact with humans, was observed by Juan-Carlos Gomez and colleagues (Gomez, 1990). The gorilla progressed from using a human companion as a forcibly manipulated object to eventually seeing the human as an intentional creature whose attention could be gained, and whose behavior could be directed, by gaze and non-forceful touch. The gorilla then developed communicative strategies that involved a series of actions, asking the human first to move to a certain location and then to carry out a particular action. These different types of communication appeared at successively later ages, the more complex appearing after the age of two years. Gomez (1990, 1991, 1994, 1996) emphasizes the importance of visual behavior accompanying a touch or gesture, particularly mutual gaze as a monitoring of the other's attention. In a study of four young hand-reared gorillas Gomez (1996) found that certain tactile and vocal gestures of the gorillas were specifically directed toward getting a human's visual attention; then further gestures could direct the human's attention toward an object or location.

Though signing apes have been excluded from the present discussion of "natural" gesture, the use of untaught gesture by the signing apes Koko and Michael should be noted and will be described in detail in a later chapter (Patterson, 1980; Patterson & Tanner, 1988; Patterson & Cohn, 1990). Another gorilla, Ndume, kept at the Gorilla

Foundation on breeding loan, but not actively involved in any sign language studies, uses signs that he has learned by observation of Koko and Michael as well as his own unique gestures, and responds appropriately to some signs without training (Kranz, 1993).

Further description of captive gorillas' communicative gestures can be gathered from Ogden and Schildkraut's (1991) *Compilation of Gorilla Ethograms.* This will be incorporated into Table 3.2 in Chapter 3, where my own data is compared to that available from other captive gorillas and gorillas in the wild.

Field studies of the great apes: non-vocal communication in the wild

How anthropoid apes communicate has fascinated people ever since the "discovery" of apes by the Western world. From the late nineteenth-century attempts by Garner (1896, 1900) to observe chimpanzees and gorillas in Africa from the safe confines of a cage for himself, to the long-term studies of Jane Goodall, Dian Fossey and Birute Galdikas in the second half of the twentieth century, the quest for better understanding of our "sibling species" continues. Long term field studies began in the 1960s, concurrent with the development of ape language studies in captivity. Several ape language projects have also become long term studies continuing for the life span of the ape, making possible developmental observations parallel to those of apes in the wild.

Chimpanzees in the wild

Descriptions of aspects of chimpanzee non-vocal communication are available from studies of chimpanzees in diverse geographic locations throughout Africa (Reynolds, 1965; Reynolds & Reynolds, 1965; Kortlandt, 1967; Goodall, 1968a,b, 1986; Plooij, 1978, 1984.) The existence of study sites in many differing locations has made possible comparisons of differences in communicative conventions in different populations (McGrew & Tutin, 1978; Nishida, 1987; Goodall, 1986). In addition to the aforementioned information on silent gestural communication, Boesch (1991) reports

on a possible relationship of tree-drumming to group movement that points to the possibility of non-vocal auditory communication through the timing and spatial relationships of sounds.

Pan paniscus in the wild

Study of *Pan paniscus*, the pygmy chimpanzee or bonobo, in the wild began only in 1974. The two principal study sites have been Lomako and Wamba in Zaire. Gestures are mentioned in reports on the social behavior of the pygmy chimpanzee by Kuroda (1980, 1984). These gestures are in the context of begging and food-sharing, and expressed frequently by the extended hand and mouth-touching; there were also four observations of a much rarer gesture "mimicking the eating of food" (Kuroda, 1984, p.311). An analysis of the structure of the pygmy chimpanzee behavioral system was published by Mori (1984), modeled on that of Van Hooff (1973) for the common chimpanzee. Here too, "holding out the hand" is the most frequent manual gesture. The principal investigator at Wamba mentions a few gestures in his book but describes none in physical detail or in regards to quantity (Kano, 1992).

Wamba has been the location for investigation of a mode of symbolic communication that may be used by *Pan paniscus* in the natural environment. Sue Savage-Rumbaugh and another independent observer found evidence of directional trail-marking by these apes through alteration of the environment with flattened and broken vegetation that pointed in the direction of travel. Observations were made only on two days when optimal conditions occurred for data gathering. Occurrence of trail marking when the trail was unclear and not easily followed (the case in 72 of 114 instances) was highly correlated with movement in the same direction by separated groups of animals (Savage-Rumbaugh et al., 1996). Also at Wamba, Ingmanson (1996) found communication by branch-dragging that initiated group movement and indicated its direction. Branch-waving was used as an attention-getting activity to draw attention

to a more specific gesture, such as a mother reaching an arm out to an infant or a male soliciting copulation (there is no physical description of these gestures, however).

Orangutans in the wild

Orangutans (*Pongo pygmaeus*), like bonobos, have been studied extensively at several sites in their native habitat but gestural communication has not been a focus of investigation. General accounts include occasional descriptions of gesture of the limbs (Rijksen, 1978; Galdikas, 1995). A study of the development of infants' begging gestures to their mothers discussed these begging gestures only (Bard, 1990, 1992). When primarily solitary orangutans do interact, they often do so close up and face to face, which allows visual communication to be an efficient medium. Cognitive abilities of orangutans in the wild indicate gesture use might be likely. Related areas of orangutan behavior are imitation (Russon & Galdikas, 1993) and use of elements of the environment as locomotory or food-processing tools (Chevalier-Skolnikoff et al., 1982, Povinelli & Cant, 1995). Captive studies of sign language with a young male orangutan, Chantek, confirm the potential for gesture use (Miles, 1990), as does the use of signs by ex-captive orangutans taught in their native environment in Borneo (Shapiro, 1975; Galdikas, 1995).

Gorillas in the wild

Until very recently any long-term observation of gorillas in their native habitat has been limited to mountain gorillas (*Gorilla gorilla beringei*). The almost complete void in direct observational study of western lowland gorillas (*Gorilla gorilla gorilla)* and eastern lowland gorillas (*Gorilla gorilla graueri*) becomes even more of a lack in light of emerging knowledge that social organization and feeding patterns are extremely different between the several subspecies of gorilla and even between populations of lowland gorillas in different habitats (Goodall, 1977; Sabater Pi, 1977; Fay et al., 1989; Tutin & Fernandez, 1993; Remis, 1994).

The earliest ongoing studies with substantial amounts of direct observation of mountain gorillas were by George Schaller (1963) and Dian Fossey (1983). Descriptions of gesture are primarily anecdotal for both observers but include reports of tactile as well as auditory-visual communication. Other observers before and since have not achieved much opportunity to directly observe gorillas' daily activities, catching glances of gorillas mainly when they were disturbed or fleeing; e.g., Wordsworth (1961) in Uganda; Goodall (1979) for eastern lowland gorillas in Kahuzi-Biega; and Tutin (1996) for lowland gorillas in Gabon. There are numerous more recent studies that have emanated from research with the groups near Fossey's Karisoke site in Rwanda, but none has focused on gesture.

Gestures are not discussed in Fossey's (1979) study of the first thirty-six months of development of the mountain gorilla, except a mention that chest-patting appears between ages 12 and 24 months and that one infant clapped hands, a sound that its mother recognized as that of her infant when the infant was not visible. Fossey (1983) also describes some idiosyncratic gestures of young individuals. Schaller (1963) includes a close analysis of the typical male display series and particularly of chestbeating, and describes numerous other instances of gesture. He also describes distinctive postural gestures that indicate initiation or direction of group movement: a motionless quadrupedal posture for several seconds with arms and legs spread farther apart than usual, facing the direction of movement to come, and a stiff-legged rapid gait when initiating movement. None of the considerable amount of more recent field research on mountain gorillas has been on gestural communication, though Yamagiwa (1992) has studied the function of the gaze, or stare, in mediating social interaction in an all-male group.

I made an attempt in 1989 to discover whether, as an observer accustomed to gorilla signing and gesture, I could by close viewing of available film of mountain gorilla activity discern more gesture than has been reported in published material. I viewed all

of Robert Campbell's film of Dian Fossey's research groups that is stored at the National Geographic Society in Washington D.C. Little gesturing other than chestbeating was seen. This rather negative result was not been published, but the few instances of gesture seen will be included in Table 1.1 below.

Because no long-term direct observation of lowland gorillas has yet been accomplished, there is very little information on close social interactions for *G. g. gorilla* in the wild. There have only been a few rare, but telling, observations of lowland gorillas in their native habitats that hint at directional indications through sound and/or gesture. Beating the ground and beating the chest were associated with the starting or turning of group movement, as well as with threat and inter-group encounters, 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) and has been reported earlier in a hunter's account, as a means of summoning a group in time of crisis (Denis, 1963; in then French Equatorial Africa, near Oka). 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, facing the older, 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. This was followed a minute later by the appearance of a silverback, who charged the human (personal communication, M. Goldsmith, 1996).

Though much of the information regarding function is anecdotal, I will list in Table 1.1 all the gestures of limbs or head observed in mountain gorillas in the wild, including those from my viewing of the film of Robert Campbell. (My working definition of "gesture," to which the table conforms, is found in Chapter 2.) There is virtually no information for lowland gorillas in the wild other than that in the paragraph above, so I will not include lowland gorilla data in this table. All gestures reported in the wild are compared to my own data on the San Francisco Zoo gorillas, in Chapter 3, Table 3.2.

Table 1.1 Gestures observed in mountain gorillas in the wild

Gesture and description	Context, possible function	Gorillas using gesture	Observer and where published
armcross crossed arms wrapped over chest and shoulder	when missed grabbing another gorilla; and when blocking the play attack of another	juveniles	Campbell film
arm waving arms waved slowly and alternately over head	approaching another gorilla (bipedally) in play; also seen sitting, and in infants lying on back	juveniles	Schaller 1963
away arm swept quickly toward recipient of gesture	indication or threat, toward other gorilla or human, to get away from signaller	all ages and sexes	Schaller 1963 Campbell film
bite on side of hand or wrist	directed to younger juvenile	one juvenile	Campbell film
body beating variations of location of chestbeating motion, such as on abdomen, thighs, feet or head, or on object held to body, one hand or both	often in play context	all ages and sexes; juveniles in play	Schaller 1963
cheek-beating palms slap cheeks, audible	a variation of "body beating"?	unknown	Baumgartel 1976 Burbridge, 1928

Gesture and description	Context, possible function	Gorillas using gesture	Observer and where published
chestbeat open, slightly cupped palms alternately slap chest, audible effect; both hands or one hand. Widely variable number of slaps, from 2 to 8 or more.	expression of excitement and release of tension in response to human or gorilla intruders or any unidentified disturbance; often contagious when another gorilla chestbeats; advertises a gorilla's presence and intimidates; evokes alertness in others; in males, climax of display series; in infants and juveniles, in play: Schaller 1963 "excitement or alarm," and "gains attention,": Fossey 1983 alarm, threat; in infant, "for the fun of it,": Baumgartel 1976	all ages and sexes, observed from age 12 months: Fossey; from 4 months: Schaller	Fossey 1979, 1983 Schaller 1963 Baumgartel 1976 Campbell film
chin-slapping alternate hands slapped under chin, causing teeth to clack	in play, also sometimes as solitary activity or attention getting, Fossey, 1983	at first in only one infant, then adopted by two others: Fossey 1983	Fossey 1983 Burbridge 1928
clap hands palms contact each other with audible force	in play, also sometimes as solitary activity or attention getting:	in only one infant	Fossey 1979, 1983
extend arm arm lifted and extended toward another gorilla	other gorilla comes to signaler, arm is put around her	one blackback male	Campbell film
head nod head moved abruptly down	seems to gather others for play	one blackback male	Campbell film
head turn also "head jerk", an abrupt turning of head	toward other gorilla, response is to move away	adult male	Schaller 1963
head twirling rapid pivoting of head	greeting or approach for grooming session, only when mother had wounds	in only one 5-year-old gorilla:	Fossey 1983
slap open palm, on ground or other surface	final element of male display ("ground thumping"): Schaller 1963; part of male display: Fossey 1983	all ages and sexes	Fossey 1983 Baumgartel 1976 Schaller 1963 Campbell film
tactile gestures light, non forceful pushes	express action to be taken by recipient of gesture; most often from dominant to subordinate, to move away; also mother to infant to change position:	several adults	Schaller 1963

Gesture and description	Context, possible function	Gorillas using gesture	Observer and where published
tap other fingers or knuckles of outstretched arm rapidly contact other gorilla	to get attention or indicate other as subject or object of activity	all ages	Campbell film Schaller 1963
up raise arms above head	infant anticipating being picked up by mother	one infant	Schaller 1963

From these observations of mountain gorillas, as well as zoo animals, it would appear that *chestbeating* (and other forms of "beating") and *slapping* are universal behaviors for the species, and thus can safely be referred to as species-typical.[1] Schaller suggests that all the components of the typical, though individually variable, male display sequence[2] are innate; he quotes observations of these behaviors in captive infant gorillas who had no contact with other gorillas. Tactile gestures were also observed to be used in several different situations, but are so variable in form that it is more difficult to describe them as typical items of the gorilla behavioral repertoire. Other gestures in Table 1.1 were observed only in one or a few individuals, and generally in only one age class. This provides evidence that some gorillas may develop, and continue to use, idiosyncratic gestures. The problem of what gestures are "species-typical" and which are created by individuals, and whether there is a gradation between these extremes (i.e., gestures used only by a few individuals, or by only certain age or sex classes), will be an

[1]Though mountain gorillas *(G. g. beringei)*, lowland gorillas *(G. g. gorilla)*, and eastern lowland gorillas *(G. g. graueri)*, are different subspecies, and it has recently been suggested that they may be better described as separate species (Ruvolo et al., 1994), similarity in the most commonly observed gestures is apparent. Given the lack of information for lowland gorillas in the wild, comparisons will be made here as if all gorillas were of one species.

[2]According to Schaller (1963), components of the male display are typically *booting, symbolic feeding, rising, throwing, chest beating, leg kicking, running, slapping and tearing vegetation, and ground thumping (slapping).* Additionally, Schaller states that the gorilla's chestbeating sequence is one of the most complex ritualized displays found among mammals.

ongoing pursuit throughout this dissertation. Heretofore, however, I will refer to as species-typical only those gestures that all gorillas seem to come to use regardless of developmental conditions.

The great apes compared

Research implies that the cognitive capacity of all the great ape species is similar. A summary and criticism of testing of general intelligence for ape and monkey species in captivity by Essock & Rumbaugh (1978) includes a compilation of information from numerous studies on rapidity of learning set acquisition (improvement in trial 2 performance) by various species. The success of species on these tests roughly follows taxonomic relationships and relative neo-cortical size. New world monkeys were surpassed by old world monkeys (rhesus, mangabey), who were surpassed by gorilla and chimpanzee.

Rumbaugh & Gill (1973) tested 45 great apes (15 each of *Gorilla, Pan,* and *Pongo*), 6 gibbons, 4 vervet monkeys, 5 talapoin monkeys, and 4 lemurs on reversal tasks. Reversal testing took place after the subjects had reached pre-designated performance levels on the original task, regardless of length of time, in order to be sure that only ability to respond to the reversal problem was tested. To produce a species-fair test, final results were scored according to a "Transfer Index" developed by Rumbaugh, consisting of the ratio of percentage correct on reversal trials to percentage correct during the criterion period. Superiority of the great apes over lesser apes and monkeys was apparent. Great apes showed a more striking reversal learning advantage over lesser apes and monkeys when the original task had been learned to a higher criteria of correct responses; for monkey species it seemed that the better the original task was learned, the harder it was to reverse. In a summary of the results of three studies supervised by Rumbaugh, no consistent differences were found between the performances of chimpanzees, gorillas and orangutans (Rumbaugh & McCormack, 1967; Rumbaugh, 1970; Rumbaugh & Gill, 1973). Gill and Rumbaugh (1974) also

investigated learning differences within species and found consistently "bright" and "dull" individuals.

Apes, with their quick reversal abilities, seem to have cognitive skills flexible enough to be expressed in different ways according to the needs of the various situations in which they live—often diverse ones even for the same species (Byrne, 1995; diverse within-species behavior is also discussed in many chapters in Wrangham et al., 1996 and Russon et al., 1996). The great apes thus probably all have equal capacity to produce communications that are intelligent responses to changing conditions.

Discussion

Overall, study of gorillas and orangutans has been neglected to some extent. For field studies, this may be because of the relative rarity and isolation of gorillas and orangutans in the wild, and for captive studies because of their unsuitability for keeping as lab animals. Also, gorillas and orangutans have not seemed to be the most appropriate models for evolution of "human" behavior since they are genetically more distant from humans than are the chimpanzee species. The chimpanzee has frequently been considered to be the model of choice for hypothesized behavior of human ancestors (for a summary of the genetic information, see Zihlman, 1996). For ecological reasons, the baboon has in the past also been a model (Tanner, 1981, 1987; Kinzey, 1987; Tooby & DeVore, 1987). More recent information about the close genetic relationship of *Pan* and *Homo* has kept the chimpanzee to the forefront (e.g., Bailey et al., 1992). The pygmy chimpanzee (*Pan paniscus*) has also recently become a candidate for ancestor model (Zihlman et al., 1978). Nonetheless, gorillas and orangutans, traveling on individual evolutionary paths, with individual adaptive problems to solve, have done so with similar cognitive equipment to the two chimpanzee species. Because of these similarities, studying how gorillas and orangutans have arrived at solutions to challenges from the environment is likely to lead to understanding of ape intelligence as

well as is study of the problem-solving abilities of chimpanzees. One solution to such challenges, in the area of communication, has been the use of gesture.

Gestural communication takes place in many animal species, both primates and non-primates. How then can gesture be an indicator of intelligence or cognitive abilities? First, "gesture" can be defined in many ways. The term can refer to any whole body motion or facial expression that is "ritualized" to some degree within an animal's behavior patterns. For human behavior, *gesture* can refer to almost any intentional and voluntary kind of nonverbal communication. Between these two extremes there is a continuum. Savage & Rumbaugh (1977) have attempted to classify nonverbal communicative acts of animals "according to their increasing ability to separate, in both time and/or space, representations of events from events per se" (Savage & Rumbaugh 1977, p. 298). Their classification scheme ranges from the lowest level of *physiological attributes*, to *social acts* and *social patterns*, then *incipient acts* and *iconic gestures*, and finally *arbitrary signs*. A similar classification is found in Liska (1994), beginning with "symptoms" (autonomic responses) wired in to the nervous system, then "semblances" that are iconic, that once ritualized move toward becoming "proper" symbols.

The application of such classification systems to gorilla gesture will be further discussed in the context of my own research. "Iconic" gesture has until now been documented and formally studied only in *Pan paniscus* and humans, though there are numerous anecdotal reports for the common chimpanzee, many mentioned earlier in this chapter. In iconically depicting the action of another, a signaler's hands and arms and their motion *stand for* another's body and its motion. Such flexible depictions are facilitated by ape, but not monkey, anatomies, in the rotational movements of shoulder, elbow and wrist that are part of the brachiator's heritage.

A long-term investigation of gesture in a group of gorillas has been lacking. A zoo study offers a middle ground between field studies and studies of highly enculturated

apes. Through the exploration of cognitive abilities manifested in the communication of untaught captive apes, it becomes possible to better assess what communicative capabilities are common to all great apes, captive or free-living. Knowledge of the communicative inventions of untaught apes also makes it possible to assess to what extent for signing apes "enculturation" during development channels communicative behavior further in a "human" direction. With these questions in mind, I have investigated the gestural communication of a group of zoo-living gorillas over a seven-year span. Different kinds of adaptive problems arise for each individual in a zoo's social group, so the background and history of these individuals is important. In the next chapter I discuss the setting for my research, the San Francisco Zoo, and each of the gorilla subjects. In following chapters I classify the gestures of individual gorillas in this zoo group according to form, sensory medium, and function. Next I look at individual similarities and differences in use of gesture and at changes in use of gesture over a gorilla lifetime. I apply this information to questions of learning processes, make comparisons with other species, and compare zoo gestures with untaught gestures of signing gorillas. Finally, I discuss the possible relationship of ape gesture to the evolution of hominoid cognitive capacity and the evolution of language.

Chapter 2
The San Francisco Zoo gorillas: Research setting and methods

History of the present study

My decision to study the gestural communication of a zoo-living group of lowland gorillas was the result of initial informal observations as a casual visitor to the San Francisco Zoo. My background for these preliminary visits was an extensive knowledge of both taught and untaught signs and gestures of sign language–tutored gorillas Koko and Michael of the Gorilla Foundation (Patterson et al., 1987), and an interest in the gestures of zoo gorillas (Patterson & Tanner, 1988). I had been a companion for Michael or Koko for approximately four hours a week for seven years at the time I began regular zoo observations.

From my very first visit to the San Francisco Zoo I observed a striking amount of gestural communication among the gorillas, some of which resembled "natural" or "invented" gestures used by the signing gorillas I knew well. Why these zoo gestures were so similar in form to those of signing gorillas, and how closely these zoo gestures actually might match them in function, were impelling questions. These first observations resulted in the immediate purchase of a video camera by me and my husband, Charles Ernest (CE), who became the regular cameraman for the project. We began to make return visits on a regular basis. This soon generated a regular research protocol, described below.

General methods

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.

Since October 1988, continuing through the present writing, observations have been made outdoors one morning each week for approximately three hours, conditions permitting, except for one six-month hiatus in the study from September 1989 to March 1990. The study team has consisted of both myself and the camera operator (CE) except for nine months in 1992–1993 when in my absence a team of trained students followed the same general procedure, which was to videotape all social interaction continuously wherever it was possible to use the video camera.

I, as researcher, would scan the activity taking place and suggest to the camera operator the most relevant area to film. For the first few years of the study the choice of subjects was easy; 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 or feeding contexts or between other gorillas. Later in the study, when play sometimes occurred simultaneously between two of the older gorillas and between an infant and older gorilla, the interaction thought most likely to contain gestural communication would be followed continuously. 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 the following chapters. (On average, a three-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, diary-style written notes were taken about any events affecting the gorillas' activity that the camera was unable to record (i.e., annoyance from zoo visitors, airplanes or construction noise causing distraction, information from the zoo keeper about events during the previous week).

Each filmed instance of gesture was catalogued in a Filemaker Pro computer database. Only gestures clearly visible on the videotape were included. A gesture was catalogued as only one instance if it was rapidly repeated consecutively several times in the same form. The quiet nature of most gorilla vocalizations rendered analysis of any vocal component of communication impractical.

Definition of 'gesture'

The word *gesture* has been defined in many different ways, even within the field of animal behavior. It is frequently used to refer to any whole-body motion or facial expression that is "ritualized" to some degree within an animal's behavior patterns. For human behavior, gesture can refer to almost any kind of nonverbal communication. Kendon (1981) provides this definition of gesture:

> . . . a gesture is usually deemed to be an action by which a thought, feeling, or intention is given conventional and voluntary expression . . .

and distinguishes gestures from:

> . . . expressions of emotion, involuntary mannerisms, and actions taken in the pursuit of some general aim. . . however informative such actions may be (Kendon, 1981, p. 28).

We may reflect, however, that humans are often unaware of the flow of gestures with which we accompany speech; so the inclusion of "voluntary" in Kendon's definition is arguable. McNeill (1992) calls these "gesticulations," and defines them as "spontaneous movements of the hands and arms . . . (p,37)." Since it is impossible to measure an animal's intentions, for my purposes here intention cannot be included in a *definition* of gesture. However, intention can be measured in the sense that it can be determined whether an animal is aware of the effect of its actions upon another, for instance by ascertaining another animal's attentional state before signaling. One aim of

my study will be to learn which of the gorillas' communications are in this sense intentional.

As a working definition, the term *gesture* will here be used for ***all discrete, non-locomotor limb and head movements that appear to be potentially communicative, regardless of receptive sensory modality*** (sight, sound, touch). Initially all gestures, whether visual, tactile, or auditory (but non-vocal), were catalogued, with the aim of eventually defining different functional classes of these gestures. Because an aim of this study is to focus on the degree to which signs and signals removed from whole body action are used by gorillas, body postures and locomotory gaits were excluded from categorization as gesture here. Gestures were considered to be communicative if two or more gorillas were in proximity and social interaction was taking place, or immediately preceded or followed the gesturing.

There are specific problems that arise in applying this definition for different sensory modalities. For *tactile* communication, gestures may be defined as different from ordinary motion in that they involve transformations of purposive behaviors so that they are no longer mechanically effective (Bretherton and Bates, 1979; Goldin-Meadow, 1984; Gomez, 1990). For example, lightly brushing a hand downward on another's body to encourage downward movement on another's part would be a *tactile gesture*, as opposed to the direct *action* of forcefully pushing the other down.[1] 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 without making contact, while having the visual attention of the other. *Audible gestures* are limb movements that result in sound that can be detected without a viewer's visual attention (though they

[1]The decision of what is "forceful action" is necessarily subjective on the part of the viewer, but in reality seems fairly easy to discern on videotape.

occur in a wide spectrum of volume, so that some make sounds that carry further than others).

Subjects and setting

The subjects, the gorillas at the San Francisco Zoo, are members of a stable social group; all of them have spent nearly all of their lives at this zoo. The group at present includes first- and second-generation descendants of the wild-caught founder, Bwana, who has been at the zoo since 1958. Bwana's son Kubie and grandsons Shango and Barney remain in the group, as well as unrelated individuals. An elderly wild-caught but human-reared female, Pogo, grew up at the zoo with Bwana; and 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. Further information about each of the gorillas in the group during the study is given in Table 2.1 (page 40), including ages at the beginning and end of the period covered in this dissertation. Though they interact daily with keepers and are exposed to zoo visitors, none of these gorillas has had any exposure to gestural communication in behavior modification programs or had any other kind of intentional human instruction.

Bawang is the mother of Kubie's offspring, Shango and Barney. Bawang has always been Kubie's preferred mate, but when she was pregnant or involved in caring for her first infant, Kubie switched his attentions and play activity to the younger female, Zura. After the birth of the Bawang's second baby, Barney, Kubie's most frequent play partner became his older son, Shango.

The two senior gorillas, Bwana and Pogo, gestured very little throughout my observations but had important social roles in the group. Until his death, Bwana was a strong leadership factor for the group, continually watchful and alert to every event. The co-existence of two silverback males is unusual in zoos, and the interaction between Bwana and his son Kubie influenced the whole group dynamic. Kubie's mother died when Kubie was three years of age, and Bwana took over a watchful and

nurturing role with regards to his son. Though frequently challenged by Kubie once Kubie reached adolescence, 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 on Bwana's behalf to subdue Kubie if the younger male was overly aggressive toward a youngster or female. It is therefore difficult to say which was the "dominant" male in the group without a lengthy discussion of the meaning of "dominance" (as in Saayman, 1971).

Table 2.1
Gorillas of the San Francisco Zoo

Name	Sex	Age March 1989	Age January 1996	Birthplace and rearing	Parents
Bwana b. 1958	male	31	died 1994	wild born, Cameroon; came to SF Zoo at approx. 1 year of age	unknown
Pogo b.1958	female	31	38	wild born, human-reared in Cameroon; came to SF Zoo at age 3 years	unknown
Kubie (Mkubwa) b. May 1, 1975	male	13	20	captive born, mother-reared in San Francisco	Bwana and Jackie (Jackie died in 1978, when Kubie was 3 years of age)
Bawang b. July 13, 1980	female	8	15	captive born, nursery-reared in Cincinnati; came to SF Zoo at age 1 year 5 months	Ramses and Amani (born Cincinnati)
Zura b. September 13, 1981	female	7	14	captive born, nursery-reared in Columbus; came to SF Zoo at age 1 year 2 months	Oscar and Toni (born Columbus)
Shango b. March 11, 1989	male	—	6 years 10 months	captive born, mother-reared in San Francisco	Kubie and Bawang
Barney (Ike-ozo) b. October 12, 1993	male	—	2 years 3 months	captive born, mother-reared in San Francisco	Kubie and Bawang

Plate 2.1. Two views of the San Francisco Zoo's gorilla enclosure
Top: view to north, gorilla indoor quarters on right
Bottom: rocks and viewing area to south

Pogo, the oldest female, has been a non-breeder all her life; recently a medical examination ascertained that she has a constriction in her vagina. She has continually repelled male advances over the years, though she would often teasingly court male attentions. Until the birth of Bawang's two babies she spent a lot of time in the trees or on the periphery of the social group trying to avoid harassment, from Kubie in particular. When Bawang's infant Shango was born she was extremely interested in the baby and continually tried to get near him, but Bawang did not allow contact until Shango was six months old. After that, Pogo very gradually became a preferred playmate and frequent "baby-sitter" for Shango. She also played with young Barney, but less than she had with Shango, because Barney then had older brother Shango as a play partner. Pogo, like Bwana, rarely gestured, but once in a while in the course of play would engage in a surprising burst of communicative activity.

The San Francisco Zoo's present gorilla enclosure has been this 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 (see Plate 2.1, facing page).

Previous studies of the San Francisco Zoo gorillas

Because the senior members of the group (Bwana and Pogo) have remained in San Francisco for over thirty years, the San Francisco zoo's gorilla group is a valuable resource for research on establishment of group traditions and social learning, and has already been the subject of a number of studies. With San Francisco Zoo gorillas as her subjects, Chevalier-Skolnikoff (1977) described gorilla early development in Piagetian terms and compared it to monkey and human infants. She also suggested the existence of traditions in the San Francisco Zoo gorilla group in regards to tool use to get out-of-

reach food. Stick tools were regularly used by all group members at the time of her writing, and this continues to be the case at the present time. Other early observations of the group are published in Redican (1982) and describe interactions on the part of Pogo and Bwana involving planning and deception. A study of Kubie's play during his first three years of life (Parker, 1993 and in press) indicates group continuity in some gesture types and play styles; these findings will be discussed in reference to my own observations. Parker (1994) also observed the responses of the gorillas in the San Francisco group in 1978 and 1989 in regards to their responses to a mirror, detecting in all of the animals some signs of mirror self-recognition.

Another study followed the transfer of the group in 1980 from an older pit enclosure to the present spacious, naturalistic enclosure (Goerke et al., 1987). The frequency of Kubie's play activities was sampled before and after transfer to the present enclosure. Contrary to the authors' hypothesis, play behavior decreased rather than increased after the move. Reasons for this unexpected finding were proposed to be: stress of moving, need to explore the new area, maturation, or gorilla tendency to prefer wider inter-animal spacing when it is possible.

The San Francisco group was included in a study of gorilla laterality that surveyed the handedness of 47 gorilla subjects from 5 different zoos (Shafer, 1987, 1993). More than three-quarters of the subjects were significantly right-handed. One of the categories included in the study was "gestures," which provides useful material for comparison with some of my findings.

The results of stress from construction work near the zoo in 1989 was documented by Gold & Ogden (1992). The decrease in play and sexual behavior they noted at this time was noticeable in my own observations during the same period, in a decrease in overall quantity of gesture (see Chapter 3, Table 3.3). Also documented at this time was an increase in aggressive behavior from Kubie directed toward Bwana, and a decrease in feeding time on Kubie's part.

The San Francisco group's unusual status as a zoo group with two co-existing adult male silverbacks was explored in a longitudinal study by one of their keepers. Her observations allowed her to reach conclusions regarding methods of efficient group management where two silverbacks are housed together (Kerr, 1993).

Before I present my own studies of gestural communication in the San Francisco group, the next chapter will provide an overview of these gorillas' corpus of gestures, in both type and quantity, during the seven-year span of my observations. The tables contained in that chapter will provide reference points for the material in the rest of this thesis.

Chapter 3

Overview of data:

Study periods, gesture types, gesture quantity

This chapter is a reference source for information utilized in the studies presented in the rest of this thesis. Its three sections 1) describe the study periods into which the long-term data was divided for purposes of analysis; 2) provide a table of all the major gesture types seen during the duration of the study with quantity of usage, context, physical description, and comparison to other gorillas and other species; and 3) give an accounting of the total quantity of gesture observed in the group over the different study periods.

Study Periods

Data on gesture usage was cataloged by "Study Periods," which were of only roughly equal duration. The choice of delineating a Study Period was made on the basis of the occurrence of important social events or changes in group composition. Notes on features of the social history of the group, correlated with the designated Study Periods, follow in Table 3.1, page 45.

Description of gesture types

For reference throughout this work, Table 3.2 (at end of this chapter, page 49) provides a descriptive list of all gesture types used by the San Francisco Zoo gorillas with any regularity (that is, observed in an individual 5 or more times during a Study Period). The entire database, not a sample, is included. Classification of gestures into "types" and the names assigned for each gesture type evolved gradually with repeated viewing of the data, and was based on physical similarity of actions. The physical description of gestures employs the three parameters commonly used for describing the signs of American Sign Language (Stokoe et al., 1965; Stokoe, 1978): *place* (location on body or in space), *configuration* (hand shape), and *motion* (path of movement of hand or arm).

Table 3.1. 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 six 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 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.

For each gesture type quantity observed per individual during each study period is listed, and also total quantities for the group. "Usual context" refers to all individuals using the gesture, unless specified otherwise.

Gestures observed in the San Francisco group are compared in the table to published reports of gesture usage by gorillas at other zoos and in the wild, utilizing Ogden and Schildkraut's (1991) *Compilation of Gorilla Ethograms* as a primary source. Schaller, Fossey, and Robert Campbell's film are the main references for gorillas in the wild. Comparisons to other species are drawn from numerous sources, each listed where relevant, and are only for spontaneous gestures; no taught signs or gestures are included. Comparison was sometimes difficult because authors rarely gave careful physical description of gestures; terms such as patting, poking, tapping, hitting and swiping may have been interchangeable in ethograms from different zoos. The comparisons in Table 3.2 are therefore not always exact, and in some cases may be guesses.

In addition to inconsistent descriptions in gorilla ethograms and other sources of comparison, behavioral elements themselves were often strikingly different from each other. Many gestures and other behaviors are listed for other zoos that have not been observed in San Francisco, but likewise some San Francisco gestures are not reported elsewhere in ethograms. 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 the ethograms also varies widely from one to the other, perhaps because of the individual goals and observational foci of the studies they were for, but probably also because behaviors do differ from zoo to zoo and in the wild.

Overall quantity of gesture

Table 3.3 (page 47) illustrates total quantities of gesture observed in the San Francisco Zoo gorilla group over the years, by study period. This compilation provides evidence of

Table 3.3. Summary of number of gestures observed over seven years, October 1988-January 1996

Number of social gestures	Period 1 October '88 11 months 30 visits	Period 2 March '90 15 months 34 visits	Period 3 July '91 14 months 36 visits	Period 4 October '92 9 months 24 visits	Period 5 July '93 14 months 39 visits	Period 6 Sept. '94 16 months 44 visits	Totals by individual for duration of study
Kubie	598	342	9	1	93	145	1188
Zura	547	238	103	80	129	146	1243
Shango	0	89	83	41	182	222	617
Bawang	4	134	19	15	14	61	247
Pogo	2	5	11	10	9	24	61
Bwana	7	4	2	0	6	X	19*
Barney	X	X	X	X	X	261	261*
Totals by Period for group	1158	812	227	147	433	859	3636

*not in group for all of Study Period

X= gorilla not yet born, or deceased; thus not present in the group for that Period

change over time both within and between individuals in quantity of gesture use. The most striking changes in quantity of gesture were clearly related to social circumstances (described briefly for each study period at the beginning of this chapter). Though the study periods were only roughly equal in length, in some cases changes of quantity are so dramatic that they do not require statistical analysis. For instance, the number of gestures observed for Kubie during Periods 1 and 2 (nearly a thousand gestures) was dramatically greater than the number observed in Periods 3 and 4 (ten gestures). Social circumstances seem to provide an explanation for this. During Periods 1 and 2 Kubie

regularly played with Zura; Bawang during Period 1 was occupied with pregnancy and then with her newborn infant, Shango, but she also engaged in some play with Kubie during Period 2, when Shango was more independent but still nursing (note increase in number of Bawang's gestures from Period 1 to 2). During Periods 3 and 4, when almost no gestures were observed, Kubie continually followed Bawang, his preferred mate, while she generally tried to avoid him by escaping through the narrow opening (too small for Kubie to enter) into the indoor enclosure and coming out only when he was distant enough from it to prevent successful pursuit. Kubie's guarding behavior may have been related to the presence of the older male in the group, Kubie's father Bwana, and that Bawang sometimes made sexually receptive advances toward Bwana (Kerr, 1993). Because gestures were most frequently found in a play context, the lack of play behavior by Kubie for these Periods apparently meant cessation of communicative gesture. There was a concomitant, though not as radical, drop in gesturing by other members of the group during Periods 3 and 4. An earlier less drastic drop in Kubie's gesturing from Period 1 to 2 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 and Ogden, 1992). Kubie's amount of gesturing increased again in Periods 5 and 6 when he began to play regularly with his young son Shango.

From Table 3.3, it becomes apparent that the gesturing in the context of play between Kubie and Zura during Periods 1 and 2 is a rich source for investigation, as is also the gesturing in play by Kubie and his two sons during Periods 5 and 6. The next chapters will move to a closer inspection of usage of gestures by individual gorillas, look at variation in the gesturing of individuals over time and in interaction with different gorillas, and make comparisons between individuals.

Table 3.2. Social gestures of the gorillas at the San Francisco Zoo

K= Kubie
Z=Zura
Bw= Bwana
Ba= Bawang
Po= Pogo
Sh= Shango
By=Barney

Key to gesture physical descriptions in table:
P= place (location on body, or location in space)
C=hand configuration or shape
M=motion (direction, force) of gesture
(after Stokoe et al., 1965)

References for comparisons to other gorillas:
1. Ogden & Schildkraut, 1991
2. Schaller, 1963
3. Robert Campbell films at National Geographic
4. Fossey, 1983
5. personal observation at Rio Grande Zoo, JET 1992; see Appendix 2

P (in columns 1 and 2)= study period as described in Chapter 2

T=(column 2)= total for all periods

Gesture types performed fewer than 5 times during a study period, either total or by an individual, are not listed.

Gesture type	number of times gesture used by individuals per period(P)	total number of occurrences by period and total for all periods	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
armcross	P1 Z 11 P2 Sh 5 P6 By 6	P1=13 P2=11 P6=7 T=31	play	P: chest C: open arms and hands M: cross arms, wrap around chest and shoulders, release	zoo 1, 5	
armshake	P1 K 41 Z 119 P2 K 48 Z 89 P3 Z 36 P4 Z 32 P5 Z 38 P6 K 10 Z 49 By 32	P1=160 P2=145 P3=39 P4=34 P5=42 P6=93 T=513	play, sometimes warning	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	several zoos, also called wave or hand shake; solitary or stereotyped only in some gorillas; 1	bonobo: DeWaal 1988, nervous request or threat; Mori 1984; chimpanzee: wristshaking, Goodall 1986, threat; DeWaal 1988, warning, approach invitation; Plooij 1984

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
armswing under	P1 K 39 Z 9 P2 K 16	P1=49 P2=17 T=66	play	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		capuchin monkey: pers.obs.=sexual invitation? chimpanzees: ? beckoning, Goodall 1968b; stretch over, Van Hooff 1973; Plooij 1984; bonobos: Savage-Rumbaugh et al. 1977
away	P1 K 11 Z 17 P2 Z 7 P4 K 5 P6 Z6	P1=29 P2=12 P3=6 P4=5 P6=16 T=68	agonism	P: in front of body C: extended arm M: arm moved quickly away from body toward recipient, may or may not touch other gorilla	frequent at zoos; also called armswing, hitting out; 1; in wild 3	chimpanzees: hitting away, arm raise, or flap, Goodall 1968b; upsway, Van Hooff 1973, Plooij 1984
backhand	P1 K 30 Z 7 P2 K 27 P5 K 12 Z 5 P6 K 9 Sh 16	P1=37 P2=31 P5=19 P6=27 T=114	play, agonistic display	P: any environmental surface C: fist M: back of hand hits surface forcefully, usually audible	frequent at zoos 1; in wild 2	chimpanzees: for threat or attention; Fouts unpublished ethogram; hitting away, Goodall 1968a
beat sides of head	P2 Ba 6 P6 Ba 8	P2=6 P6=8 T=14	play or self protection	palms slap or cover sides of head	in wild 4	
bite	P1 K 16 Z 14	P1=30	play	P: mouth, between front teeth C: extended finger, thumb or side of hand M: finger or hand held briefly between teeth	personal observation, JET, Michael at Gorilla Foundation, Ivan in Tacoma; zoo, reported in 2; in wild 3	liontailed macaques: personal observation, JET, National Zoo

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
body beats	P1 K 12 Z 38 P2 K 6 Z 8 Ba 34 Sh 5 P3 Z 8 P4 Z 11 P6 Z 12 Ba 8 By 6	P1=52 P2=53 P3=9 P4=11 P5=7 P6=34 T=166	play	any location on body except chest beaten with alternating open hands or fists. Often audible but not as resonant as real chestbeating	frequent at zoos 1, 5; in wild 2	
chest beat	P1 K 39 Z 49 P2 K 27 Z 58 Sh 19 P3 Z 20 Sh 6 P4 Z 7 Ba 5 Sh 15 P5 K 18 Z32 Sh 22 P6 K 23 Z 34 Sh 91 By 44	P1=89 P2=111 P3=33 P4=29 P5=81 P6=199 T=542	play, agonism, display	chest is slapped with alternating open palms, audible effect	species typical: details on use in wild see 2	
chest pat	P1 K 22 P2 K 7	P1=27 P2=8 T=35	play	P. chest C: one cupped hand M: hand taps chest lightly, no audible effect	at several zoos 1; in wild 3	bonobos: DeWaal 1988

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
chest knock	P1 K 13 P2 K 17 P5 Z 6	P1=13 P2=17 P5=8 P6=8 T=46	play	P: chest C: loose fists M: alternating hands beat chest, knuckles or sides of hands making contact. Low audibility.	personal observation, JET, Koko and Michael at Gorilla Foundation	
circle hands	P1 Z 7	P1=7	play	P: space in front of body, may or may not touch body slightly C: open hands or loose fists M: hands circle each other, palms toward body	in wild 2	
clap	P1 K 8 Z 7 P2 K 5 Z 10 Ba 29 Sh 16 P3 Z 17 Sh 5 P5 Z 9 Sh 69 P6 K 8 Ba 12 Sh 31 By 103	P1=16 P2=60 P3=26 P4=7 P5=84 P6=158 T=351	play	flat hands, palms contact in space in front of body. Audible effect	frequent in zoos 1; in wild, 3,4, Fay 1989	bonobos: Ingmanson 1987, DeWaal 1988, Thompson 1993
down	P1 Z 12	P1=16	play, mating positioning	P: space in front of or next to body C: open hand M. extended arm moves downward		

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
extended palm	P1 K9 Z 10 P2 K 5 P6 Po 8 K 8 Z 5	P1=19 P2=8 P5=8 P6=23 T=58	play, invitation for making contact, including sexual contact, also food request	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	frequent in zoos 1,5; see also Hess, 1973; in wild 2	chimpanzees: frequent in all reports bonobos: DeWaal 1988, Kuroda 1980, begging food; Mori 1984, appeasement; Savage-Rumbaugh et al. 1977, approach orangutans: Bard 1990
facewipe	P1 Z 9	P1=10	annoyance or avoidance	P: on face or in front of face C: open, relaxed hand M: thumb side of hand or wrist brushes down face, usually from nose to chin		baboons: muzzle wipe, Ransom 1981, Kummer 1995 chimpanzees: startle, common in captivity and wild
finger down lips	P1 Z 6	P1=6	estrus checking by other gorilla	P: mouth C: index finger M: finger moves vertically down lips		
foot back	P1 Z 14	P1=14	play, mating invitation	P: space behind body C: foot M: knee bent, foot is raised from ground and suspended behind body, usually while standing tripedally with rear presented to other gorilla	several zoos, also called foot dangle; 1, 5	baboons: footback present, Ransom 1981 chimpanzees: leg bend for infant to mount mother's back, also used as play invitation, Goodall 1968a; Kohler 1925, Kortlandt 1967, Van Hooff 1973 bonobos: DeWaal & Lanting 1997

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
go	P1 Z 5	P1=5	moving self forward	P: space in front of body C: open hand M: arm thrust or swung forward in front of actor		
hands behind back	P1 Z 19	P1=21	play, approach invitation	P: behind body C: open hands, arms extended behind back M: fingers wiggle behind back, or wrists may tap ground or back. Usually performed seated	zoo, Mitchell 1989	baboons, Ransom 1981: rear present with hand back chimpanzees: Goodall 1968a, 1986; scoop gesture, reaching back to transport infant
hand(s) between legs	P1 K 9	P1=11	play, sexual invitation	P: between legs, at crotch C: open hand M: pats between legs, sometimes fingers wiggle	zoo 5	
hands on shoulders	P1 K 6	P1=8	play, making contact	flat hands contact actor's shoulders		
head nod	P1 K 99 P2 K 47 P6 K 11	P1=102 P2=48 P5=7 P6=11 T=168	play	head moves abruptly downward and then returns to vertical position	in zoo 5; in wild 3	baboons:? bobbing Ransom 1981 Hall & DeVore 1965 chimpanzee: DeWaal 1988, Fouts unpublished. ethogram; warning other, inviting approach
head shake	P2 K 13 P6 K 7	P2=13 P6=9 T=22	play	head shaken from side to side on horizontal axis	at several zoos 1; in wild 2	
head turn	P1 K 10 P2 K 13	P1=10 P2=13 T=23	play	head turned abruptly to side on horizontal axis, then returned to front	at several zoos, also head jerk? 1; in wild 2	baboons: looking away, Ransom 1981, Hall & DeVore 1965

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
head twirl	P1 K 10 P2 K 19 P5 K 5 P6 K 11	P1=12 P2=21 P5=5 P6=12 T=50	play	head fully rotated rapidly, often combined with twirling bag in teeth	frequent at zoo but as stereoptyped or solitary 1; in wild 4	
hide playface	P1 Z 27 P2 Z 6	P1=27 P2=7 T=34	avoiding play	P: open mouth C: open, curved hand M: hand covers mouth		
knock	P1 K 22 Z 6 P2 K 14 P5 K 10 P6 K 10	P1=29 P2=18 P5=17 P6=16 T=80	play	P: any environmental surface C: fist M: knuckles or side of hand hits surface, sometimes audible	frequent at zoos 1	
mouth/lips	P1 Z 5	P1=5	(perhaps variation of *bite* or *hide playface* gesture)	fingers contact mouth or lips		
pat off	P1 K 13 P2 K 7 Z 5	P1=14 P2=13 T=27	ending play	P: other gorilla's body C: open hand M: flat hand contacts body and then is pulled sharply away	perhaps at other zoos, described as patting or swiping 1	

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
slap surface	P1 Z 35 P2 Z 10 Ba 22 Sh 30 P3 Sh 53 Z 5 P4 Sh 13 P5 Z 13 Sh 63 P6 Ba 6 Sh 36 By 41	P1=37 P2=64 P3=61 P4=16 P5=77 P6=88 T=343	play	P: any environmental surface C: open palm M: palm contacts surface forcefully, usually with audible effect	frequent at zoos 1; in wild 2, Mori 1983	baboons: stamping, Ransom 1981, Hall & DeVore 1965 langur: Jay 1965 chimpanzees: common in wild and captivity
tactile close gestures	P1 K 65 Z 16 P2 K 28 P3 Ba 8 P6 Po 7 K 14 Ba 6 Sh 11	P1=83 P2=36 P3=14 P4=12 P5=14 P6=44 T=203	positioning, mating play	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	probably at other zoos, described as push, brush, or nudge; 1, and see also Hess, 1973; in wild 2	baboons: ? pushing, Ransom 1981 bonobos: Savage-Rumbaugh et al. 1977 chimpanzees: Kohler 1925, Yerkes 1943, Goodall 1968a
tap other	P1 K 83 Z 25 P2 K 22 P5 K 12 Sh 8 P6 K 9 Z 5 Sh 7	P1=109 P2=24 P3=9 P4=9 P5=24 P6=28 T=203	play	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	at several zoos, may be called poking, tagging or touch with hand; 1,5; in wild 3	bonobos: Savage-Rumbaugh et al. 1977; punching?, DeWaal 1988 chimpanzees:? poke, Van Hooff 1973; punch or poke, Fouts unpublished ethogram

Gesture type	use by individuals by period (if n= or>5)	total number of occurrences by period and total for all periods (if n= or>5)	usual context	physical description	similar gesture in other gorillas? other names for gesture?	similar gesture in other species?
teeth	P1 Z 7	P1=7	play	P: front teeth C: curved hand M: fingertips tap teeth		
up		P1=5	request or intention to move upward	arm raised in space in front of body	in zoo 5; in wild 2	
wrist glance	P1 Z 8 P2 Z 7	P1=9 P2=7 T=16	delaying action	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		

References for comparisons to other gorillas:
1. Ogden & Schildkraut, 1991
2. Schaller, 1963
3. Robert Campbell films at National Geographic, viewed by JET 1991
4. Fossey, 1983
5. personal observation at Rio Grande Zoo, JET 1992; see Appendix 2

Plate 4.1. Kubie, a young silverback during Study Period 1

Chapter 4
Gestures of a young adult male gorilla: A communicative repertoire and its stability over time

Introduction

Kubie, a male lowland gorilla, utilized a great quantity of gesture. Kubie was the gorilla in the study group for whom the broadest range of data is available; he was born and mother-reared in the San Francisco group. In addition to my seven years of observations, information is available on Kubie's behavior as an infant (Parker, 1993 and in press) and film of Kubie's interaction with Pogo, the oldest female in the group, is available from five years before my study began; all this allows a broad picture of Kubie's gesture use over time. Thus I will begin with a study of Kubie's gesture.

In order to first establish whether Kubie's gestures were performed with intent to communicate, I analyze some of Kubie's most frequent types of gestures in terms of the behaviors which accompany them. I seek the function of different types of gestures by noting the behavior which follows them and the social and physical contexts in which gesture types most frequently occur. I classify each gesture type as part of more general gesture "classes" that have certain physical and contextual features in common.

I next address the stability of Kubie's gestures over time as a regular pattern of behavior. I look at Kubie's usage of gestures at different time periods with other gorillas of different ages and sexes; I compare the types of gestures Kubie used when with different females in different time periods, thus surveying the continuity of Kubie's gestural repertoire over time. I also compare the gestures used with females to those used in interaction with his young sons, Shango and Barney, during a later time period. By assessing variation in the distribution of gesture types when Kubie interacts with different social companions it can be better understood how Kubie's gestures function as specialized communicative elements. I hope in this chapter to establish the nature of

Kubie's gesturing as part of a successful and perhaps partly novel system of communication.

Kubie's most frequent gestures (Study Period 1): an analysis

(A portion of this analysis has been published as Tanner & Byrne, 1996)

Subjects and setting

Play between Kubie and Zura during Study Period 1 (October 1988 through September 1989) was the richest source of gestural communication throughout the seven years of my observations. During this Study Period, Kubie was a young silverback, 13 years old (Plate 4.1, opposite p. 58). His play partner, the female Zura, was 7 years old and much smaller in size than he (Plate 5.2, opposite page 109, illustrates this size difference). Both gorillas seemed to use their gestures to regulate the flow of play, and each was observed to perform an approximately equal quantity of gestures; over 500 gestures for each gorilla were videotaped during Period 1 (see Table 3.3, Chapter 3). Virtually all gestures observed of Kubie during Period 1 were performed when he was interacting with Zura.

Certain factors in the environment during the period of study reported here seemed to have an effect on Kubie's relationships with the young females. The door to the gorillas' indoor quarters was kept open to a width that allowed free entry and exit by the two younger females but was too narrow for the adult males and the older female.[1] Further, all the females readily climbed the large trees in the enclosure and the youngest and oldest female were frequently up in trees. The older male never climbed trees; the younger male, Kubie, only did so upon rare occasions. Because of this setting

[1]Zoo decisions related to the door situation, which was intended to alleviate tension in the group related to competition between the two silverbacks, are discussed by gorilla keeper Mary Kerr (1993) in a Master's Thesis regarding group management.

the females had freedom to avoid interaction with the older males totally if they so desired; thus negotiation through gestures might be more effective than physical force.

Methods

A total of 22 hours of videotape of gorilla social interaction from Study Period 1 was used for this analysis. From Kubie's corpus of gestures (Table 3.2, Chapter 3) a set of the 9 most frequent gesture types was chosen for closer study. These were: *armshake, armswing under, backhand, chestbeat, chest pat, head nod, knock, tactile-close* gestures, and *tap other.*[2] The reason for choosing this particular number of gestures is that these 9 gestures are those that had large enough sample sizes to be viable for statistical analysis. These gestures can be further classified according to physical characteristics as follows:

Tactile close-range gestures:

tactile-close gestures

Silent gestures:

tactile longer-range: *tap other*

silent in space: *armshake, armswing under*

on signaler: *chest pat*

head gesture: *head nod*

Audible gestures:

backhand, chestbeat, knock

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[2]See Table 3.2, Chapter 3 for more complete physical description of these gestures; general observational methodology and a working definition of "gesture" is found in Chapter 2. Following the *Results* section in the present study, the characteristics and usage of each gesture type will be summarized individually.

The following aspects of Kubie's 9 most frequent gesture types were chosen for more detailed observation from video:

1) *Visual attention:* To learn which gesture types might be intentional visual signals, I examined whether a gesture was performed by Kubie when Zura could see it.

2) *Playfaces:* To learn about possible motivation of gesture types, I recorded whether a gesture by Kubie was accompanied by his playface (an open mouth).

3) *Contact:* To identify an immediate function of gesture types I observed whether a gesture by Kubie led to contact with Zura within 5 seconds of the end of the gestural motion.

For the above analyses 1), 2), and 3), I viewed the video of each instance of the nine gesture types selected and catalogued the relevant aspects of visual attention, playface and contact for each instance. I then used the chi-square statistic to learn what significant differences there were between gesture types for these characteristics.

4) *Function of playface vs. gesture*: For those gestures most often accompanied by playfaces I examined the relative effectiveness of *playfaces alone, gestures alone, gesture+playface,* and *neither*, in achieving contact with Zura. A sampling was taken from each type of situation, in order to compare the resultant numbers of contacts (within 5 seconds) achieved under each condition. The pre-existing data on gestures and playfaces was used for the *gesture alone* and *gesture+playface* categories. A sample was taken of Kubie's *playface alone* by observing the first one that occurred (if one occurred) on each Period 1 videotape that contained play sessions between Kubie and Zura, after play had already been initiated once after a gesture, or a gesture accompanied by a playface. To find a corresponding sample of moments during the same play sessions where *neither* a gesture nor a playface occurred, the tape was run forward at least 5 seconds after the same starting points as for the *playface alone* sample, and then advanced until a suitable instance was found.

5) *Context:* To learn whether usage of gesture types varied according to situation, both as to proximity and type of play, I investigated whether the physical classes of gesture types varied in proportion of use during different play session contexts between the partners. I selected six different "game" sessions where the gorillas retained a focus on a certain kind of activity in a specific location for a length of time sufficient for a good sample of gestures. Each was a different location and different type of play. I noted the number of gestures of each type and the larger physical classes into which they fell, for each game. For more information on these "games" and the number of gestures in each, see Appendix 1.

Results

Table 4.1 (page 64) provides a summary of analyses 1), 2) and 3), and gives the specific gesture types and raw frequencies upon which the chi-squares are based.

1) *Visual attention:* To learn which gesture types might be intentional visual signals I examined whether a gesture was performed by Kubie when Zura could see it. If the two were face to face, even if one face was not itself visible on the video, the gesture was counted as having the recipient's visual attention.

For the 9 different gesture types, there was significant variation (from 39% to 100%) in the number of gestures of each type that Kubie performed with Zura's visual attention available ($\chi^2(8)80.8$, $p<.001$), compared with the null hypothesis that the number of gestures performed with visual attention would match the overall gesture frequencies. The gestures appeared to fall into three attentional groups; a high visual attention group consisting of 5 silent limb and head gestures, a medium visual attention group of the 3 audible gestures, and a low visual attention group of the tactile close gesture type alone. After dividing the chi-square table into these three categories, further tests failed to reach significance, supporting this categorization: ($\chi^2(4)7.3$, $p>.1$), ($\chi^2(2)2.1$, $p>.3$), and *tactile-close* gestures alone.

2) *Playfaces:* To learn about possible motivation of gesture types, I recorded whether a gesture by Kubie was accompanied by his playface.

The proportion of accompanying playfaces for each gesture type varied from 0% to 70% among the 9 gesture types ($\chi^2(8)83.0$, $p<.001$), showing significant variation compared with the null hypothesis that playfaces would be distributed randomly with respect to gesture type. The gestures appeared to fall into three groups: a group of 3 silent limb gestures for which there was a high proportion of gestures accompanied by a playface; the silent gesture *head nod* by itself at a medium level, and a group of the remaining 5 gestures, for which an accompanying playface was infrequent. Dividing the chi-square table into these three groups, further tests failed to reach significance, supporting this categorization: ($\chi^2(2)1.4$, $p>.3$), ($\chi^2(4)5.6$, $p>.2$), and *head nod* alone.

3) *Contact:* To identify the immediate function of gesture types I observed whether a gesture by Kubie led to contact with Zura within 5 seconds. "Contact" means that the gorillas' bodies actually touched in play activity, usually wrestling and biting, within 5 seconds of the end of the gestural motion. The gesture may or may not have been followed by other gestures before contact took place.

The proportion of each gesture type followed within 5 seconds by contact in play varied from 6% to 79% ($\chi^2(8)77.3$, $p<.001$) showing significant variation compared with the null hypothesis that contact would be distributed randomly with respect to gesture type. There appeared to be a high contact group of the 5 silent limb gestures, 2 medium contact audible gestures, and a very low contact audible gesture, *chestbeat.* Dividing the chi-square table into these three groups, further tests failed to reach significance: ($\chi^2(4)3.9$, $p>.3$), ($\chi^2(1)1.7$, $p>.1$), and *chestbeat* alone. For the high contact gestures, on the average, 76.4 % of contacts were made by Zura rather than Kubie.

TABLE 4.1. Summary of results for Kubie's nine most frequent gesture types

Gesture Type And Class (n=number of instances Kubie used gesture with Zura)	percent performed with visual attention of Zura	percent where Kubie has playface	percent where contact resulted within 5 seconds after gesture
tactile close tactile close range n=64	39 (n=25/64) low*	15 (n=9/62) low*	(contact criterion not applicable here) 66% of time Zura's body moves in signaled direction
tap other silent limb, tactile long range n=83	83 (n=62/75) high*	57 (n=32/56) high*	69 (n=54/78) high* 76% of contacts by Zura
head nod head n=100	88 (n=84/95) high*	32 (n=23/71) medium*	63 (n=63/100) high* 78% of contacts by Zura
chest pat silent limb n=22	83 (n=15/18) high*	11 (n=2/19) low*	59 (n=13/22) high* 77% of contacts by Zura
armswing under silent limb n=39	100 (n=36/36) high*	70 (n=19/27) high*	79 (n=30/38) high* 80% of contacts by Zura
armshake silent limb n=41	88 (n=29/33) high*	59 (n=16/27) high*	67 (n=24/36) high* 71% of contacts by Zura
chestbeat audible n=39	65 (n=19/29) medium*	0 low*	6 (n=2/34) low* high (70%) rate of change of gaze and/or activity
backhand audible n=30	68 (n=15/22) medium*	5 (n=1/21) low*	39(n=11/28) medium*
knock audible n=22	47 (n=8/17) medium*	6 (n=1/16) low*	21(n=4/19) medium* high (78%) rate of change of gaze and/or activity

Descriptive terms marked with an asterisk* reflect groupings for which the chi-square value did not reach significance, thus the gestures in these groups did not vary in amount of the characteristic under consideration; *high, low* and *medium* are relative terms reflecting these groups; see *Results.*

Number in far left column is total *n* of this gesture type recorded. In other columns in parentheses, *n* on the left of the slash is the number of gestures fitting the named criteria; on the right of the slash the is total number of gestures employed in that particular analysis, which may differ from total in left column for reasons of visibility on video of the particular element under study.

The above test was not applied to *tactile close* gestures, where contact was already established. For these, 66% of the time a tactile close gesture led to the result that Zura moved her body, or let it be moved, in the direction Kubie indicated.

4) *Function of playfaces vs. gestures:* For those gestures most often accompanied by playfaces simultaneous with the gesture (*armshake, armswing under, tap other*) I examined the relative effectiveness in achieving contact with Zura of *playface alone, gesture alone, gesture plus playface* and *neither gesture nor playface* (yet the gorillas were in visual proximity during play sessions). The results are shown in column two of Table 4.1.a.

Table 4.1.a. Precedents and sequels of playfaces and gestures

Kubie's action	**Percent followed by contact**	**Percent preceded by approach by Zura**
Playface alone	93% (n=14/15)	93% (n=14/15)
Gesture alone	59% (n=24/41)	combined categories=2%, (n=1/47)
Gesture with playface	88% (n=52/59)	combined categories=2%, (n=1/47)
Neither gesture nor playface	5% (n=2/21)	

Comparing these frequencies, there was a highly significant association of the *playface alone* with subsequent contact ($\chi^2(1)27.3$, $p<.0001$) compared to occasions when there was *neither gesture nor playface*. Both *gesture+playface* and *gesture alone* also had significantly higher frequency of contact than *neither gesture nor playface* ($\chi^2(1)46.7$, $p<.0001$), ($\chi^2(1)15.9$ $p<.001$). The level of contact for a *gesture+playface* varied significantly from the lesser amount of contact when a *gesture alone* was performed ($\chi^2(1)11.6$, $p<.001$): contact in play was more likely after a gesture if accompanied by a playface. A *playface alone* was more often followed by contact than

gesture alone ($\chi^2(1)6.1$, $p<.05$) but there was no difference between *playface alone* and *gesture+playface* ($\chi^2(1)0.3$, $p>.9$).

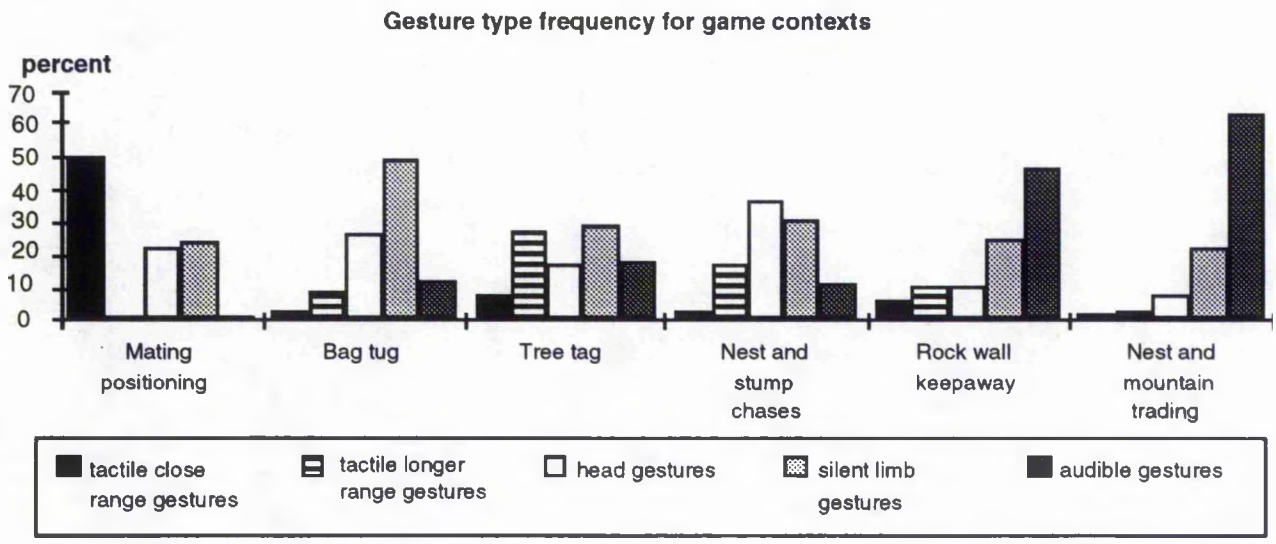
In viewing the video for the analysis above, I noticed that Kubie seemed to get a playface whenever Zura began an approach, regardless of gestures. Therefore, I compared Zura's activity *preceding* Kubie's *playface alone* to Zura's activity *preceding* Kubie's *gesture alone* or *gesture+playface* (a sample of 47 instances, combined categories) and found there was a highly significant difference ($\chi^2(1)51.6$, $p<.0001$); see Table 4.1.a, column 3. An approach by Zura to Kubie almost always immediately preceded Kubie's *playface alone*. Kubie's *gestures*, whether alone or with playface, were almost never preceded by an approach by Zura (only once in 47 cases), but rather by her remaining apart, resisting, or backing away from Kubie. In other words, the *playface alone* was not a signal but rather a response, an apparent recognition that contact in play was about to take place. Gestures, on the other hand, were performed by Kubie when Zura was not showing any signs of imminent approach. Frequently an approach by Zura then followed. Gestures were, thus, signals rather than responses.

5) *Context:* To learn whether usage of gesture types varied according to situation, both as to proximity and type of play, I investigated whether the proportion of different classes of gesture types varied during different play session contexts. This analysis included all gestures recorded during each game segment, not just Kubie's 9 most frequent gesture types, because my intention was to find out whether the physical properties of gestures were related to context.

There was very significant variation in the distribution of five gesture classes or subclasses (here *tactile close range* gestures, *tactile longer range* gestures, *silent limb* gestures, *head* gestures, and *audible* gestures) within six different "game" contexts ($\chi^2(20)241.7$, $p<.001$). Figure 4.1 (following page) illustrates the distributions, and Appendix 1 gives detailed descriptions of the "game" contexts. (A "game" was a play

session that continued without any lengthy pauses, in one location and with one particular context and focus of the play.) The six games seemed to fall into 4 groups: 1) "mating positioning", with a high proportion of *tactile close range* gestures, stands alone; 2) in "bag tug" gesture class distribution is somewhat similar to "tree tag" and "nest and stump chases", but its relatively high proportion of *silent limb* gestures and lower proportion of *tactile longer range* gestures ($\chi^2(8)17.5$, $p<.05$) allow its placement as a group of its own; 3)"tree tag" and "nest and stump chases" are very similar ($\chi^2(4)6.8$, $p>.1$); 4) "rock wall keepaway" and "nest and mountain trading" are also very similar to each other ($\chi^2(4)5.2$, $p>.2$), with a predominance of *audible* gestures. These results matched the different physical characteristics of the games. For instance, audible gestures were in highest proportion in the games where the gorillas were most distant from each other. Gestures appear to be used according to situational appropriateness in each new set of conditions; the variation by context would seem to imply variation in function.

Figure 4.1.



Summary of results of analyses

Kubie's different types of gestures varied in degree of visual attention, in whether they were accompanied by a playface, and in the amount of contacts in play made subsequent to a gesture. Variation in visual attention was related to the physical class of gesture: *silent* gestures in space in front of the body were usually performed when visual attention was available from Zura, the receiver, but *audible* and *tactile* gestures were less frequently performed with visual attention. This implies that *silent* gestures were intentional visual signals. Playfaces by Kubie were most frequent with gestures that had the highest rates of subsequent contact, that was usually initiated by Zura. Both playfaces and contact were less frequent after the *audible* gestures, and playfaces were also very infrequent with *tactile close* gestures, where in many cases the gorillas were not face to face or had already made contact.

The relationship of playfaces and contact brought up a question of the function of gestures in relationship to playfaces: were their functions the same, or differing? An investigation of the consequences of gestures accompanied by playfaces, compared to the sequels of the same gestures alone, playfaces alone or instances during play sessions when there was neither gesture nor playface, showed that *playface alone* and *gesture+playface* had equally high rates of subsequent contact; *gestures alone* had a lower rate of contact, but still much higher than for when *neither* gesture nor playface were present. Most important, however, were the results of a further analysis, that showed Kubie's playfaces to be highly related to the activity preceding these categories; immediately before a *playface alone*, there was almost always an approach by Zura. Kubie's gestures, on the other hand, whether alone or with playface, were almost never preceded by Zura's approach, yet they still resulted in a relatively high rate of contact compared to the absence of gestures. Thus the playface seems to be more a response than a signal, contrary to many interpretations of the primate playface found in the literature (see Pellis & Pellis, 1996a for numerous examples). A gesture, on the other

hand, is an active signal when approach is not necessarily forthcoming, and promotes the occurrence of approach.

The last analysis found that the physical classes gesture types belonged to varied in their proportions in different play contexts. Physical distance between partners was the variable that seemed to elicit different classes of gestures. *Tactile close* gestures were involved in close proximity interaction, *silent limb* and *longer range tactile gestures* were used most with slightly more distance between partners, and at greater distances or with visual barriers, more *audible* gestures were performed.

Discussion: gesture types and gesture classes

Here Kubie's nine most frequent gesture types from Study Period 1 will each be explored in detail in an attempt to discover as much as possible about their functions. As well as incorporating information from the five analyses above, I will include other observations of aspects of their use. Descriptive terms with asterisks, such as high* (usually*, often*), medium* (sometimes*), and low* (seldom*) employed in the following discussion reflect groupings from the *Results* section where the chi-square value did not reach significance, and are intended as relative terms.

Tactile gestures at close range

Tactile close gestures had a high success rate in promoting cooperative action by getting Zura to move her body or, equally often, to allow her body to be moved, in the direction indicated by the gesture, although Zura had the option of getting up and leaving rather than cooperating in any way. These 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). The 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 motion desired of the recipient

In spite of the close proximity of the gorillas for these gestures, a low* proportion of the observations were performed with Zura able to see the gestures. These gestures occurred both during play and when Kubie attempted to get Zura into a position suitable for mating and/or estrus checking. The low* level of accompanying playfaces by Kubie for *tactile close* gestures indicated the relative seriousness of the pursuit of body positioning, or perhaps just that contact was already made, rather than imminent.

During one observation, Zura showed her recognition of a long series of Kubie's tactile gestures as manual communication; communication that she did not wish to receive. She at one point during Kubie's gesturing took hold of his gesturing hand and removed it deliberately from her body, placing it firmly in Kubie's lap (both gorillas were seated on the ground). This was after earlier in the sequence snapping at him with a pouting facial expression, and shrugging away an earlier gesture. The final result of this particular series of Kubie's was that Zura did not cooperate in moving toward him, and instead got up and ran away.

Tactile gesture at longer range: *tap other*

Another type of tactile gesture was labeled *tap other*. This was a quick contact and withdrawal of Kubie's knuckles or open hand on Zura's body. In the great majority of

cases contact was made with the head or chest areas. *Tap other* did not usually seem to be performed in a manner that exerted any directional force on Zura, nor was it a "hitting" action. It was quite stylized in the quick withdrawal of the hand, which was usually extended at arm's length, and often performed when in bipedal or quadrupedal motion.

Tap other was often* accompanied by Kubie's playface. This gesture occurred at highest frequency in two game contexts with a medium level of proximity between the partners. Both games involved "keepaway" activities, with trees and stumps as barriers for hiding and chasing, and Kubie's nest of burlap bags as a "home base." *Tap other* usually* was performed when Zura was watching, and there was a high* degree of subsequent play contact. Three-quarters of these contacts were made by Zura.

Tap other was sometimes followed within the same motion by *armswing under*, a gesture directed by Kubie to his own genital area (see Plate 4.2, opposite p. 72). In these cases *tap other* may have served to point out that Kubie desired Zura's visual attention to continue to be directed to him. It also seemed to notify her that she was to be the object or agent of further action, whether play or positioning for mating. In other cases, *tap other* seemed to indicate exchange of roles in chases. A variation performed with a distinctive "up and off" motion sometimes ended rounds of games as Kubie withdrew, and was catalogued separately as *pat off*.

Head gesture: *head nod*

Head nod was the most frequent of all Kubie's gestures. *Head nod* was usually* performed when he had Zura's visual attention and was followed by a high* level of play contact. A playface only sometimes* accompanied this gesture. *Head nod* was most frequent in medium to close proximity games; one was a "nest and stump" chase game, the other a closer proximity game, "bag tug." In "bag tug" Kubie remained with at least one foot constantly on his bag nest, and Zura made approaches attempting to "steal" a burlap bag from him.

a) *tap other*

b) *come*

c) *armswing*

d) *under*

Plate 4.2. (from video) Kubie gestures to Zura

Head nod may have served to capture attention where a tactile signal was impractical, either because 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. In fact, one of these circumstances was the case in every instance of a sample of 44 *head nods* reviewed. The downward movement of *head nod* traced a motion path to Kubie's body, where further gestures could be noticed or attention given to direct engagement in play. *Head nod* tended to be used at the beginning of a sequence of gestures when it occurred with other gestures.

Silent limb gestures, touching signaler: *chest pat, armswing under*

Another gesture that seemed to direct attention to Kubie himself was labeled *chest pat.* Though superficially similar in form to chestbeating, it was quite distinct. It did not involve the circular slapping motion of chestbeating, but was rather a gentle and silent patting motion on the chest with a single partly closed hand. *Chest pat* was usually* performed when Zura's was watching, was seldom* accompanied by a playface, and contact was the result in a high* proportion of instances. The gorillas' keeper reported that Kubie's father, Bwana, for many years used the same gesture in interaction with keepers when requesting desired food (Mary Kerr, personal communication). Kubie, however, was only observed to use *chest pat* in social interaction with Zura.

Armswing under was another gesture where Kubie touched his own body, in this case between his legs. Kubie performed *armswing under* exclusively when Zura could see him, and this gesture also had the highest rates of accompanying playfaces and of subsequent contact. *Armswing under* appeared at highest frequency in close to medium distance game contexts, as did *tap other, head nod,* and *chest pat. Armswing under* was frequently combined with *tap other* in a single cohesive phrase (Plate 4.2, facing page), thus incorporating both deictic and iconic elements. Its motion path led to Kubie's genital area, obviously a salient location anatomically for male/female interaction and bonding. A closely related gesture, that had a sample too small for

analysis here, was *hand(s) between legs,* patting the genital area without the *armswing under*. The complete phrase, however, was more common: *Tap other ('you')/armswing under('come')/touch between legs ('here')*. This might seem to be a mating invitation, but was never observed to lead to actual mating, though it was followed by a high rate of approach and play contact by Zura.

Silent limb gesture in space: *armshake*

Armshake varied a great deal in form, from minute flicks of a single hand to large motions of both arms and sometimes, simultaneously, other parts of the body. It was seen at highest frequency in two game contexts, "bag tug" and "rock wall keepaway." Both games involved elusive keepaway tactics by one or the other of the partners. *Armshake* was often* performed by Kubie with a playface and when Zura was watching, and a high* degree of contact followed this gesture.

In Kubie and Zura's interactions *armshake* often alternated from one gorilla to the other, and was sometimes simultaneous. It was often performed not only by the gorilla beginning an approach, but by one gorilla just as the other one began to move; perhaps *armshake* may sometimes represent the gesturer's readiness for motor activation, and at other times be a reflection of another's visible activation. When performed by both gorillas simultaneously, *armshake* seemed to indicate agreement upon readiness for action in play.

Schaller (1963) describes *arm waving* above the head as often preceding contact play; however, *armshake* does not seem at all similar to his description, as the arms were always hanging loosely at the sides in *armshaking.* Though forms of *armshaking* have been seen occasionally at other zoos, *armshake* seems to have developed into somewhat of a tradition in the San Francisco group. Records of the group's earlier history indicate that at times all members of the group that existed in 1976 in San Francisco engaged in *armshaking* (Parker, 1993 and in press). More recently I have

observed the emergence of *armshake* in the youngest male, Barney, but have not seen it as a regular part of the repertoire of Shango, Bawang, or Pogo.

Audible gesture touching signaler: *chestbeat*

The species-typical *chestbeat* is highly audible; the *chestbeats* observed were performed with Zura watching two-thirds of the time (only a medium* rate compared to the high attention* group gestures). *Chestbeats* were never accompanied by a playface, and had a very low* rate of immediate contact in play. Kubie's *chestbeat* instead frequently was followed by Zura's directing her gaze toward him, and/or a change in Zura's locomotor activity (a similar usage was seen in the young gorillas studied by Redshaw & Locke, 1976). *Chestbeat* was most frequent in a game where the gorillas were the most distant from each other of all the game contexts, "trading places" between Kubie's nest on the ground and the top of a large rock "mountain".

Audible gestures hitting surfaces: *backhand, knock*

Kubie frequently hit the ground, rocks, or trees with a fist. I distinguished two categories of this hitting. *Backhand* appeared to be a more forceful expression, often a protest, always audible, and often done in the course of bipedal locomotion. *Knock,* hitting with the side or knuckles of the fist, was done with less force, was often audible but was not as loud, and was more often performed seated or from a quadrupedal stance. Both were performed with medium* rates of visual attention from Zura, followed only occasionally* by play contact, and seldom* accompanied by a playface from Kubie. *Backhand* and *knock* appeared in highest proportion in game contexts in locations involving trees or rock walls, where the partners were in mixed or medium proximity. *Backhand* and *knock* were followed by a change in Zura's locomotor activity more often than they were followed by actual contact with Kubie. Additionally, *knock* in some cases seemed to indicate, or at least draw attention to, a particular location. In

several cases Zura proceeded to the exact spot where Kubie knocked, even though Kubie moved away before she arrived.

Kubie's gestures with different females in different time periods

Method

Another way to look at the influence of different contexts on gesture use is to compare Kubie's use of gestures with different individuals, rather than (as above) with the same individual in varied contexts. Video and film from 3 different periods of Kubie's life provide data on gesture use by Kubie at different times with each of 3 different females, bridging a six year span. The gestures during Kubie and Zura's play from Period 1, described in the study above, are used to represent Kubie's interaction with Zura in 1988-1989. Forty-five minutes of video of Kubie in play sessions with Bawang from Study Period 2 in 1990 is used for Bawang's sample. Twenty minutes of film of Kubie with Pogo in 1984 (made available by Sandra Keller of "Friends of the Zoo") was used for Pogo's sample. All Kubie's gestures from these three periods were logged and counted (Table 4.2, page 77).

Subjects and settings

Kubie's motivation in his interactions seemed to be consistent across the three time periods; gesturing appears almost exclusively in play situations, and in accompanying attempts to get a female to assume positions appropriate for ano-genital (estrus)-checking and/or mating. (Gorillas do not display visible signs of estrus as do chimpanzees and many monkeys.) The level of cooperation of the three females in play appeared to differ greatly, however. Pogo, the oldest female, who has to date never bred, was the least cooperative. Pogo would stay in one spot and in one posture while Kubie would attempt to get her to change her position. Since at that time Pogo was

larger and heavier than Kubie, this was not easy to accomplish. Zura, who was smaller than Kubie, was quite variable in her level of cooperation. With Zura, Kubie often stayed in one spot, or frequently returned to a spot, while enticing Zura to come to him. Zura's role seemed to be elusive or teasing, attempting to get Kubie to move and pursue her. Bawang, Kubie's preferred mate, was the most cooperative, at least in the sample used. Play sessions between Bawang and Kubie all took place in a partially sheltered "cave" area in a rock formation, where they would sit and play face to face, remaining physically close, at most a meter or two apart.

Results

Table 4.2 (next page) illustrates the repertoires of gesture types Kubie was observed to use with Pogo, Zura, and Bawang, respectively, during the three sampled periods. Of the 26 gesture types listed in Table 4.2, 12 were seen during all three periods. The 7 gesture types Kubie used most frequently with Zura in Study Period 1 were used in all three periods with all three females. Some gesture types were seen only during one or both of the last two periods, perhaps indicating new additions to Kubie's repertoire after 1984, but the 1984 sample is so brief that this cannot be known with any certainty. Only one gesture from 1984 was not found in Kubie's repertoire of 1989-90; this was *pound lap*, which may have actually been an act of masturbation.

Though Kubie used his 7 most common gesture types during all three time periods with each of the three different females, proportions used of each of these gesture types differed very significantly ($\chi^2(12)45.2$, $p<.001$) between the three females. Moreover, comparisons of Kubie's difference in usage between Pogo and Zura ($\chi^2(6)21.87$, $p<.01$) and between Bawang and Zura ($\chi^2(6)18.5$, $p<.01$) were also significant.

Discussion: Kubie and females

The contexts for the existing film of play with Pogo and Bawang are quite constrained compared to those varied contexts for the larger sample of Kubie's play

TABLE 4.2. Kubie's gestures over 3 time periods with 3 different females

Gestures used by Kubie	n with Pogo 1984	% of Pogo's total	n with Zura 1988-9 (Study Period 1)	% of Zura's total	n with Bawang 1990 (Study Period 2)	% of Bawang's total
head nod *	5	6	90	16	22	18
tap other *	17	20	83	15	9	7
tactile gestures*	20	24	64	11	11	9
arm shake *	3	4	40	7	6	5
*armswing * under*	6	7	39	7	3	2
*chest beat**	2	2	36	7	16	13
*backhand**	1	1	30	5	12	10
chest pat		0	22	4	5	4
knock		0	22	4	3	2
*head turn**	3	4	19	3	6	5
bite		0	14	3		0
body beats		0	12	2	6	5
chest knock		0	13	2	5	4
pat off		0	13	2	1	1
away		0	8	2		0
*head twirl**	1	1	10	2	1	1
*extended palm**	6	7	9	2	1	1
hand(s) between legs		0	9	2	1	1
*clap**	3	4	8	1	4	3
hands behind back	2	2	2	< 1		0
*armcross**	5	6	2	< 1	2	2
slap surface		0	2	< 1		0
hands down shoulders	1	1	2	< 1	0	0
head+body shake	4	5		0	11	9
throw stuff	2	2	1	< 1		0
pound lap	2	2		0		0
TOTAL	83		550		125	

Gestures are listed in order of the most frequent use with Zura. An asterisk indicates a gesture observed in all three time periods.

with Zura. Thus I exercise caution in drawing any conclusions about variation in Kubie's gesture repertoires at different periods from this analysis. It is interesting, though, that the proportion of *tactile close* gestures and the proportion of *tap other,* a longer range tactile gesture seeming to indicate the recipient as object of activity, is highest with the least cooperative and most immovable of the females, Pogo. *Tap other* was highly associated with subsequent contact with Zura, and *tactile close* gestures were found to result in Zura's cooperation in moving her body in the direction Kubie indicated. If Kubie used these gesture types similarly with Pogo, they must have been successful in eliciting some cooperation.

One conclusion that can be drawn with certainty from Table 4.2, however, is that Kubie's repertoire of most frequent gesture types was unchanged over the three periods with different females. This implies that these gestures were understood by and effective with all three females. This is a finding that will be discussed at the conclusion of this chapter.

Kubie's gestures with females vs. with juvenile males

The idea that Kubie's gestures function as specialized communicative elements is further supported by looking at the difference in distribution of types of gestures observed of Kubie during periods when his young sons were his play partners, and periods when females were his play partners. Kubie still used the same repertoire of most frequent gesture types in all these periods.

Subjects and setting

During Periods 1 and 2 Kubie's play was with the adult females Bawang and Zura; during the later Periods 5 and 6, his play was almost exclusively with his juvenile sons, Shango and Barney.

Method

For this analysis, Periods 1 and 2 were combined into an "early" period, and Periods 5 and 6 were combined for a "later" period. The 9 gesture types that were most frequent during both periods were used for this analysis, with the following exceptions. In this analysis, *backhand* and *knock* were combined as one gesture type, because I learned from the study of Kubie's gestures in Period 1 that these gestures were very similar in form and function. *Clap* was not included in the earlier Period 1 study, but was included here because of its relatively greater frequency in play with Shango and Barney.

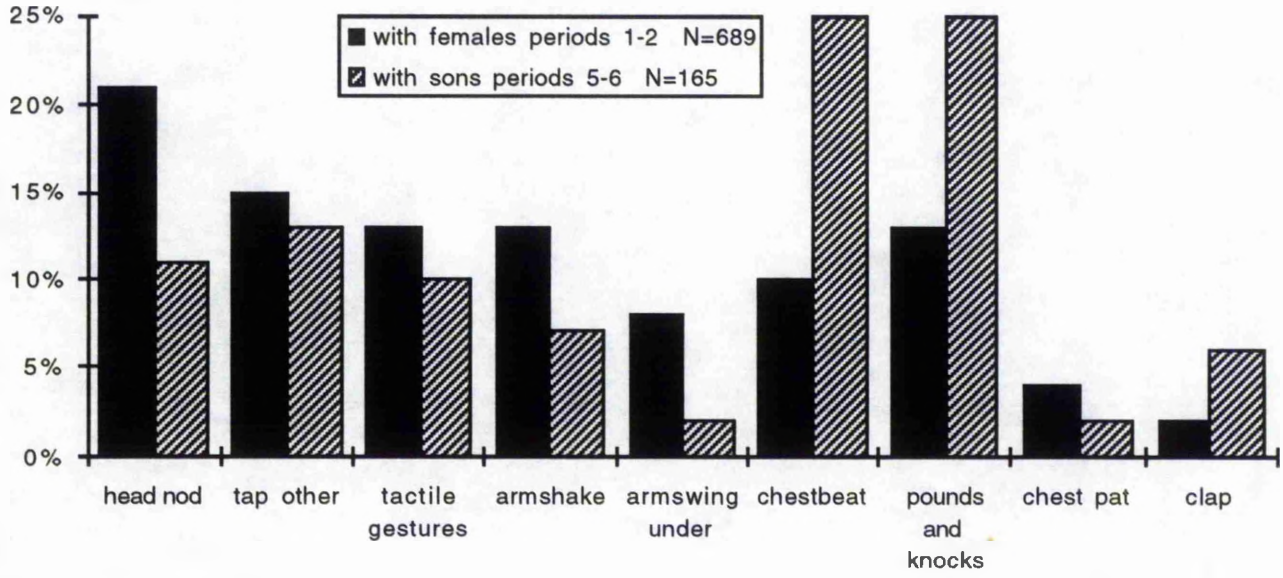
Results

Proportions of the nine gesture types used by Kubie within each period varied very significantly overall between the earlier and later periods ($\chi^2(8)67.26$, $p<.0001$). In order to investigate whether this variation was particularly associated with certain gestures, I examined each gesture separately, in comparison to all other gestures pooled. Thus, for each gesture type, I constructed a 2x2 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. Figure 4.2 (following page) summarizes the results. Some gestures did not show significant variation relative to the whole set: *tap other* ($\chi^2(1)0.67$, $p>.4$), *tactile close* gestures ($\chi^2(1)1.10$, $p>.3$) and *chest pat* ($\chi^2(1)2.11$, $p>.1$). 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* ($\chi^2(1)9.28$, $p<.01$), *armshake* ($\chi^2(1)5.03$, $p<.03$), and *armswing under* ($\chi^2(1)7.99$, $p<.005$), but increase in *chestbeat* ($\chi^2(1)28.32$, $p<.0001$), *knock* and *pound* ($\chi^2(1)12.97$, $p<.001$) and *clap* ($\chi^2(1)8.85$, $p<.01$).

Discussion: Kubie's gestures with females or males

Though some of the differences in gesture distribution could perhaps be attributed to the fact that interaction with young males and interaction with females took place in different periods, the nature of the differences show a strong relationship to the different qualities of interaction when Kubie was with females vs. young males. The gestures *head nod, armshake, armswing under* were used extensively by Kubie during Period 1 to 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

Figure 4.2. Kubie's most common social gestures during periods with different play partners, with percent 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.)

6 were typical audible male displays (*chestbeat, knock* and *pound*), plus *clap*, 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 did sometimes engage in mounting behavior and anal inspection with his sons, and *tactile close* gestures were seen in these situations. *Tactile close* gestures also functioned to adjust body location in ordinary play when the gorillas were already in close contact.

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 (see Table 3.3, Chapter 3, p. 47). Perhaps the females required greater persuasion to participate in interactions than the youngster Shango. Shango often actively tried to initiate play, and used gestures to do so, even when Kubie initially showed no interest and did not gesture himself. The number of gestures observed of Shango during Periods 5 and 6 was roughly double the number of gesture observations for Kubie during the same periods. Though in Period 1 Zura initiated the actual contacts 70% to 80% of the time, it seemed that Kubie's gestures to her were important in influencing her choice to take part in contact interaction. These differences in Kubie's use of gesture in differing social situations (interaction with females vs. young males) support the earlier finding that gestures function as specialized communicative elements and vary according to context.

Summary of chapter results

A close look at the gestural communication of one young silverback male zoo-housed gorilla shows that he uses three main classes of gesture: 1) *tactile* gestures at close range, that depict direction of motion desired of another gorilla on its body and that do not require the other gorilla to see them; 2) *silent* gestures that are usually performed with the visual attention of the other gorilla, some in space and some contacting the

signaler's or receiver's body; 3) *audible* gestures, which are performed with a lower rate of visual attention available from the other gorilla and, unlike the other two classes, are well-known to be species-typical gorilla behavior. Each class of gesture functions to achieve consistent communicative results: for *silent* gestures receiving visual attention, contact in play; for *tactile* close range gestures, body movement in an indicated direction; for *audible* gestures, direction of visual attention or change in locomotion.

Gesturing for Kubie appeared almost exclusively in play and sexual play situations, that often included attempts to get the female to assume positions appropriate for ano-genital inspection and/or mating. (Actual mating was not observed, and this was confirmed by the zookeeper's own observations.) Even in the limited context of play and sexual play, however, gestures served several functions: getting visual attention, promoting future body contact, indicating directional whole-body motion, indicating play location, indicating readiness for engagement in play, drawing attention to a specific subsequent gesture, requesting a particular action, and drawing attention to the recipient as agent of activity.

A further finding was that the playface did not function as a signal actively promoting play (at least for Kubie) though gestures did so. Kubie's playface performed alone was instead a *response,* presumably involuntary, to the actual playful approach of another gorilla.

Kubie's most frequently used gesture types all remained in his repertoire over the 12 year span for which videotaped or filmed observations exist, from his adolescence to his maturity as the sole silverback in his group. The proportions of each gesture type used varied in different contexts, however. The gesture types most frequently used varied with the physical proximity of partners in different types of "game" contexts with the same partner; they also varied when Kubie played with different partners, whether females or juvenile males.

General discussion

The communicative intent of the gorilla Kubie's gestures is shown by the fact that in the large majority of cases, his silent gestures (except for *tactile close* gestures) were performed when another gorilla's visual attention was available. Capture of visual attention, or eye contact, can be considered a sign of intentional communication in apes as well as humans (Sperber & Wilson, 1986; Gomez, 1996). Kubie's "high visual attention" gestures (*tap other, head nod, chest pat, armswing under, armshake*) and his *tactile close* gestures have been infrequently reported for other gorilla groups (Schaller, 1963; Fossey, 1983; Ogden & Schildkraut, 1991; and personal observations of the author at several zoos).

Tactile close gestures seem to be used by other gorillas at times, but have not been studied. Schaller (1963) states that the most frequent gesture involving bodily contact that he observed was a light tap with fingers or hand, on the back or arm, from a dominant animal to a subordinate. He describes such a tactile gesture by a mountain gorilla who attempts to communicate without the use of force, shown by the fact that forceful action is taken only in the absence of response to more subtle communication:

> A silverbacked male sits on a log, a juvenile beside him. He leans over and gives the juvenile a light push with his forearm. The juvenile moves over one foot. Five minutes later the male rises and faces the juvenile, who ignores the male even when touched lightly with the forearm. The male then suddenly pushes the juvenile sharply, and the juvenile rapidly clambers to one side while the male descends from the log (Schaller, 1963, p. 241).

Several of Kubie's high visual attention silent gestures and the *tactile close* gestures seem possibly to be incipient actions ("intention movements") that have become ritualized. However, the *tactile close* gestures and several other gestures such as *head nod, armswing under,* and *armshake,* appear to represent action inferred to be desired by the signaler from the recipient, not action that the signaler himself is preparing to undertake (as in the Schaller example above). Other gesture types seem to

serve a *deictic* (pointing) function, indicating Kubie, the signaler (*chest pat*), or Zura, the recipient, as actor or object of action (*tap other*), or sometimes indicating locations in the environment for shared focus of attention in play (*knock*).

For sign language, Klima and Bellugi 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)." It seems that Kubie, by drawing a path in space with a limb or his head, or on another gorilla's body with his hands, is depicting the form of actions that he desires another gorilla to perform; in the majority of cases the other gorilla actually did move in the depicted direction. In its gestural form, the motion is also of a reduced scope compared to the action it denotes. Therefore some of Kubie's gestures can be considered to be *iconic* gestures. Some gestures contain both iconic and deictic elements, in that any motion (iconic) begins and ends at a specific location. When a location is pointed out by a gesture, the gesture may function as deictic as well as iconic. The gesture as an action that encompasses several structural elements during a single motion will be further discussed in Chapters 9 and 11.

Here, I will discuss several examples from the gestures that have been studied in this chapter, in terms of their iconic and deictic qualities. T*actile close* gestures, performed on another gorilla's body, seem to be purely iconic in indicating direction. *Tap other* is deictic, in that its contact points out another gorilla, but the motion after the gesture may be iconic, moving to a location such as a tree, or to the signaling gorilla; there another deictic gesture might take place, such as *knock* on the tree, or *chest fist pat* on the signaling gorilla's chest. *Armswing under,* as mentioned earlier, seems to be iconic in its motion toward a specific location between the signaler's legs, and then deictic when the hand reaches that location. A bit more difficult to interpret is the frequent head gesture, *head nod;* it may have both iconic and deictic properties in that it seems to trace a motion path with the eyes from the recipient to the signaler's body; perhaps *head nod* is a more condensed functional equivalent of *armswing. Armshake*

is a gesture for which it is difficult to give an iconic interpretation, but the gesture certainly suggests motor activation, and it seems to function to bring about activity in the recipient. In fact, each instance of gesture must be viewed individually in order to analyze deictic and iconic components. Though each gesture falls into a category that has a specific physical description, the direction of gaze of the signaler, the motion path of the gesture, the size and scope of the motion, the starting point and ending location, as well as the angle of direction within three dimensions, and whether the gesture flows into another, are all elements of a gesture that may vary. [3]

The finding that Kubie's communications include gestures that are in the above definition iconic, and other gestures that seem deictic, is similar to results of Savage-Rumbaugh et al. (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 et al., 1996), and in common chimpanzees the representation of direction and duration through sound placement in drumming (Boesch, 1991), provide

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[3]As well as some of the 9 "gesture types" studied in detail in this chapter, Kubie had other gestures that can be interpreted as iconic or deictic. Some were seen only once or a few times, therefore can only tentatively be interpreted; however, if one accepts iconicity as a frequent basis for gesture formation, many gestures make sense in this framework. For example, in one instance Kubie and Zura sit apart but facing each other with intense eye contact. Kubie *head nods* (both iconic and deictic elements), then taps Zura's chest *(tap other*-deictic*)* with an open-mouthed face. After a few seconds there is no response from Zura. Kubie then flings an arm up and *pats his shoulder*, then pats his chest with a fist *(chest pat*-deictic*)* and simultaneous small *armshake* (iconic?*)*. Zura immediately stands up and places her hand on Kubie's shoulder where he patted it, and they begin wrestling play. All the gestures in this excerpt are among the 9 analyzed in this chapter, except *pat shoulder*. Interpreted iconically, *pat shoulder* makes sense, motioning Zura to take action and come up to Kubie at the shoulder, which she does. But *pat shoulder* is deictic in well, in that the motion ends by indicating a specific location.

further support for the presence of an ape faculty to plan, remember, and represent 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 Kohler (1925), Yerkes (1943) and Van Hooff (1973) discerned the mimetic character of the gestures of the chimpanzees they watched (see Chapter 1). In their study of young chimpanzees, Tomasello and colleagues have described some chimpanzee gestures that appear to be similar to those classified here as iconic, but did not discuss that aspect of young chimpanzees' gesturing (Tomasello et al., 1985, 1989, 1994). In spite of a lack of specific information for chimpanzees and orangutans, it appears likely that all the great apes can develop the ability to depict action iconically through gesture, because their cognitive abilities are in general so similar (Essock & Rumbaugh, 1978). In addition, the apes share anatomies that, unlike those of monkeys, have fully rotatable joints of the limbs, allowing movement in three dimensions.

For Kubie, development of novel (and silent) forms of visual communication, including the iconic and deictic, may have been promoted by social and physical conditions in the San Francisco group. The effect of free entry to the indoor enclosure only for the younger and smaller females has already been mentioned as a factor allowing females a choice as whether to interact with the larger gorillas at all. Gestures gently indicating the male's desires for the female's position and activity were not likely to cause the females to terminate interaction. Further, the presence of Bwana, a second mature male, may have at times meant a need for silence in interactions. The gestures that led to a high degree of cooperation and interaction were the silent ones. 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). Zoo-living

gorillas have been observed to use distractive manual activities to achieve interaction (Mitchell, 1989, 1991).

For iconic gestures to become established in an animal's behavioral repertoire, the recipient must have the capacity to interpret the signaler's "pictorial" representations of action, and must respond to them often enough so that it benefits each of the pair in some way to establish such communication (cf. Maurus & Ploog, 1984). The process of "conventionalization" or "ontogenetic ritualization" of certain gestures was posited for chimpanzees as the process by which individually unique but mutually understood gestures might develop (Tomasello, 1990; Tomasello et al. 1989, 1994). A similar process of progression from action to gesture was described by Savage-Rumbaugh et al. (1977) for pygmy chimpanzees, whose iconic gestures showed two kinds of removal 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 succeeding in attaining the same goal, such as ventro-ventral sexual positioning. Gomez (1990) reports another related developmental process in a study with a young gorilla, Muni, as subject. This gorilla first used a human companion as a physical object to climb upon or manipulate in reaching a goal. Later she began communicating intent, through gaze and gesture, to the human, in order to influence the human to collaborate in reaching the goal (Gomez, 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 this conventionalization process might work for Kubie's gestures, let us look at the frequent gesture *armswing under,* which was usually preceded by the gesture *tap other.* Kubie would tap Zura without force, presumably gaining her attention as subject of activity (a deictic gesture), then, having her visual attention, would swing his arm toward himself (an iconic depiction of the motion

desired from Zura), moving his open palm to a final position between his legs (deictic). (See Plate 4.2, opposite page 72). This might have developed as follows: when Kubie wanted Zura to come to him he might first have pulled Zura to him; when cooperative, 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). Unfortunately, there are no observations of the actual emergence of such gestures because my regular observations of Kubie began after he was a mature adult.

There are problems, however, with this "conventionalization" or "ontogenetic ritualization" interpretation, in Kubie's case. The appearance of new gestures in Kubie's repertoire in the later two time periods with Zura and Bawang might imply that Kubie as a young adult (between ages 8 and 13 years) expanded his repertoire but also maintained his earlier repertoire of gestures. Tomasello et al. (1989, 1994) reported that items dropped out of chimpanzees' repertoires over time with different stages of development and different partners. Tomasello's subjects, however, were observed from infancy to the beginning of young adulthood, so the results may not be comparable.

Kubie's use of a similar gestural repertoire with three females implies that if conventionalization was the process by which his gestures were established, he went through a similar process three different times with three different individuals. Was the whole conventionalization process repeated or was observational learning involved on the part of the younger females? Repetition of the process, arriving at the same gestures with three different females, as well as later with his sons, seems unlikely. Observational learning 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.

Another case in the literature that speaks against the conventionalization process is Crawford's (1937) description of the use of "soliciting" gestures by chimpanzees confronted by a task where the cooperation of two animals was required in order to gain food rewards. One chimpanzee suddenly and spontaneously began to use a held-out hand, finger flexing "beckoning" gesture directed at the other. Upon the second usage he successfully gained the other's participation in the task, and subsequently this gesture became regularly successful for soliciting his partner's participation. This was the same begging gesture frequently used by chimpanzees in food-begging contexts, but here it appeared directed at another chimpanzee in a new context with, at times, a different orientation in space (toward the object, the rope to be pulled). Another chimpanzee confronted with the same problem consistently used a different kind of gesture, a tactile gesture gently pulling or turning its partner's head toward the task. This, too, was successful upon its second usage and in most of its subsequent usages. The first chimpanzee also employed tactile gestures of several kinds, including first pushing the other chimpanzee gently down with a hand on its head while bouncing up and down with flexed knees. Later the chimpanzee brushed its hand up and down its partner's shoulder while performing the same bouncing motion. Like Kubie and Zura, these chimpanzees were confronted with a situation where one desired the cooperation of the other. Also like Kubie and Zura, these chimpanzees were not the most dominant animals in the group, and the most successful solicitor was the more dominant of the pair. In the chimpanzees' case, those individuals who developed solicitational behavior generalized it to other chimpanzees besides the original partner as did Kubie from Pogo to Zura, though the level of success varied with different partners.

A simpler explanation of the understanding of gestures might suffice rather than invoking the conventionalization process. Comprehension of the motion depicted in gestures may be biologically encoded for the great apes; the perception of forelimb motion involves specific neuronal structures in primates (Perrett et al., 1989). The

ventral pre-motor area of the nonhuman primate brain, which represents forelimb, facial and mouth movements, is homologous to Broca's area in humans, which handles both motor and linguistic functions of these parts of the body (Preuss, 1993, 1994, reviews relevant neuroanatomical information). An innate ability to read and predict the consequences of limb motions would eliminate the need for conventionalization on the receiver's side of the interchange.

In the attempt to explain mutual understanding of gestures, more than one explanation may have elements of truth, and different explanations may suit different cases, but none completely satisfies. In both Kubie's case and that of Savage-Rumbaugh's *Pan paniscus* subjects, and with Gomez's young gorilla, it seems that something like the process of conventionalization led not simply to learning a gradually more finely shaped association of stimulus and response, but to a real 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 seemed to understand the other's potential actions and what the partner might in turn understand from his (the signaler's) performance of gestures. The great variety and quantity of tactile gestures performed by Kubie supports this explanation; these gestures varied so greatly in type and size and force (as performed in a three-dimensional space on the body of another gorilla) that an individual conventionalization of each gesture would seem a very unwieldy event. The understanding of iconic motions on the body and in space may instead be a natural part of great ape development when conditions make such gestures useful. Schaller (1963) observed two cases in mating contexts where a female made motions that were followed by interest in mating by a previously disinterested male. In one case (in a zoo), the female took the male's hand and held it pressed onto her genital area; in the other case (in the wild) the female mounted the male from behind and made thrusting motions. In both examples, the female seemed to

be acting out what she desired the male to do, and the male seemed to read and act upon the message.

Another finding of significance in this chapter is the usage of the playface by Kubie not as a signal, like gestures, but as a response to imminent contact with another gorilla. Traditionally the playface has been considered to be a "play signal." Recent work by Pellis & Pellis (1996a, b) reanalyzing the playface argues that the open mouth of the playface arises from the automatic response of preparation to fend off the "attack" of another animal by biting. In a comparative study of play behavior in captive great apes, Maple and Zucker (1978) also question accepted interpretations of the playface, stating that they "have found the playface to be an unreliable indicator of play in chimpanzees, gorillas, and orangutans for it may or may not precede a vigorous play bout (p. 135)."[4] The playface, then, does not seem to be a metacommunicative "play signal" as some have interpreted it (for instance, Bateson, 1979), though it may serve as a signal of intent when observed by another. Kubie's usage seems to fit the newer interpretation. However, when Kubie made a playface while also gesturing this usually occurred before Zura began an approach. Perhaps Kubie anticipated the frequent success of his gestures in eliciting Zura's approach, by preparing for contact with the open mouth of the playface. The function of the playface is an area calling for more research, particularly to learn whether there are individual differences in its usage.

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[4]Goodall (1968a) observed that the playface was used to initiate play by only one individual among the entire troop of chimpanzees 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) 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. The playface is not mentioned at all as a signal for play initiation.

Though no other detailed studies of gesture in zoo gorillas have been done, Kubie's usage of gestures is not unique. Zura, his female play partner, had an extensive range of gestures of her own, some of which were shared in her and Kubie's repertoires (Chapter 5). Further, I recorded gorilla interaction at the Rio Grande Zoo in Albuquerque, New Mexico that includes gestural communication that appears similar to that of Kubie and Zura. The interaction at the Rio Grande Zoo took place in a similar social milieu, when a very young male attempted a sneak mating with an older female, meeting her in a moat and avoiding an older male's attention (see Appendix 2 for a complete transcription of this incident).

In the next three chapters, I will further explore the gestural repertoires of other gorillas in the San Francisco study group. I hope to fill in the picture of development of gesture in infancy and the juvenile period, and of gesture use by females and the oldest gorillas. In the next chapter, Zura's gestures will be compared to Kubie's; shared elements of repertoire as well as gestures unique to, or most prevalent with, Zura will be studied.

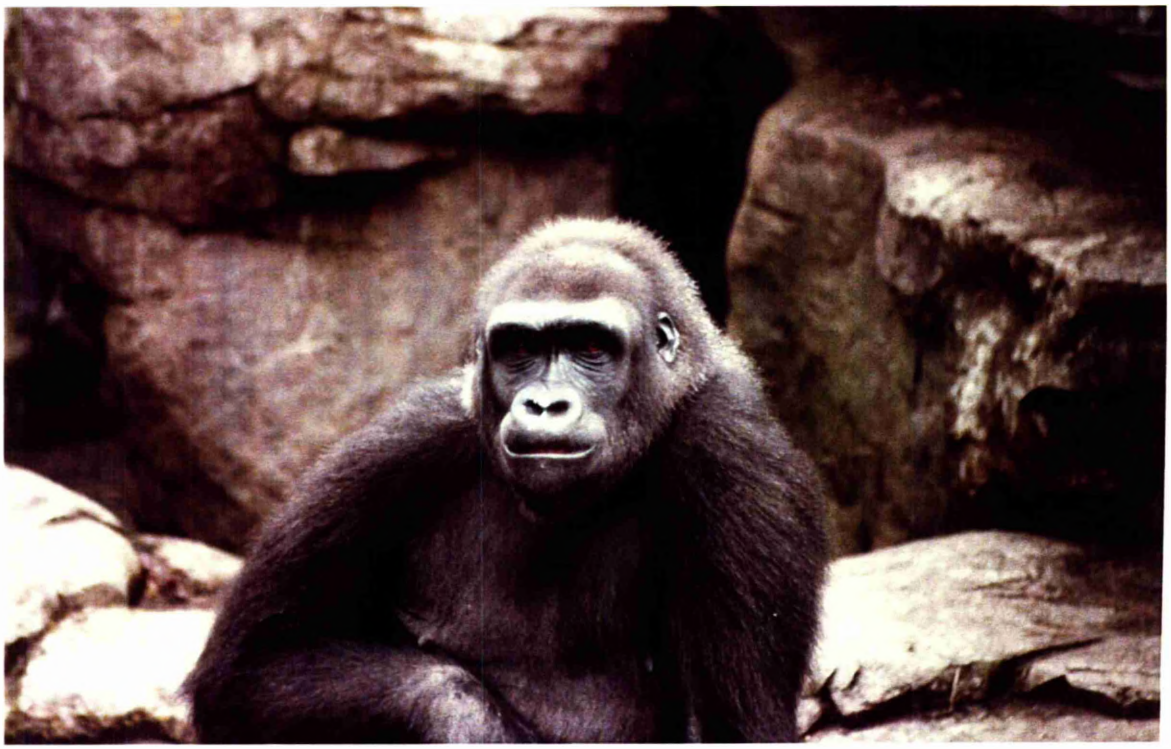


Plate 5.1. Zura at age 8 years, Study Period 1

Chapter 5
Gestures of a young adult female gorilla: Comparison to the gestures of a young silverback male

Introduction

Zura, a young female gorilla, was the frequent play partner of the male Kubie during the early periods of study (Plate 5.1, facing page). Zura was observed to use approximately the same number of gestures as Kubie during Study Period 1; further, nearly all Kubie's and Zura's gestures during this period were directed to each other. I will analyze Zura's most frequent gestures for Study Period 1 in the same manner as I did Kubie's most frequent gestures in the previous chapter, then compare the two gorillas' gestures.

The content of Zura's gestural repertoire overlaps with Kubie's, but there are also unique elements in the repertoire of each gorilla. In this chapter I compare the gesture types shared to learn if both gorillas use the same gesture types in similar contexts and with similar functions, and if not, how they differ. I also look at gestures unique to one gorilla, analyzing those gestures in terms of the differing social needs of each individual to learn why certain gestures may be more useful for one gorilla than the other. For Zura, as for Kubie, there exists longitudinal data for seven years of observations, and information from later Study Periods will be brought into the analyses of individual gesture types to further highlight differences in Zura's usage of gestures in comparison to Kubie.

Zura's gestural repertoire in comparison to Kubie's

The number of gesture types observed of the young female gorilla Zura was comparable to the number of gesture types observed of the male Kubie, her frequent partner in play during Study Periods 1 and 2. The total number of gestures observed of Zura during Study Period 1 was also very similar to Kubie's total for the same period: 598 gestures in

TABLE 5.1 Gestures of Zura and Kubie, Period 1

Gesture	Number of observations for Zura	Number of observations for Kubie
armcross	11	2
armshake	119	41
armswing under	9	39
away	17	11
backhand	7	30
bite	14	16
body beats	40	12
chest beat	49	39
chest knock	0	13
chest pat	4	22
down	12	4
extended palm	10	9
foot back	14	0
hands behind back	19	2
head nod	2	100
head shake	0	13
head turn	1	11
head twirl	1	10
hide playface	27	0
knock	6	22
pat off	1	13
slap surface	35	2
tactile close	16	65
tap other	25	83

social contexts were recorded of Kubie, and 547 of Zura.[1] Table 5.1 lists 24 gesture types that at least one of the gorillas used 10 times or more during Study Period 1 (descriptions of the physical form of these gestures can be found in Table 3.2, Chapter 3). Of these gesture types, 20 were observed of both Kubie and Zura, though some were infrequent for one or the other of the gorillas.

Zura's most frequent gestures: an analysis

The nine gestures most frequently observed of Zura were subjected to the same analysis as Kubie's most frequently observed gestures. Table 5.2 lists Zura's nine most frequent gestures for Study Period 1, as well as Kubie's gestures studied in the previous chapter.

Table 5.2. Most frequently observed gestures of Zura and Kubie, Period 1

Zura's gestures in order of frequency	number observed in Period 1	Kubie's gestures in order of frequency	number observed in Period 1
armshake*	119	head nod	100
chestbeat*	49	tap other*	83
body beats	40	tactile close*	65
slap surface	35	armshake*	41
hide playface	27	armswing under	39
tap other*	25	chestbeat*	39
hands behind back	19	backhand	30
away	17	knock	22
tactile close*	16	chest pat	22

*indicates gesture in this "most frequent" category used by both gorillas

[1] Zura performed many "solitary" gestures that might be considered to be stereotypic or abnormal behavior; some of these were the same as her social gestures, and some were not. This behavior contrasts with Kubie, whose gesturing was always social. However, communicative gestures only are included in the tables for study here. See Discussion section of this chapter regarding solitary gestures.

Methods

I assessed, as previously for Kubie, the degree of correlation with gestures of 1) availability of visual attention from the partner, 2) playface by the gesturer, 3) contact in play within 5 seconds, and analyzed 4) function of playface versus gesture. Please refer to Chapter 4 for methods of analysis. Table 5.3 (on the next page) presents overall results for Zura.

Results

1) Visual attention: For different gesture types, there was significant variation (from 38% to 100%) in the number of gestures Zura performed with Kubie's visual attention available ($\chi^2(8)83.3$, $p<.0001$), compared with the null hypothesis that the number of gestures performed with visual attention would match the overall gesture frequencies. Then, I partitioned gestures with apparently similar patterns of associated circumstances into groups. Chi-square tests on each partitioning failed to reach significance, indicating that these were groupings within which visual attention did not vary:

a) Zura's silent limb gestures (*away, hide playface, armshake)* were in 95% to 100% of instances performed when visual attention was available from Kubie; there was no significant variation within this group of gestures in visual attention ($\chi^2(2).67$, $p>.7$).

b) Gestures with tactile elements, *tap other* and *hands behind back,* appeared to fall into a into a medium group for visual attention, with these gestures visible to Kubie 77-79% of the time. Chi-square supported this partitioning ($\chi^2(1).02$, $p>.9$).

c) *Tactile close* gestures, *chestbeat,* and *slap* fit into either a medium group for visual attention with *tap other* and *hands behind back* ($\chi^2(4)4.9$, $p>.2$), or a low group including *body beats* ($\chi^2(3)3.3$, $p>.3$) without causing significant variation in either

TABLE 5.3. Summary of results for Zura's nine most frequent gesture types

Gesture Type and Class (n=number of instances of gesture observed for Zura)	percent performed with visual attention of Kubie	percent where Zura had playface	percent where contact resulted within 5 seconds after gesture
tactile close tactile close range n=16	60 (n=9/15) medium or low*	0 (0/15) low*	(contact criterion not applicable here) 50% of time (n=8/16) Kubie's body moves in signaled direction
hands behind back tactile close range n=19	79 (n=15/19) medium*	0 (0/19) low*	84% remain in contact 5 seconds later (n=16/19) but contact criterion not applicable; usually already in initial contact
tap other silent limb, tactile long range n=25	77 (n=17/22) medium*	35 (n=7/20) medium*	30 (n=7/23) high or low*
away silent limb n=17	100 (n=15/15) high*	6 (n=1/16) low*	25 (n=4/17) high or low*
hide playface silent limb n=26	95 (n=21/22) high*	92 (n=24/26) high*	31 (n=8/26) high*
armshake silent limb n=119	97 (n=99/102) high*	34 (n=33/96) medium*	46 (n=53/116) high*
chestbeat audible n=49	57 (n=17/30) medium or low*	5 (n=2/42) low*	14 (n=7/49) low*
body beats audible n=38	38 (n=13/34) low*	5 (n=2/36) low*	5 (n=2/37) low*
slap audible n=35	56 (n=14/25) medium or low*	3(n=1/29) low*	12 (n=4/34) low*

Descriptive terms marked with an asterisk* reflect groupings for which the chi-square value did not reach significance, thus the gestures in these groups did not vary in amount of the characteristic under consideration; *high, low* and *medium* are relative terms reflecting these groups.

Number in far left column is total *n* of this gesture type recorded. In other columns, in parentheses, *n* on the left of the slash is the number of gestures fitting the named criteria; on the right of the slash is the total number of gestures employed in that particular analysis, which may differ from total in the left column for reasons of visibility on the video of the particular element under study.

grouping. The *body beats* gesture was performed least often with visual attention. These gestures that were performed with medium to low visual attention from the recipient all had tactile or audible properties.

2) Playfaces: There was significant overall variation among gesture types in whether Zura's gestures were accompanied by her open-mouth playface ($\chi^2(8)116.3$, $p<.0001$), compared with the null hypothesis that playfaces would be distributed randomly with respect to gesture type. Only *hide playface* had a high level of playface (inevitable by definition of the gesture). All other gestures were accompanied by a playface in only 0-35% of cases. *Tap other* and *armshake* formed a medium playface group that did not show statistical variation ($\chi^2(1).003$, $p>.9$). Playfaces were never observed to accompany *tactile close* gestures, and almost never accompanied the audible gestures or the silent limb gesture *away.* Those two low playface gestures as a group did not show significant variation in number of playfaces ($\chi^2(5)1.9$, $p>.8$).

3) Contact: The proportion of each gesture type followed within 5 seconds by contact in play varied from 5% to 46% ($\chi^2(8)61.9$, $p<.0001$), showing significant variation compared with the null hypothesis that the number of gestures followed by contact would be distributed randomly with respect to gesture type. (A random sample during play sessions when both gorillas were near each other and in visual contact but there were no gestures resulted in a contact rate of 17%.) The "highest" frequencies of contact for Zura followed *armshake* and *hide playface*, for which level of contact did not vary ($\chi^2(1)1.93$, $p>.1$); however, these gestures were only followed by contact in 46% and 31% of the instances, respectively. The audible gestures *chestbeat, body beats,* and *slap* were seldom followed by contact; these formed a low contact group that did not vary significantly in the amount of contact ($\chi^2(2)1.76$, $p>.4$). Further tests showed that *tap other* and *away* fit into either the "low" or "high" groups without causing

significant variation (high: $\chi^2(3)5.29$, $p>.1$; low: $\chi^2(4)8.24$, $p>.08$). The test of contact within 5 seconds was not applicable to two gesture types, *tactile close* and *hands behind back,* where the gorillas were already in contact at the time of the gesture.

4) Function of playfaces versus gestures: A sample from Study Period 1 was used to determine the relative effect for Zura of gesture versus playface on interaction (see Chapter 4 for methods). *Armshake* was the only gesture considered for Zura because it was her only "high contact" gesture and was a gesture shared by both gorillas (*armshake* was also "high contact" for Kubie). Table 5.3.a shows the results.

Table 5.3.a. Contact after playfaces and/or armshakes

Zura's action	Percent followed by contact
Playface alone	100% (n=20/20)
Gesture with playface	73% (n=24/33)
Gesture alone	32% (n=20/63)
Neither gesture nor playface	17% (n=4/23)

Comparing these frequencies, there was a highly significant association of the *playface alone* with subsequent contact relative to *neither playface nor gesture* ($\chi^2(1)29.6$, $p<.0001$) or *gesture alone* ($\chi^2(1)28.3$, $p<.0001$), and a significantly higher association of *playface alone* with contact than *playface+gesture* ($\chi^2(1)4.7$, $p<.05$). For *gesture alone,* frequency of contact did not differ significantly from *neither a playface nor a gesture* ($\chi^2(1)1.7$, $p>.2$) On the other hand, *gesture+playface* was followed by a significantly higher frequency of contact than were instances with *neither a playface nor a gesture* ($\chi^2(1)16.6$, $p<.0001$) or *gesture alone* ($\chi^2(1)14.7$, $p<.001$); contact in play was more likely after an *armshake* if accompanied by a playface.

I also looked at the activity *prior to* Zura's *playface alone*. For Kubie, an approach of Zura always preceded a *playface alone*. For Zura, however, half of her *playfaces alone* were elicited by Kubie's approach; the others occurred as she was approaching directly to "play attack" Kubie. Nevertheless, the *playface alone*, as for Kubie, seemed to be a response to an approach that was about to lead to physical contact.

Often Zura would make slow or oblique or behind the back approaches to Kubie, for instance when attempting to grab and run with his burlap bag (see game contexts, Appendix 1, *bag tug*). Her playface would usually not appear in these situations, but would appear when her approach was instead open, rapid, and face to face. In a sample from the *bag tug* game session, this was supported statistically; chi-squares showed real variation in the frequency of the occurrence of the playface in relationship both to location and to speed of approach (see Table 5.4).

Table 5.4. Relationship of playface use to type of approach

Type of approach by Zura	**oblique or from behind**	**frontal**
playface	3	11
no playface	8	3

$\chi^{2(1)}4.7$, $p<.05$.

Type of approach by Zura	**slow**	**fast**
playface	3	11
no playface	8	3

$\chi^{2(1)}4.7$, $p<.05$.

NOTE: Numbers in both the above tables are only by chance the same; frontal approaches were not always the same instances as fast approaches, etc.

Summary of results

Zura's gestures included the same three classes of gesture as Kubie's: silent limb gestures, audible gestures, and tactile close gestures. Like Kubie's gestures, the silent limb gestures were almost always performed when visual attention was available from the receiver, but those with a tactile element slightly less often had visual attention. The *tactile close* gestures (where contact was already made) and audible gestures had the fewest instances performed with visual attention. Zura's gestures were less often accompanied by playfaces and less often resulted in contact than Kubie's, overall. Zura's visually received gestures were still relatively high contact gestures, however, compared to a contact rate of 17% for a random sample during play sessions when both gorillas were near each other and in visual contact, but there were no gestures. For both gorillas there was a very low level of contact after audible gestures. For *tactile close* gestures, for both gorillas, in more than 50% of cases the receiving gorilla moved in the signaled direction.

For Zura, as for Kubie, the playface alone was a response to imminent contact with another gorilla. The activity *preceding* a playface alone was always either Kubie's immediate approach to her or her approach to Kubie. Thus the playface alone was followed by contact more often than a gesture accompanied by a playface or a gesture alone. Zura's playface was also strongly associated with rapid, frontal approaches on her part; it seldom appeared when she approached Kubie slowly, obliquely, or from behind. Therefore, the playface seemed to be associated with imminent contact where the two gorillas were visually aware of each other. The playface did not occur if Zura was attempting a deceptive "sneak" attack. In such instances, she seemed to repress the playface, or perhaps mutual visual contact is necessary for a playface response. The playface and its control will be further discussed in the next chapter in conjunction with Zura's frequent *hide playface* gesture.

Gestures shared by Kubie and Zura: comparison of use

Among their most frequent gestures, Zura and Kubie had four gesture types that were shared in their repertoires: *armshake, tap other, tactile close* and *chestbeat.* A closer look at these gestures will help to clarify the differences and similarities in usage between the two gorillas. Table 5.5 summarizes the results from the previous studies for both gorillas and contains numerical values that will be referred to in the subsequent discussion of each of the four gestures. Several other gestures appeared in both gorillas' repertoires frequently enough to be worthy of discussion: *armswing under, away, bite,*

Table 5.5 Comparison of gestures shared in repertoires of Kubie and Zura

Gesture Type (n=number of instances of gesture observed)	**percent performed with visual attention of partner**	**percent where gesturer has playface**	**percent where contact resulted within 5 seconds after gesture**
armshake Zura: n=119 Kubie: n=41	Zura: 97 (n=99/102) Kubie: 88 (n=29/33)	Zura: 34 (n=33/96) Kubie: 59 (n=16/27)	Zura: 46 (n=53/116) Kubie: 67 (n=24/36)
tap other Zura: n=25 Kubie: n=83	Zura: 77 (n=17/22) Kubie: 83 (n=62/75)	Zura: 35 (n=7/20) Kubie: 57(n=32/56)	Zura: 30 (n=7/23) Kubie: 69 (n=54/78)
tactile close Zura: n=16 Kubie: n=64	Zura: 60 (n=9/15) Kubie: 39 (n=25/64)	Zura: 0 (n=0/15) Kubie: 15 (n=9/62)	(contact criterion not applicable here) For Zura, Kubie's body moves in direction signaled in 50% of cases (8/16). For Kubie, Zura's body moves in direction signaled in 66% of cases. (n=42/56)
chestbeat Zura: n=49 Kubie: n=39	Zura: 57 (n=17/30) Kubie: 65 (n= 19/29)	Zura: 5 (n=2/42) Kubie: (n=0/29)	Zura: 14 (n=7/49) Kubie: 6 (n=2/34)

Numbers in far left column are total *n* of this gesture type recorded for each individual. In other columns in parentheses, *n* on the left of the slash is the number of gestures fitting the named criteria. On the right of the slash are the total number of gestures employed in that particular analysis. This number may differ from the total in the left column for reasons of visibility on the video of the particular element under study.

body beats, and *extended palm* (Table 5.1, p. 94). These are treated in the appropriate sections, depending on whether they appeared most frequently for Kubie or for Zura.

Armshake

Armshake was Zura's most frequently observed gesture (n=119), and Kubie's fourth most frequent (n=41), in Study Period 1. When either Zura or Kubie used *armshake,* the visual attention of the other gorilla was nearly always available. *Armshake* was also followed by contact at a relatively high rate for both gorillas. Whether *armshakes* were performed by Zura or Kubie, the majority of subsequent play contacts was initiated by Zura's approach. This reflects the nature of their play, where Zura was usually the one who came and went freely from the play scene and thus was the one who needed to be enticed, while Kubie more often stayed in one location. The number of instances when Zura's playface was observed to accompany *armshakes*, like the rate of contacts after her *armshakes*, was considerably lower than for Kubie.

Table 5.6 presents comparisons between the number of times I observed Kubie and Zura each using *armshake* over the span of my study. Overall, chi-square showed that there was variation between Zura and Kubie in the distribution of their usage of *armshake* over the six study periods ($\chi^2(5)45.7$, $p<.0001$). Periods 3 and 4, when Kubie was not observed to use *armshake,* are periods when he did not engage in play

Table 5.6. Kubie/Zura armshake comparison

n social *armshakes*	ZURA	KUBIE
Period 1	119	41
Period 2	89	48
Period 3	36	0
Period 4	32	0
Period 5	38	0
Period 6	49	11

at all. In Periods 5 and 6, Kubie resumed play but did not play with Zura; his play was with his two juvenile sons.

Zura was observed to use *armshake* in more social contexts than Kubie did. For Kubie, *armshake* was only observed in the context of play, usually preliminary to contact with wrestling and play biting. During Study Period 1, in 12 cases *armshake* was seen to be performed in synchrony by both gorillas for several seconds, that is, when one gorilla began to armshake, the other gorilla would immediately do so also. (Of these synchronized cases, 5 of the 11 were followed by contact in play.) Zura's *armshakes* were seen primarily in play situations but also sometimes in mildly threatening display to other gorillas and zoo visitors (gestures to zoo visitors are not counted in the totals here, however). Zura also sometimes used *armshake* in a way that seemed to function as a warning to another gorilla of impending activity on the part of a third party. This usage was observed several times during study periods 3 and 4 directed to Bawang, the other female, when Kubie was about to charge and chase Bawang as she approached the narrow door opening to the indoor enclosure. The *armshake* seemed in these cases to be a reflection of Kubie's activity. Sometimes Zura performed *armshake* as a "solitary" gesture, not seeming to direct it to any other gorilla, for instance *armshaking* when Kubie would run past her, ignoring her in his pursuit of Bawang.

This variety of usage for Zura's *armshakes* is probably why, during period 1, the number of contacts (following within 5 seconds) for her *armshakes* was less than 50%, a lower rate than for Kubie. I looked at the 63 cases where contact did not follow to try to determine the situations in which Zura used *armshake*, and discovered the following:

In 11 cases, *armshake* was performed in proximity of a gorilla other than Kubie. Though qualifying as social gestures, these cases cannot properly be compared with Kubie's sample, which was always in interaction with Zura. Zura did not engage in contact play with the other gorillas, thus gesture function was different when directed

to a gorilla other than Kubie. For instance, once when Bwana, the older male, was blocking entry to the door to the indoors enclosure, Zura repeatedly approached him *armshaking*, perhaps in an attempt to induce motion on his part (if my interpretation of *armshake* as a representation of motor activation is correct).

In 4 cases, although another gorilla was in the area and able to see Zura, thus fitting my criteria defining a social gesture, Zura directed her *armshake* and gaze at water pools in the environment where she was playing or streams she was crossing. This association of *armshake* with water was seen in several other cases where the gesture was classed as solitary and thus not included in the numbers here. Arguably these 4 cases should be discounted also. *Armshake*, however, was rarely seen as an entirely solitary behavior, unlike other movements Zura frequently performed.

In 9 cases, Zura performed an *armshake* with one hand while hiding a playface with her other hand. *Hide playface*, which will be extensively discussed in the next chapter, was associated with cancellation or delay of motivation toward play activity. This gesture would presumably cancel the motivation toward activity represented by *armshake*.

If the above 24 cases are dropped from Zura's sample, 53/92, or 58%, of Zura's instances of *armshake* were followed by contact. Thus it becomes clearer that for both Kubie and Zura, *armshake* was most often an indication of motivation to engage in play activity that was often contact play.

Even in cases where contact play did not soon follow, *armshake* was often a predictor of bodily activity. In 18 of these cases, Zura's *armshake* was followed immediately by action on Kubie's part, such as gesturing or pursuit of Zura, though it did not lead to contact. In 14 cases, Zura performed an *armshake* and then immediately moved away from Kubie, probably indicating an invitation for Kubie to take action and follow, though he did not do so in these cases. In only 12 of 116 cases of *armshake* did both gorillas remain static after Zura's gesture; in these cases, perhaps some other factor

such as facial expression, vocalization, or external circumstances, affected the consequences.

Tap other

Tap other was another gesture that both Kubie and Zura used, though it was observed of Kubie (n=83) more frequently than of Zura (n=25). A high rate of visual attention was similar for both gorillas. Rates of both playfaces accompanying the gesture and contact after the gesture were much lower for Zura than for Kubie. Upon reviewing the video for the non-contact cases, it appears that Zura often chose to move away after performing the gesture. In these instances, and also in other cases where Zura did not move away, Kubie did not choose to respond or take any initiative to further contact. *Tap other* by definition involved withdrawal of the gesturing hand after a brief contact, so it was physically natural for the gesturer to withdraw if the receiver did not pursue contact. When Kubie made the gesture *tap other*, it was the receiver, Zura, who actually made 76% of the contacts. Thus success of *tap other* in promoting contact was dependent on the reaction of the receiver.

Tactile close gestures

Zura was observed to perform considerably fewer *tactile close* gestures (n=16) than Kubie (n=64). About half of Zura's *tactile close* gestures were performed when Kubie was able to see them, probably because their bodies were in such close proximity to each other for these gestures. Kubie's *tactile close* gestures were less often performed when Zura could see them, and *tactile close* gestures were low in playfaces for both gorillas. For both gorillas, in half or more of the instances, the result of *tactile close* gestures was that the receiver's body moved in the direction the signaler indicated.

Chestbeat

Zura and Kubie used *chestbeat* in very similar ways and the number of instances observed for each in Study Period 1 was similar (Kubie, n=39, Zura, n=49). For both,

the proportion of gestures performed when the other gorilla could see the gesture was lower than for the silent gestures *armshake* and *tap other*. Playfaces accompanying the gesture were almost nil, and for both there was a very low rate of contact after the gesture. Apparently chestbeat is not primarily a visual signal and not associated with imminent contact.

Other shared gestures

Two other gestures, *bite* and *extended palm,* were used more than ten times by both Kubie and Zura, though they were not in the "most frequent" category for either gorilla. *Bite* was an actual biting of a finger of the performer; it was associated with subsequent actual play-biting of another gorilla in more than half the cases. *Extended palm* was essentially a "come" gesture, or what has sometimes been called a begging gesture; however, it was associated only with social interaction, and never seen in association with food. In half the cases, the gorilla receiving the gesture moved toward the performer (and in one case the performer subsequently pulled the other gorilla toward him).

Gestures observed primarily of Zura

Body beats

The gesture *body beats* (n=40) was nearly as frequently observed of Zura as was *chestbeat.* The *body beats* gesture was performed with the same alternating-hand slapping motion as *chestbeat,* but on any body location except the chest. *Body beats* was only observed infrequently of Kubie. For Zura, *body beats* was the gesture she performed most frequently without Kubie looking at her. *Body beats* also was rarely accompanied by a playface and rarely followed by contact. Among Zura's solitary gesturing (not included in this study) *body beats* was very frequent. Some of Zura's *body beats* that qualified as social gesture because of another gorilla's proximity

actually seemed to be done in a "solitary" manner, ignoring the other gorilla. At other times, it was apparent that *body beats* was being used in a play interaction context.

Slap surface

Zura frequently slapped surfaces (usually the ground, trees or rocks) with her open palm; Kubie rarely did. The proportion of instances performed when Kubie was watching her (56%) was about the same as for *chestbeat. Slap surface* was almost never accompanied by a playface, and few contacts followed. Because the slaps were usually audible, *slap surface* was not necessarily a visual signal. It was sometimes performed after a partial approach toward another gorilla, and sometimes on a rock wall or tree that was between Zura and Kubie.

Hands behind back

Hands behind back was often really a *tactile close* gesture but was so distinct in its physical configuration that it was categorized as a separate gesture type. It was usually performed when Zura was sitting in front of Kubie, facing away from him; she would extend her arms, reaching behind her back, and wiggle her fingers or sometimes tap her hands on the ground, often actually touching Kubie. Whether or not Zura touched Kubie, in 84% of cases the two gorillas would be (or remain) in contact 5 seconds after the gesture; the gesture seemed to promote maintenance of contact, and sometimes "bottom checking." Sometimes the gesture was done while Zura backed toward Kubie, ending up in his lap. Though *hands behind back* was a gesture usually done with Kubie's visual attention available, this was only because Zura's body location in front of Kubie meant he could see her action; Zura could not see him. For her, *hands behind back* functioned as a tactile gesture. Kubie was only observed twice to use a gesture similar to Zura's *hands behind back.*

Plate 5.2. Kubie and Zura interact in play

Away

Zura's gesture *away* was used by both gorillas but in Period 1 most frequently by Zura. Contact rarely followed this gesture. *Away* was definitely a visual signal, performed 100% of the time directly in Kubie's line of vision, and almost never with a playface. Contact did follow the gesture in a few instances, presumably against Zura's desires. *Away* was frequent among Zura's gestures. Probably this was because Zura was the youngest and smallest gorilla in the group until the younger males were born, and she had more need to avoid harassment than other larger and more dominant gorillas. When Zura was interacting with Kubie, even in play, he had a considerable advantage because of his larger size (Plate 5.2, opposite), so she might be expected to avoid further contact when play was getting rough. Zura's unique gesture *hide playface,* next to be discussed, was also related to avoidance of contact.

Hide playface

Zura often hid or inhibited her playface by placing one or both hands over the open mouth, a behavior that has so far not been observed in any other gorilla at the San Francisco Zoo nor reported elsewhere. This was of special interest because of its seeming similarity to a much-noted observation of facial self-correction in a zoo-dwelling chimpanzee (DeWaal, 1982) that had never been replicated. DeWaal's observation has been interpreted as implying ape awareness of spontaneous facial expressions and the consequences they entail, but was a single observation. I was fortunate to capture multiple observations of Zura's playface hiding on videotape and thus be able to test consistencies in its usage and arrive at an interpretation of the behavior. An extended study of this gesture has been published (Tanner & Byrne, 1993); with some few alterations and updating, this study is attached as the next chapter after this one.

Other gestures unique to Zura or more often observed of Zura than Kubie

Other gestures apparently unique to Zura were observed less frequently (Table 5.1, page 94). Zura but not Kubie used *foot back,* an invitational gesture presenting the rear of the body that is found in many ape and monkey species (see Table 3.2 for species comparisons). Rarely observed of Kubie, but more frequently for Zura, was *armcross,* for which possible function has not been identified (however see Chapter 10, Table 10.3, in comparison to spontaneous gestures of a signing gorilla). *Down* was another gesture used over ten times by Zura but only a few times by Kubie; *down* was performed in the space in front of the body and seemed to be an anticipation, or intention movement, of downward movement by Zura. Zura also used several other types of gestures consistently in form and context that were not observed to be performed by Kubie (seen less than ten times, thus not listed in Table 5.1, page 94) :

wrist glance (raising her wrist and studying it intently), 9 instances, used in pauses and delay of play; perhaps a "displacement activity";

finger down lips (a downward motion of the index finger made on the mouth), 7 instances, all associated with bottom checking of Zura by another gorilla; the motion is similar to that performed when a gorilla bottom-checks another;

teeth (tapped with fingers), 7 instances all performed when biting activity had just occurred, or before she bit another gorilla;

circle hands, 5 instances for which a consistent context was not obvious.

Two of these gestures, *teeth* and *finger down lips,* seem possibly to be iconic representations of activity to be performed by the signaler either in the immediate future or just performed in the past, or of activity by another.

Gestures observed primarily of Kubie

Gestures seen used frequently in Study Period 1 by Kubie but rarely performed by Zura were: head gestures, especially his very frequent *head nod; armswing under; backhand; knock;* and *chest pat.* Slightly less frequent gestures that were exclusively

Kubie's were *pat off*, that indicated ends of rounds of play, and *chest knock,* a playful and quieter version of chestbeating. Some of these gestures have been treated individually at length in the previous chapter.

Backhand and *knock* were frequent audible gestures for Kubie that gained attention but did not lead to a great amount of physical contact. A similar gesture on Zura's part was *slap surface.* She did sometimes use *backhand* or *knock*, but not nearly as often as *slap*. Kubie's gestures with his head, including not only his very frequent *head nod* but also *head shake, head nod, head turn,* and *head twirl,* were almost never observed in Zura. These gestures seemed to draw visual attention to Kubie's body (*head nod)* or indicate directional movement (*head turn*), and were often performed when he could not use his hands.

Discussion

The gestural repertoire of two young adult gorillas, Zura and Kubie, shows overlap in the sets of gestures used. Each gorilla, however, also used gestures that seem to be unique to the individual and used some gestures far more frequently than the other. Varying social or sexual needs may provide explanations for some of these differences. In spite of differences, all the gestures of both gorillas could be classified into the same three categories: silent, visually received gestures; tactile close gestures; and audible gestures. Each class of gestures resulted in similar consequences whether Zura or Kubie was the receiver: silent gestures most often promoted contact in play; tactile close gestures often resulted in directional body movement as depicted by the signaler; and audible gestures attracted attention but did not frequently promote contact.

Why were some gestures used principally by one gorilla and not the other? To attempt to answer this question, I will consider some of the gestures used much more frequently by one gorilla than the other, in contrast to gestures used frequently by both. *Armswing under* was a gesture used frequently by Kubie but seen less than ten times in Zura during Study Period 1. Kubie also used *armswing under* frequently during Study

Period 2 when he was involved in play with Zura, but hardly at all during later periods in play with his sons. *Armswing under* is a beckoning gesture leading the gaze between the signaler's legs and under the body, appropriate as a sexual invitation from male to female; this would appear to explain the usage of the gesture primarily by Kubie, though it was occasionally observed from Zura. For Zura, a complementary invitation suited to female behavior was *hands behind back* or *foot back,* both of which invited contact from the rear, the most frequent mounting position. As would be expected, these gestures were used almost exclusively by Zura. *Tactile close* gestures, though used by both gorillas, were more frequent for Kubie, who was often in the role of attempting to position Zura for sexual play. Zura's unique *hide playface* and her frequent *away* gesture suited her need to control and avoid rough play where she would have a disadvantage because of her size.

Reasons for differences in the use of some of Kubie's and Zura's other gestures are not clear. Kubie's most frequent gesture was made with his head (*head nod*) and he also employed other head gestures. Why Zura did not also use such gestures is not apparent. Because *head nod* drew visual attention to Kubie without the need to use of his hands, and he was frequently in the position of attempting to invite Zura's approach, it was a useful gesture for him. Zura was less likely to want to invite Kubie's approach. Among audible gestures, *chestbeat* was used by both Kubie and Zura. Otherwise, why Zura preferred *slap* and Kubie preferred *knock* and *backhand* is not clear. The most common male juvenile gestures were *slap, clap,* and *chestbeat,* but these gestures occurred much less frequently in male adulthood. The female gorillas, however, did continue to use *clap* and *slap* in adulthood. Perhaps the reasons for some of these differences in gesture use are sexual, anatomical, or developmental; in Chapter 7, I will discuss evidence for developmental differences in gesture use.

In contrast to gestures used much more by one gorilla or the other, the gestures *tap other* and *armshake* were among the most frequent silent visually received gestures

for both gorillas. These two gestures were sexually neutral in function. *Tap other* for both gorillas often seemed to be an indicator that the gorilla "tapped" was to be the object or agent of action and sometimes was followed by further gestures and/or contact; at other times, it seemed to be used in a simple game-like fashion, as in "tag," inciting the other gorilla to continue the game. *Armshake* was an expression of forthcoming physical activation for both gorillas, often leading to contact and play.

Tap other and *armshake* are not gestures reported as universal to gorillas as a species, nor are Kubie's *armswing under* and *head nod* and Zura's *hide playface.* All these idiosyncratic gestures share a silent mode of delivery and visual mode of reception. The circumstances of Kubie and Zura's style of interaction may have made such silent visual communication especially useful because the older silverback frequently intervened in their play. A further reason for these special gestures may be the relationship of Kubie and Zura as individuals. Though Kubie, twice the size of Zura, had an advantage over her in interactions, he was often unsuccessful in maintaining play sessions because Zura tended to run away or be uncooperative, and had escape routes not accessible to Kubie. Thus a great deal of negotiation was needed in order for the two to interact successfully. Gestures such as Zura's *hide playface* and *away* enabled her to regulate play that might otherwise become overly boisterous. Kubie's inviting gestures and *tactile close* gestures allowed him to keep play going without forcibly overwhelming Zura.

Like Kubie, Zura used gestures that can be interpreted as iconic or deictic. These include *tactile close* gestures, *armshake, armswing under* (iconic), *tap other* (deictic), and *head nod* (combines both iconic and deictic aspects) as well as a number of other less frequently used gestures discussed earlier in the chapter. The ability to create and comprehend iconic gestures (discussed at length in the previous chapter) seems therefore to be an ability shared by both gorillas, allowing them to develop a mutually functional communication system. Gestures by one gorilla were often responded to by

gestures from the other gorilla in a "conversational" manner, a topic further explored in Chapter 9.

Of all the gorillas in the group, Zura was the only one who gestured in a solitary manner with a large range of motions comparable in quantity to, yet mostly different from, her communicative repertoire. This appeared to be a form of stereotypic or nervous behavior, yet it was very complex and varied, with chains of many different "gestural" motions, unlike the repetitive behaviors commonly found as stereotyped in zoo animals. At times these rounds of solitary gestures seemed to be related to events in the group, when Zura would remove herself from a social problem and seem to mull it over, then return to take some real action. Another kind of situation where she would engage in solitary gesturing was when she was excluded from or ignored by the group. She also often performed these chains of gestures toward zoo visitors. Zura was the least dominant adult in the group, and was nursery-reared for several years. She seemed to be more engaged with human visitors than any of the other gorillas, and more likely to sometimes be detached from the other gorillas' activities.

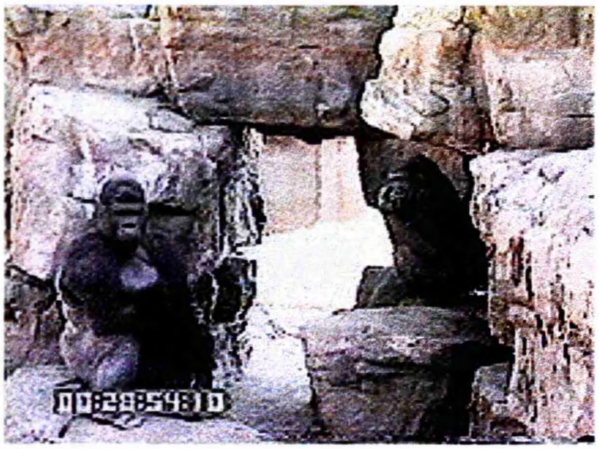
The difference between solitary "gesturing" and use of gestures in communication was quite clearcut. When gesturing communicatively, Zura would face another gorilla, and ascertain eye contact for visual gestures, as reported earlier in this chapter. There is no way to know whether her solitary gesturing represented anything in her mind, but it did sometimes seem to reflect, or follow, activity by other gorillas from which she was excluded or a striking social event. Though entirely anecdotal, I will give a few examples: In one case, a conflict involving biting took place in the group. Immediately at the close of this incident, Zura retreated from the group, sat on a rock and tapped her fingers forcefully on her teeth. She was observed to make this same motion in several instances immediately before biting Kubie forcefully in play settings. Another use of "solitary gesturing" was during the period when Kubie was obsessed with following Bawang to her retreat inside the partly open door and totally ignored Zura and any

solicitation to play. Zura would "shadow" Kubie from a distance, moving and *armshaking* when he moved, but without making eye contact or even remaining in Kubie's possible line of vision at all.

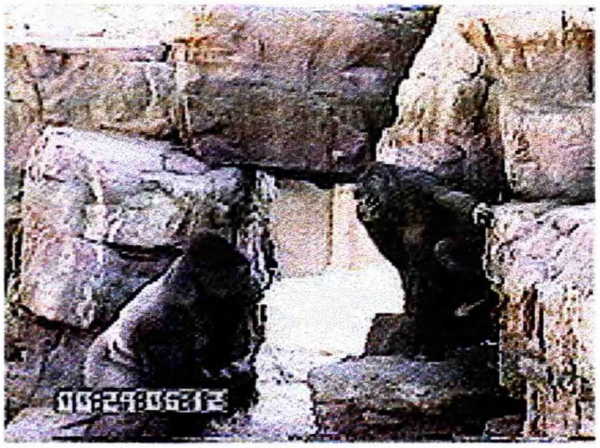
The behavior I have called *hide playface*, seemingly idiosyncratic to Zura, is the topic of the next chapter, Chapter 6. The interpretation of this gesture raises additional questions about metacommunication and self-awareness. Another issue, pertaining to gestures that have not been observed in more than one individual, is the question of how such gestures are acquired. The appearance of gestures over the course of a gorilla lifetime will be explored, to the extent that limitations of data allow, in Chapter 7. In Chapter 8, I will explore whether imitation could be a learning process for gestures such as *armshake* that are shared by more than one gorilla but have not been observed as frequent communicative gestures for gorillas as a species.

a)

b)



c)



d)

e)

f)

Plate 6.1. (from video) Zura hides her playface: six instances

Chapter 6

Concealing facial evidence of mood: Perspective-taking in a captive gorilla?

(The contents of this chapter have been published in slightly different form as Tanner & Byrne, 1993.)

Introduction

Zura, a captive female lowland gorilla was observed repeatedly to hide or inhibit her playface by placing one or both hands over the face. This action, heretofore labeled *hide playface*, appeared to sometimes be useful in deception, and in other cases to function as metacommunication modifying the spontaneous message of the playface. Whatever interpretation is warranted, *hide playface* seemed to imply awareness by Zura of her facial expression and the behavioral results it produces.

Method

Twenty-two hours of videotape, recorded between October 1988 and September 1989 at the San Francisco Zoo (Study Period 1), were examined. The behavior categorized as *hide playface* was noted 26 times, during 10 separate episodes of social interaction on 8 different days scattered over an 8 month period. Of the group only Zura, at seven years of age, performed this action, and it occurred only during play sessions with Kubie.

Hide playface was performed by placing the palms of one or both open, curved hands over the mouth and lower face area and holding the hands in place for a variable length of time, from less than a second to six seconds, with median length between one and two seconds (see Plate 6.1, opposite). In 24 out of the 26 instances of *hide playface* recorded, it was possible either to see the appearance of a playface before the hands were raised to the face, to see a portion of a playface beneath the hands, or to see a playface after the hands were dropped.

Results

Hide playface can be considered an intentional signal because, of the 22 instances where the animals' relative positions could be ascertained, 21 were performed when Kubie and Zura were directly in each other's line of vision. The hypothesis tested was that *hide playface* is a means of delaying onset of play or preventing resumption of play after a break, whereas a playface alone is a good predictor that play will begin soon. In the course of rough-and-tumble wrestling and mock-biting play, that was the usual mode of play for the two gorillas in these episodes, the animals often broke contact at intervals. Therefore, in order to test the hypothesis, the 26 instances of *hide playface* were compared with 26 control instances of playfaces that occurred after pauses in play between the two gorillas. Control instances were chosen so that each instance of a playface was as close as possible to a *hide playface*. Usually a suitable control instance was found on the same day of observation as the *hide playface*; where several were found, that nearest in time to the *hide playface* was used. If none were found on the same day, an instance near the following *hide playface* was chosen, but no instance was used twice. Thus, underlying motivational state was likely to be similar for both *hide playface* and control, and any effect found should be due to the act of hiding the playface. The time between appearance of each playface or *hide playface* and onset of play (i.e. physical contact) was noted. The results appear in Table 6.1, and confirm that *hide playface* was significantly associated with delayed play.

TABLE 6.1 Effect of *hide playface* on the timing of play onset

Delay to play onset	**after a playface**	**after *hide playface***
4 seconds or less	24	8*
5 to 10 seconds	0	2
10 seconds or greater	2	16
	n = 26	n =26

$\chi^2(2)20.889$, $p < .001$

Note: the statistical test is made on acts of one individual, thus the finding is only reliable for the future acts of this one individual, and cannot generalize to other gorillas.

* In 3 of these cases, Kubie "play attacked" Zura even though she was attempting to back away at the same time.

More details of all 26 instances are given in Table 6.2, which explores the possibility that *hide playface* is used where play is becoming too rough or a third party threatens to interfere.

TABLE 6.2 Contexts and sequels of *hide playface* signals

case #	rough play	third party interference	seconds delay to play	approach by Zura	approach by Kubie
17	*	-	12	*	-
18	*	-	8	-	*
19	*	-	long*	-	-
20	*	-	1	*	-
23	*	-	long	-	-
24	*	-	1	*	-
25	*	-	long	-	-
8	*	*	4	*	-
2	-	*	long	-	-
3	-	*	long	-	-
4	-	*	long	-	-
5	-	*	3	-	*
6	-	*	60	*	-
7	-	*	25	*	-
13	-	*	2	-	*
1	-	-	2	-	*
9	-	-	long	-	-
10	-	-	long	-	-
11	-	-	4	-	*
12	-	-	10	*	-
14	-	-	7	*	-
15	-	-	60	-	*
16	-	-	4	*	-
21	-	-	long	-	-
22	-	-	60	-	-
26	-	-	long	-	-

*"Long" refers to cases in which no play occurs during the rest of the episode, or at least until the next instance of *hide playface*.

Descriptions of two episodes where *hide playface* was observed illustrate the use of the gesture in context. In the first episode, the function of *hide playface* seems to be deception, as part of play itself, in order to get the best of the play partner:

Episode 1. (Context: Zura and Kubie pause after a long series of play interactions, in which Zura has several times attempted to surprise Kubie by oblique approaches but has been unable to get the best of him.) Kubie, whose back is turned to Zura, now sits toying with a branch. Zura sits near the doorway of the gorilla house, about 6m from Kubie. A minute and a half later, Zura *hides playface* quickly with a "wiping-off" motion; when she removes her hand the playface is gone. At the same instant she stands quadrupedally. She waits for about 15 seconds and then runs to a rock ledge that is slightly closer to Kubie's location. There she again *hides playface* quickly. After five more seconds she looks decidedly away from Kubie's location, then suddenly runs to Kubie, who is now reclining on his elbows facing her, but with his gaze toward the ground. She jumps onto his back, slides down and off of it, and runs back to the spot she started from. Kubie appears to be surprised, and sits up and looks in her direction pursing his lips. Zura gets a playface again when Kubie looks at her but immediately *hides playface*, "wiping" the playface off. The playface does not appear again; in fact, 6 seconds later she lifts and intently studies her foot. A little later, both make play signals, wrestle, and play intermittently for about a minute. They then separate but remain facing each other. When Zura gets a playface, she *hides playface* briefly and the playface is gone. Immediately the two gorillas separate and go off in different directions.

Possible interpretation: Zura appears to try to deceive Kubie, in order to surprise him with her play "attack." She does this partly by her ability to very rapidly manage the disappearance of her playface and also by her method of movement and direction of gaze in approaching Kubie, evidence that Zura is concerned about his visual perspective. The last *hide playface* functions as a mutually understood signal that no more play is desired.

In the second episode, which took place about eight months earlier than episode 1, *hide playface* is apparently performed because of the presence of a third party. In spite of his interruption, which inhibits play, the two interactants are quite able to see each other's signs of play motivation.

Episode 2. (Context: Kubie and Zura have initiated play in a favorite location, an artificial rock structure that affords some visual privacy both from other gorillas and to some extent from zoo-goers.) Kubie and Zura's play session, involving wrestling with chuckling vocalizations, is interrupted by the appearance of Bwana. Both Kubie and Zura show ambivalence about continuing play. Kubie scratches and glances around nervously. Zura begins to leave the area, but returns and makes an *armshake* play signal, at which Bwana moves out of view. Kubie, facing Zura but seated perhaps 2 meters away, also begins to make play signals, such as *chest knock* (a silent, playful version of chestbeating). Zura continues to make play gestures and gets a playface, but immediately *hides playface*, and neither gorilla approaches the other. Both gorillas make more play gestures during the next 30 seconds but do not approach each other. At one point Kubie makes a playful finger biting gesture with one hand, but raises his other hand and pushes the gesturing hand away from his mouth. Zura gets a playface 3 times but each time *hides playface*. Then Zura begins to move away from Kubie and he approaches her, making play gestures. Zura gets a playface but *hides playface* and continues to back away. Kubie grabs her and they begin to play wrestle with soft hooting vocalizations. A few seconds later Bwana reappears and the wrestling immediately stops.

Possible interpretations: Hiding the playface may here have been: (1) intended as a communication to Kubie that play is undesirable in the current situation, in spite of the conflicting (unintentional) message given by accompanying play-associated gestures; (2) intended as metacommunication on the message that play is desired, but at the moment needs to be controlled or postponed in order to prevent further interference from Bwana.

In episode 2, Kubie as well as Zura suppressed play signals. Kubie did so by knocking away with one hand a *bite* gesture done by the other hand, and both gorillas used nearly silent gestures such as *chestknock* and *armshake* rather than other common gestures that have a strong auditory component, such as *chestbeat* or *slapping* or *knocking* on surfaces. Though suppression of vocalizations by gorillas has previously been reported (Byrne & Whiten, 1990), vocal suppression in the present

episodes cannot be assessed, because reliable recording of vocalization was not possible.

Discussion

The facial expression that Zura hid with her hands, the playface, is often considered to be a signal of playful intent (Bateson 1955, 1979; Van Hooff 1967, 1972). In another interpretation, the playface is an automatic response of opening the mouth in preparation for possible biting contact with a social partner (Pellis & Pellis, 1996a) and only secondarily a signal that play is forthcoming. In either case, a message is conveyed to the social partner that contact is about to take place.

The association of hiding the playface with delay or non-occurrence of play between gorillas suggests awareness on Zura's part that the playface is associated with a certain behavioral outcome, so alteration of the signal might change the result. This interpretation would not be warranted if Zura had simply learned to associate her gesture with a favorable outcome in certain circumstances, after an original coincidence of happening to cover her face at just the time when play was unwanted: then an interpretation as operant conditioning would be simpler. This seems unlikely for two reasons, however. First, covering the face is not a normal part of gorilla behavioral repertoire; only behaviors that occur at a baseline rate can be selected by operant conditioning (except by deliberate "shaping" techniques devised by humans). Secondly, she was never seen to hide her face when solitary (though she often gestured in idiosyncratic ways when alone), but only when she was in the line of sight of her play partner. Thus, Zura's behavior seems to imply that she was able to take the mental perspective of others into account; she understood that facial expression, or at the very least, certain muscle tensions in her face, could reveal motivation to others. A similar though opposite effect was seen in a group of young captive chimpanzees, where the chimpanzees apparently used attention-getting gestures to get play partners to look at their playfaces and postures (Tomasello et al., 1989, 1994).

Zura's playfaces appeared not only when Kubie, her play partner, approached, but about half the time when she herself was making the approach, as noted earlier in the study of her usage of the playface with *armshake* (Chapter 5). When hiding her playface, in most cases it was her own approach that she may have been trying to inhibit (see Table 6.2 regarding sequels of *hide playface*). Because there was also an association of *hide playface* with what seemed to be rougher than average play on Kubie's part, and with tense situations involving a third party, the hand may have been inhibiting a tendency to begin biting play. Biting play would only have exacerbated some of the already troublesome situations Zura found herself in. However, if stopping such play was the solution, it would seem that Zura could have as easily turned away or left the area, which she actually often did in other cases. Perhaps by remaining, but inhibiting the open mouth, she retained more options in the play arena.

For humans, hiding the face with a hand appears in every culture (Eibl-Eibesfeldt, 1972) and has been observed in children as early as the age of 19 months (V. Reddy, personal communication). It seems to function to attempt to prevent inappropriate but uncontrollable emotions from being visible. It can also be an action of ambivalence in situations where there is a conflict between approach and flight. Zura's usage appears to be very similar to these human ones.

Zura's usage of her hands to conceal her expression suggests that for the gorilla, at least at a certain stage of development, the hands are under more voluntary neurological control than the facial muscles (as has been suggested for the chimpanzee on the basis of a similar observation, DeWaal, 1986). Of 26 instances of hide playface, Zura performed 21 with the right hand,[1] suggesting a specific neural area of control for this gesture. Often her playface was hidden with the right hand while Zura performed

[1] In the few instances where Zura used both hands, the hand first covering the mouth was counted.

another gesture, usually *armshake*, with the left. Zura was found to be significantly right-handed in overall behaviors in a study of laterality in zoo gorillas (Shafer, 1993).

A question raised when an innovation such as Zura's is observed in non-human primates is that of the conditions that promote such behavior (Kummer & Goodall, 1985). Zura fits several of the circumstances that Kummer and Goodall suggest may favor innovation. She was the youngest, smallest, and most subordinate member of her group, presumably in need of forming a successful alliance with a potential mate but with problems of size and age differences and of interference from other members of the group. She was in a captive group with the time and energy available for play and for exploration of alternative routes of action, and in a physical situation that for a zoo is quite spacious and environmentally varied. It is also possible that extensive human contact during the first years of her life made Zura more aware of the efficacy of communication in influencing the actions of other beings.

Bateson (1968) suggested that the fashioning of a simple negative by separating a signal from its referent would be a first step toward some of the properties of human language. This in essence is what Zura did under any of the interpretations of *hide playface* discussed above. She also substituted a hand movement for direct action, and was able to alter social situations in her favor.

Plate 7.1. Barney, age 2, claps before jumping off a log

Chapter 7
Development of gestures in gorillas: Infancy through adulthood

Introduction

The origins of the gestures of Kubie and Zura cannot be known directly because my study began when they were already adults. However, the birth of two young males into the study group after my observations began made it possible to look at the development of gestures in infancy and the juvenile period. In this chapter, I compare the gestures of the two young brothers, Shango and Barney, at the same ages to learn what gestures are developed earliest and learn whether development proceeds differently in different individuals. For the older youngster, Shango, six years of data allow a look at changes in gesturing over time in one male juvenile, making it possible to find out at what ages different gesture types first enter the repertoire of one gorilla. For the adolescent male "blackback" period, there is only a little data from individuals other than Shango, but I will explore its implications. The females show differences in types of gesture from males, but I have no early developmental data because only males have been born into the study group since my observations began. The oldest adults gesture very little, and I will suggest possible reasons for this. Overall, as far as possible, I attempt to fill in a picture of gestural development over the gorilla life span.

Gestures of young juvenile males; comparison of two brothers

In order to discover what kind of potentially communicative gestures occur earliest in a gorilla life, I cataloged videotaped observations of the gestures that brothers Shango and Barney each performed socially when aged 12 to 27 months (Figure 7.1). This procedure also revealed differences in the development of gesture in these two gorillas of the same age and sex. Barney (Plate 7.1, opposite) seemed to use a larger overall

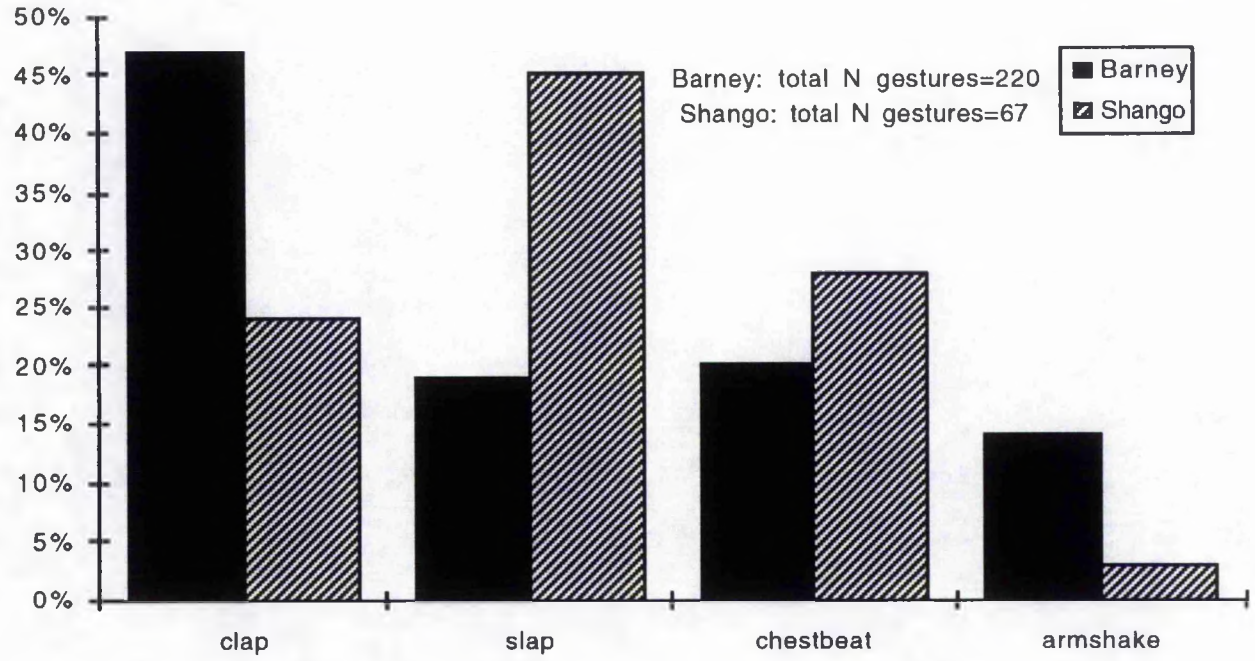


Figure 7.1. Most frequent gesture types (social) between ages 12 and 27 months in two young male gorillas, as percentage of total repertoire of each gorilla.

number of gestures of all types than his older brother Shango at the same age; though observation time was not strictly equal, Barney nonetheless was observed to use over 3 times as many social gestures as Shango. 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 ($\chi^2(3)28.13$, $p<.0001$). Further analysis did not show variation in the frequency of *chestbeat* by each brother for the matching age periods, relative to other

gestures ($\chi^2(1)2.09$, $p>.1$). However, Barney used *clap* ($\chi^2(1)11.13$, $p<.001$) and *armshake* ($\chi^2(1)6.57$, $p<.01$) relatively more than Shango, and *slap* ($\chi^2(1)18.85$, $p<.0001$) relatively less. Barney also used *clap* in non-social ways not seen in Shango; these instances are not included in the numbers above for *clap,* which are for social, communicative gestures only.[1]

Two young hand-reared male gorillas studied by Redshaw and Locke (1976) also varied from Shango and Barney in their gesture usage. Both preferred *slapping*, like Shango at a similar age (1 year, 10 months to 2 years, 2 months). *Clapping* was rare, and at this age Redshaw and Locke's subjects did not use *chestbeating* in a friendly social context. *Slapping* was always followed by the approach of the other gorilla for Redshaw and Locke'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 and Locke'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 in press) reports apparently imitative responses by Kubie to his older brother's *chestbeating* and *slapping* between age 2 and 3 years. However, Barney developed an *armshaking* gesture that was never a part of

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[1]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.

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 *armshaking* in Kubie, and also lists twice as many types of play "enticements" observed for Kubie as for his older half brother, Sunshine (now at another zoo). Perhaps the greater quantity and variety of gesture usage seen for Barney and Kubie, the younger brothers, was some kind of "sibling effect" resulting from early exposure to an older brother's gestures. Or, it was 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.

Though I have no observations of the first emergence of gestures for Kubie (because my regular observations began after he was a mature adult), Parker's (1993, and in press) observations of Kubie document his increasing awareness between ages 2 years, and 2 years, 9 months, of the communicative significance of his behaviors, as evidenced by his watching of other animals' responses to his displays and provocations. Kubie's play repertoire as listed by Parker, including behaviors I define as gestures, is very similar to that of Shango's and Barney's at the same ages. Parker does not report *tactile close* directional gestures for Kubie at this age, nor were they commonly observed in either Shango or Barney at age 1 year, to 2 years, 3 months. The 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.

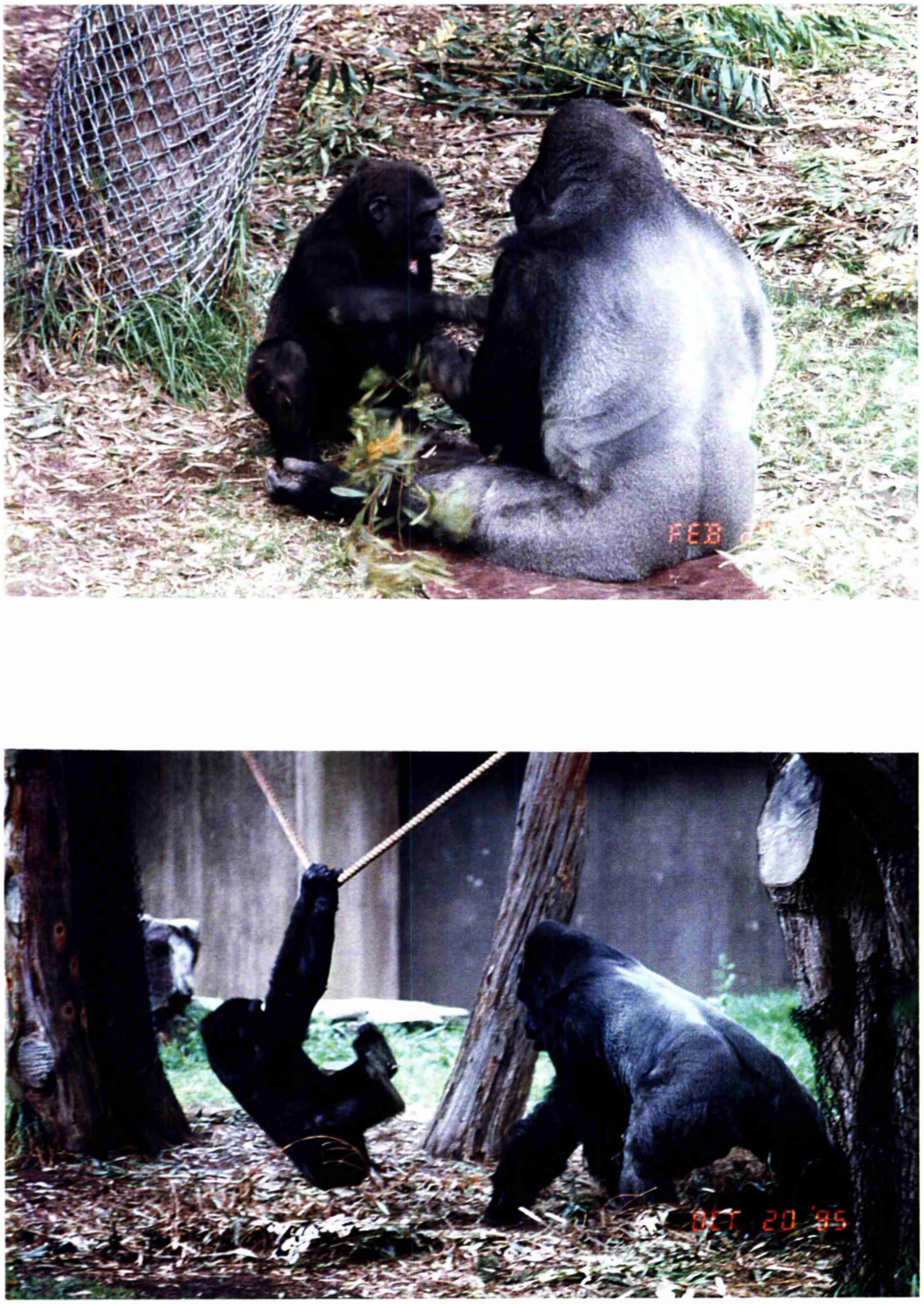


Plate 7.2. Top: Shango, age 5, plays with Kubie, his father

Bottom: Shango, age 6, plays with Kubie, his father

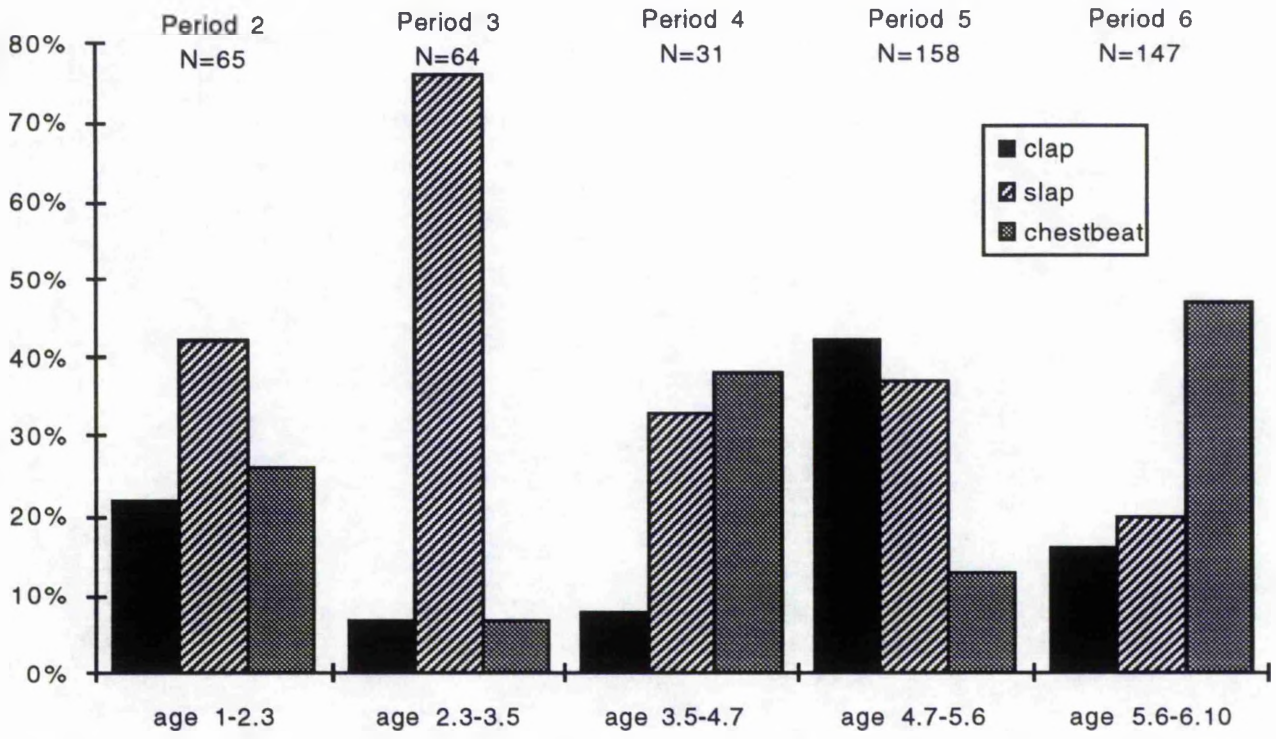


Figure 7.2. Shango's most common social gestures over a 5-year span (Study Periods 2-6) with percent of most frequent gesture types out of total gestural repertoire for each period.

Developmental changes in gesturing in a male juvenile

Some clues about development in gesture use from juvenile period to maturity may be provided by following the development of gestures in the young male Shango across time from age 1 year, to age 6 years, 10 months (Figure 7.2). Proportions of *slap, clap* and *chestbeat* during different Study Periods varied between periods very significantly overall ($\chi^2(8)134.54$, $p<.0001$); 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 (Plate 7.2, opposite), but increasingly actively with his younger brother Barney. During this period there is a sharp decrease in both clapping and slapping and an increase in chestbeating compared to the earlier Period 5. Comparison of the frequency of

observations of each of the three most common gestures to the other gestures pooled, in 2x2 tables, showed significant variation in Shango's proportion of use of each gesture between Period 5 and Period 6: for *clap*, ($\chi^2(1)22.96$, $p<.0001$); for *slap*, ($\chi^2(1)9.68$, $p<.01$); for *chestbeat,* ($\chi^2(1)61.04$, $p<.0001$). Period 6 also saw the new appearance of *backhand* and an increase in *tactile close* gestures (not shown in Figure 7.2).

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. After age 3 years, 5 months, Shango began to use some *tactile close* gestures. At age 6, he has not yet been observed to use silent visually received gestures in space or 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.

Gestures of adolescent "blackback" males

I hope in the future to follow Shango through his adolescent "blackback" period. For now, information for the adolescent period comes from different individuals, but can help bridge this age gap in the observations. A 20-minute film clip (Sandra Keller, Friends of the Zoo, 1984) shows Kubie at age 8 with the older female Pogo, attempting to get her to raise her ano-genital area for copulation and/or estrus checking. Pogo, then age 26, was at that time the only mature, cycling female in the group and thus the object of Kubie's sexual interest, though she was much larger and heavier than Kubie. Physical force in order to get her to assume the desired positions would most likely have been to no avail. Pogo, raised in Africa in the home of missionaries for her first few years, has always stalwartly refused to mate, though also pursued for many years by senior silverback Bwana.

The film contains 83 gestures by Kubie, and only 4 by Pogo. With Pogo, Kubie utilized the same gesture types that were most frequently observed in Kubie's interaction with the similarly uncooperative Zura five years later (see Chapter 4, Table 4.2). In the film segment with Pogo, Kubie performed 20 *tactile close* gestures, 17 *tap other*, 6 *armswing under*, 6 *extended palm*, 5 *head nod*, 5 *armcross* and 3 *armshake*. The most frequent gesture type in the film, *tactile close*, apparently was a successful tactic for Kubie. This gesture type consisted of many different actions, all of which shared the characteristic of touching Pogo's body and making motions on it, short of the force apparently necessary to actually move her. Some of these were: moving a hand down her arm, pulling her toward himself by one hand, moving an arm across her back toward himself, pushing her shoulder forward, pushing her head down, moving an elbow down her back. The aim of these motions generally seemed to be to get her to move from a sitting position into a quadrupedal position suitable for bottom-checking and/or mating. At several points during the film, Kubie made copulatory thrusts on Pogo's back, but without appearing to be able to actually copulate.

Because of camera cuts the outcome of gestures was not always available. However, the apparent result of gestural motions, as opposed to force, was observable in five different cases when, after a round of gesturing Pogo changed her position (though Kubie was still unable to actually mate). This was well illustrated in one segment where Kubie starts with as much force as he can muster, pushing and jumping full body as if to mount the quadrupedal Pogo. She sits down. Kubie continues jumping on her and slapping her. Pogo just sits. Kubie pauses for a moment, then approaches Pogo with *head nods*, *head turn* as he moves to the side, touches her and makes a "come" *extended palm* gesture toward himself, and *pushes her side* gently. She then gets up of her own accord.

Another piece of evidence pertaining to adolescent gestures is from videotape recorded at the Rio Grande Zoo in Albuquerque, New Mexico in 1992. This is a record

Plate 7.3. Bawang with infant Barney, age 4 months

of a "sneak" mating by a 7-year-old male and a 27-year-old female. Gestural communication was utilized by the young male and also the female, not only to promote actual copulation but also to elude the 27-year-old silverback and reach agreement upon meeting out of sight in the enclosure's deep dry moat. This incident included many silent gestures, both tactile and in space, apparently of a similar iconic and deictic quality as those recorded in my San Francisco observations; a full description is found in Appendix 2.

In both of these cases, extensive gesturing by an adolescent male gorilla was directed toward an uncooperative female who was considerably larger and older; this was also the case for Savage-Rumbaugh et al's (1977) gesturing pygmy chimpanzees. The iconic or deictic silent gestures performed in these examples have not all yet been frequently observed in 6-year-old Shango. Only future observation can provide information as to whether these types of gesture will appear in the course of Shango's maturity, and whether, if situationally elicited, they will appear only when Shango is confronted with uncooperative females. So far much of Shango's play, including the sexual, is focused on his mother Bawang, who quickly rebuffs most of his approaches or turns them into wrestling play. I have not yet observed extended attempts on his part to interact with Zura or Pogo sexually, though I have observed solicitation on the part of Zura.

The females

Developmental information is not available on females of this group, as the study began when all females had reached sexual maturity and no female infants have thus far been born in the group. I can compare only the mature repertoires of Bawang, Zura and Pogo with those of the mature males. Zura's gestures have been catalogued in detail in Chapter 5. Bawang (Plate 7.3, opposite), only a year older than Zura, gestured much less than Zura did throughout all study periods (see Table 3.3, Chapter 3). An earlier study on laterality (Shafer, 1987) confirms that this quantitative difference already

existed when Bawang was 5 years old and Zura was 6. One of Shafer's categories for laterality study was "gestures"; within an approximately six-hour sample for each gorilla, Bawang produced one gesture, and Zura 62.

Many of the gestures shared in Kubie's and Zura's repertoires were not seen in Bawang; most notably absent were *armshake*, the *tactile close* gestures and *tap other*. (Bawang did occasionally use *tactile close* gestures during other periods.) Table 7.1 presents a listing of the gestures observed of Kubie, Zura, and Bawang during Period 2, a period where both Zura and Bawang played with Kubie and the period in which the largest number of gestures was recorded for Bawang. Observation times are not equal; Table 7.1 is intended only to illustrate what gestures were observed and their relative proportion within individuals. (See Table 3.2, Chapter 3, for further description of the gestures listed.) There was highly significant variation among the three gorillas' gestures in proportion of gesture types used; Kubie and Zura ($\chi^2(20)215.8$, $p<.0001$), Zura and Bawang ($\chi^2(22)201.1$, $p<.0001$), Bawang and Kubie ($\chi^2(24)311.7$, $p<.0001$). All of the gesture types shared by all three gorillas are ones that known to be species-typical, and are also audible. Each gorilla also had idiosyncratic gestures not observed in the others.

Absence of many of the gestures shared by Kubie and Zura in Bawang's repertoire is further evidence that Zura shared a more extensive communication system with Kubie than Bawang. Particularly noticeable by its absence from Bawang's repertoire is *armshake.* I can only speculate on reasons for this. *Armshake* was observed by Parker (1993) in all group members when Kubie was an infant. Bawang came to San Francisco from another zoo and was partly human reared, but so was Zura. Zura's contact with humans was more extensive, however, because of extended illness. Perhaps Zura thus developed more awareness of communicative interchange. As noted previously, Bawang's first son, Shango, has not been observed to *armshake*, but her second offspring, Barney, does so.

TABLE 7.1. Kubie's, Zura's, and Bawang's gestures, Study Period 2

Gestures	instances by Kubie	instances by Zura	instances by Bawang
armcross	4	2	0
armshake	48	89	0
armswing under	16	1	0
away	0	17	2
backhand	30	3	1
bite	1	0	0
body beats	6	8	34
chest beat	33	65	5
chest fist pat	7	1	0
chest knock	17	0	0
clap	5	10	22
down	2	6	0
extended palm	5	1	0
foot back	0	0	1
hands on sides of head	0	0	9
head nod	48	1	0
head shake	0	0	4
head turn	13	0	0
head twirl	0	0	2
hide playface	0	6	0
knock/pound	13	1	1
pat off	4	4	0
rub palms above head	0	0	3
slap surface	3	12	21
tactile close	28	4	1
tap other	22	1	0
TOTALS	305	232	106

I noted that *clap* and *slap* were rare in Kubie's repertoire as a mature male, and became less frequent in Shango's repertoire as he entered adolescence and interacted more with Kubie. However, this was not the case for females; the preferred gestures of Bawang, Shango's mother, at the age of 9 (when Shango was between age 1 year, and 2 years 3 months) were *slap, clap* and *body* (other than chest) *beating*; she rarely *chestbeat*. The same gestures remained prevalent for Bawang at age 14 (when Barney was between age 1 year, and 2 years, 3 months), though Bawang gestured less overall at the later age. *Slap* and *body beat* were also among Zura's most frequent gestures, and she *clapped* frequently, though most often as a solitary behavior. 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 (see Plate 7.3, opposite p. 131); clapping would serve far better as auditory communication during lactation. The one period when Bawang was observed to *chestbeat* was when she had weaned Shango (Study Period 4) and was actively pursued by Kubie for mating. Zura, a female without young, *chestbeat* frequently at the same ages when Bawang did not, though she *clapped* and *slapped* as well. The fact that in the field *clapping* has been observed only in females and young (Fay, 1989) seems to support the idea that *clapping* may be a functional replacement for *chestbeating* used differently by males and females. Pogo, the oldest female, did not gesture with enough frequency to draw conclusions, but she did occasionally *chestbeat* or *clap*.

Pogo was observed in 1976 and 1977 when she was 19 to 20 years of age (Parker, 1993, in press). She engaged in play with the 1 to 2 year old Kubie and used *armshaking* ("supine limb waving" in Parker's lexicon) and *clapping* as play enticements, as well as elaborate branch throwing and catching displays. In the film clip discussed above of Pogo and Kubie's sexual play in 1984 when she was 27 years old, Pogo used only 4 gestures to Kubie's 83. In my observations of Pogo, very few gestures

Plate 7.4. The older gorillas
Top: Bwana
Bottom: Pogo, with Shango

were recorded (see Table 3.3, Chapter 3), especially during the earliest study periods. After the birth of Shango, Pogo engaged in more play once Bawang permitted her to become Shango's frequent "baby-sitter," and used a few more gestures. She also played occasionally with Barney but not as much as she had with Shango, because Shango himself engaged Barney in a great deal of play. Gestures seen in Pogo's play with the juveniles were *extended palm* "come", *tap other*, tactile close gestures such as *down* on Shango's back, *pat off* to end play, and gentle *chestbeating*.

Older adults

The fact that the two oldest individuals in the group, Bwana and Pogo (Plate 7.4, opposite), did so little gesturing is curious. Until it is possible to follow other individuals to similar ages, it will be impossible to know whether this is age, and perhaps energy, related or 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. There are some indications from earlier study of the group that Bwana and Pogo gestured more when younger (Parker, 1993, in press), but Parker does not list any play gestures at all for Bwana, not even *armshake*, though he did play with the young Kubie. Bwana also played with his grandsons during the study, but not in an active manner; he would simply let the infant approach and punch or push at him, perhaps extending a hand to it. The few gestures recorded during my six years of observations during which he was still in the group include, surprisingly, only a very few *chestbeats* in spite of frequent dominance interactions with Kubie. The rest of the gestures recorded were in contexts where Bwana intervened in a crucial social event, often where one of the youngsters was in possible danger. *Knocking* or *pounding* the ground seemed to signal a request for movement when it was directed to another gorilla (see Mori, 1983, for such usage in the wild). Often, however, Bwana seemed to be able to squelch undesirable behavior by another gorilla by simply approaching and/or staring. Gestures

were so rare that the circumstances that elicited them were striking. A few examples of gestures from Bwana follow:

> January 24, 1989: Kubie and Zura are playing roughly. Bwana, perhaps 2 meters away, *pounds* the ground and they separate immediately.
>
> May 17, 1989: Tension has been building because Kubie has been aggressive toward Bawang and newborn Shango. The females are dispersed at various distances from Bwana. Bwana *knocks fists* together, and Zura instantly moves to Bawang and the baby. A few seconds later, Bwana faces Pogo and *knocks fists*. Pogo immediately moves close to him, and Zura moves closer. A moment later they all watch Kubie and arrange themselves in an equally spaced "defensive line" across the width of the grotto, allowing Bawang a protected path to the indoor enclosure.
>
> September 14, 1990: infant Shango has climbed to the top of the high rock formation for the first time. Bwana goes to Bawang, who is not watching, and lightly shoves her (*tactile close* gesture). She still does not do anything about Shango. A few seconds later he *pounds* the ground in front of her, then walks toward her. She moves.
>
> September 14, 1990: Bwana approaches Bawang after staring at Shango up on the high rocks, and at Pogo. Bwana gestures toward Bawang with a *go* motion, then remains looking up at Shango on the rocks.
>
> April 6, 1994: Bwana *backhand* pounds on the ground in front of Kubie when Kubie gets rough and sits on Shango. Kubie then runs and drags Shango in front of Bwana.

All Bwana's gestures in the examples above were interventions in social situations that did not involve him directly, where there was some possible danger to a younger or weaker member of the group.

Pogo used gestures in her play with Shango and Barney, though they were infrequent relative to the number of gestures used by the youngsters. A few examples of Pogo's gesturing follow:

December 8, 1991: Pogo hits Shango lightly with back of her hand as she gets up; he reaches for her, then takes off after her.

April 18, 1992: Pogo puts a hand on Shango's back and moves it downward (*tactile close*); he sits down.

May 26, 1992: Shango sits apart from Pogo, having previously escaped her grasp. Pogo taps him on the head and then swings her arm under her body (*tap other, armswing under*). Shango gets a playface, gets up and approaches Pogo, and they start wrestling.

July 27, 1992: Pogo places a hand against Bwana and pushes lightly (*tactile close*) as she moves away from a site where he is displacing her. It appears to be a "stop" or "stay" to indicate she is leaving so he can stay where he is and does not need to pursue her.

October 7, 1994: Pogo *reaches back* to Shango, then appears to scratch under her arm. A moment later he grooms her back.

June 2, 1995: Pogo *reaches back* and touches Barney's hand behind her; he gets on her back.

November 17, 1995: Pogo holds out her hand (*extended palm)* to Barney, who is chestbeating. He takes it and they wrestle. Later the same day she again holds her hand out to him; he *chestbeats* and puts his hands on hers, and then they wrestle.

Summary and conclusions

The earliest gestures observed in Barney and Shango, infants born in the San Francisco group, were audible gestures, *slap, clap* and *chestbeat*. They were not, however, used in the same proportions or all the same circumstances by the two brothers. As Shango, a

young male gorilla, moved toward maturity, he began to produce iconic and deictic gestures, which have been observed in other males as especially important in the context of adjusting body location in play and sexual positioning. In addition, some gorillas created, or discovered, idiosyncratic gestures not generally used by others in the group. Some gestures have not been universally observed in the species but are shared between some individuals, such as *armshake,* a gesture which is not clearly iconic or deictic.

Two adult females had quite different repertoires of gestures from each other and from the male Kubie. Gesturing was infrequent in the oldest individuals, who were not involved in sexual play, though even the most infrequent gesturer, the oldest male Bwana, used gestures at crucial moments where they were socially effective. It was not possible in the course of this study to follow females through the life stages, nor to know the gesturing history of the two oldest individuals, so these findings may apply only to the individuals described here.

One way that gestures might be transmitted from individual to individual is by imitation. The question of whether gorillas in a zoo setting might imitate gestures will be explored in the next chapter.

Chapter 8
Imitation: A spontaneous experiment

Introduction

The fact that some gorillas share usage of the same gestures raises the question of whether these gestures may have been acquired by imitation. Most shared gestures are those commonly reported for all gorillas, whether in zoos or the wild, thus safely labeled species-typical. Others are tactile iconic gestures for whose development imitation need not be invoked; a quite varied repertoire of tactile gestures of iconic or deictic nature seem to appear around adolescence in many captive and wild gorillas when circumstances call for them (see discussions in Chapters 4, 5, 7, and for the wild, Schaller, 1963). There are, however, some important exceptions. One gesture used extensively by both Kubie and Zura, *armshake,* is an example of such a gesture. *Armshake* occurred as a frequent item in the repertoires of both Kubie and Zura, with the armshaking of one gorilla sometimes followed or joined by the other. *Armshake* has been used in the past by other group members (Parker, 1993, in press) and subsequently has been developed by the infant Barney. It seems possible that this gesture may have been propagated within the San Francisco group by imitation. *Armshake* has been observed infrequently in captive gorillas elsewhere but not with the extensive communicative function it serves in the present subjects. It is not a clearly iconic gesture, so its derivation is unlikely to be the result of the exercise of a universal iconic ability in gorillas. Speculation on the possibility that armshaking in the San Francisco group has been transmitted by imitation would be more securely grounded if it could be shown that a gorilla in the group actually does imitate specific limb movements, and that is the aim of this chapter.

The question of whether apes truly imitate has been subject to debate in recent years (Galef 1988, 1990; Heyes 1993), as has the definition of "imitation" (Mitchell,

1987; Whiten & Ham, 1992). Imitation may include the mimicking of the physical features of an action, regardless of functional result, or on the other hand producing (emulating) the end result of an action but not necessarily all the means for achieving it. Imitation may refer to reproducing a sequence of actions performed in a certain way when a different structuring of these actions would have been equally efficient. Imitation, in the sense used here, does not include the performance of an activity common in an animal's behavioral repertoire when its attention is drawn to another animal's similar activity in an appropriate location (i.e., seeing another animal picking up fruit under a tree, and then going to that location and doing the same; or running when another animal runs; or even the contagious response of one gorilla's chestbeat to another's). It may be difficult to distinguish types of imitation from one another and from non-imitative responses, thus the demonstration of "true" forms of imitation is a goal of current experimentation.

There is, in any case, much positive evidence for an ability to imitate in ways described above, for at least some apes. Descriptions of spontaneous imitation of signs, gestures and other activities abound for all species of great apes taught sign or other symbol systems (Gardner & Gardner, 1971; Patterson et al., 1988; Tomasello et al., 1993; Miles et al., 1996), though the process has not been systematically or experimentally documented. Russon and Galdikas (1993) report on rehabilitant orangutans' imitation of sequences of action. Byrne & Byrne (1993) propose imitation to be the most likely explanation of the standardization of complex food processing techniques observed in mountain gorillas. Imitation of non-functional actions of limbs and face has been documented in an experimental setting for young chimpanzees reared by humans but neither extensively "enculturated" nor taught sign language nor symbol systems (Custance & Bard, 1994; Custance et al., 1995).

Imitation has not been formally studied in captive gorillas. Because of the limited number of gestures other than the species-typical that are duplicated in the repertoire of

more than one gorilla, it does not appear that imitation is a frequent process in building communicative repertoires. It is also possible that only some individuals imitate the physical movements of others, which could be related to the early experiences of those individuals. Zura was nursery-reared at the Columbus Zoo for an extended period of time before transfer to San Francisco and thus had a great deal of interaction with humans. This probably helped make the following experiment possible; she is, in general, more oriented to interaction with humans, including zoo visitors, than any other gorilla in the San Francisco group.

Background for the experiment

I performed an informal and spontaneous experiment with Zura regarding her ability to imitate arm and hand movements on a quiet day at the zoo when very few visitors were around. I had already seen Zura imitate facial and lip movements of visitors upon several past occasions but was not able to document this formally; though I had videotape of some of her imitative actions, I did not have tape of the models for them. In the experiment, I tested her ability to imitate arm and hand movements; the camera operator (my husband, CLE) was able to videotape Zura's behavior after I modeled each action for her, immediately followed by taping me doing each action just as I had performed it for Zura.

Normally, I did not interact at all myself with the gorillas after the first few months of observations, when I realized my zoo visits might become a serious project. Zura was aware of me and the camera operator as frequent visitors and would sometimes come over to observe us, but rarely made displays to us or threw things at us as she did at strangers, who often attempted to attract her attention. Therefore, when I performed actions for Zura to imitate, it was unusual behavior on my part and as such seemed to hold her attention.

On July 11, 1993, Zura (age 11 years), at the time of our arrival for observations was engaging in an action recently new in her repertoire: "blowing kisses", making a

smacking sound into her hand then pulling the hand out away from her face. (Mary Kerr, gorilla keeper, reported Zura had been "blowing kisses" for about a month previously. The origin of the behavior is not known.) When a visiting group of children blew kisses to her, she responded by blowing more kisses. Later I blew a kiss at Zura when she came near our observation station. She did a long series of clapping, then blew a kiss. I then tried a new action (pulling my hair). She responded by blowing kisses as I repeated the hair-pulling action, and eventually walked away. I asked the camera operator to record Zura's activity as he already had been doing, and then, when it subsided, to move the camera to me for a quick demonstration of the gesture I had been making. When Zura returned later, I decided to try another test action, and slapped my cheek repeatedly with one hand, along with verbal encouragement to "try this." She watched intently. I repeated the cheek slapping once more. Five seconds later, she began to slap both her cheeks with 2 hands (with a rate of motion exactly the same as my demonstration, 6 slaps), then finished with several other gestures. When I repeated the slapping motion, she again responded after a few seconds, this time slapping with only one hand, as I had done.

Method

The method that developed when I continued this imitation "game" with Zura for the next 15 minutes was as follows. I performed demonstrations of each action several times when she was responsive (see Plate 8.1, between pages 145-146). I changed to a new action either when she appeared to be somewhat successful at imitating the current action, or if she did not seem to be successful, when she appeared to become bored with my activity and look away or move away. I demonstrated a total of 7 actions to her during the session, trying to use motions I believed were not in her usual repertoire, but ones that I believed would be physically easy for her to perform. (Later, upon review of other videotapes, I discovered that some of these actions had indeed previously appeared occasionally in Zura's gesturing, especially in her elaborate solitary

gesturing.) All of Zura's responses, as well as an example of each demonstration as I performed it, before I went on to the next one, were recorded on videotape.

Analysis

In order to evaluate whether Zura did successfully imitate any of the 7 actions I demonstrated, the video was subjected to the following test procedures that were followed by both myself (JET) and an independent, naive coder (JM). The naive coder (JM) had an undergraduate degree in anthropology with a specialization in primatology, and had observed this gorilla group for several hours each week for nine months as a research assistant during my absence several years before. Thus she was not unfamiliar with the subject, Zura, and gorilla behavior in general. She was given no information about the "experiment" other than the instructions below.

For analysis, the video was divided into seven segments, each consisting of the time from when I performed a demonstration of an action for Zura until the demonstration of the next new action. All video of my own demonstrations was cut out and made into a separate tape for the independent coder to view as a guide to detecting the imitations. Each of the segments of Zura's responses, which differed in length, was matched with a segment of control tape equal in length; these 14 segments were then scrambled in random order and edited into a test tape, with each segment numbered. The control segments were made from other video previously taken of Zura on the same location on the rocks (fortunately a favorite spot of hers), performing fairly continuously her "solitary gesture" repertoire, oriented in some cases to zoo visitors. (See discussion of Zura's solitary gesturing at the end of Chapter 5.) Her appearance and visual orientation in these segments were superficially indistinguishable from that in video of the real responses to demonstrations.

A factor considered in designing protocols for analysis was that there might be variation in the degree of accuracy of Zura's possible imitations. Sometimes it appeared that she began with not very accurate replications but that later attempts were better

copies. At other times she would seem to replicate an action fairly accurately, then incorporate it in the flow of her gesturing and play with variations upon it, so that it became less accurate. Besides actions that seemed to be imitations, Zura interspersed long strings of other gestures from her extensive repertoire. Another factor in deciding upon analysis procedures was that Zura's imitations did not always appear to be immediate; in fact, they seemed often to be delayed, reappearing in segments other than the one immediately after the demonstration.

Keeping the above factors in mind, the tape of randomized demonstration and control segments was subjected to the following two procedures:

Test 1

First, the coder was to study the tape of the human demonstrator's actions. Demonstrated actions were:

A) swing arm up
B) hide eyes
C) slap cheek
D) slap shoulders
E) rub stomach
F) slap top of head
G) thumb extended from fist pulled away from under upper front teeth (the sign for "nut" in American Sign Language)

Then she was to watch the demonstration/control tape, following these instructions:

> Watch the tape of Zura and each time you think you see her do one of the demonstration actions, please note time code and action you believe she might have been doing. Please rate each of these instances on a scale of 1 to 3:
>
> 1. Very closely or exactly resembles demonstration
> 2. Resembles demonstration in several dimensions, but not an exact copy
> 3. Rough resemblance to demonstration, but seems it could be an imitation
>
> For example, if the demonstration (a hypothetical example) were "hit knee with fist"(one hand), ratings 1-3 might be:
>
> 1. Hits knee with fist; but could be with back or side of fist instead of knuckles you saw in demonstration tape

2. Hits thigh with fist above or on side of knee, or uses 2 hands where demonstration used one.
3. Slaps knees in alternating beat with open palms

Dimensions in which imitations might vary would be such things as: exact area of body where hands make contact, one versus two hands used, hand shape differs, number of hand contacts with body varies, speed varies, arms crossed rather than separate. Of course, you will see many of Zura's gestures that you may feel do not resemble any of the demonstrations, and you need not notate these at all.

Example of coding (you do not need to record segment numbers):

Time code	Action	Rating
6.13	A	1
6.47	D	3
12.45	C	2

Test 2
The following were the instructions to the coder, using the same tapes as Test 1.

After studying the demonstration tape of the demonstrator's 7 actions, watch the tape of Zura, and for each segment, rate each of the 7 actions on a 5 point scale where 1)= You are sure Zura did the action at some point during the segment..... to 5)= You are certain she did not do the action in that segment. You do not need to use time code here.

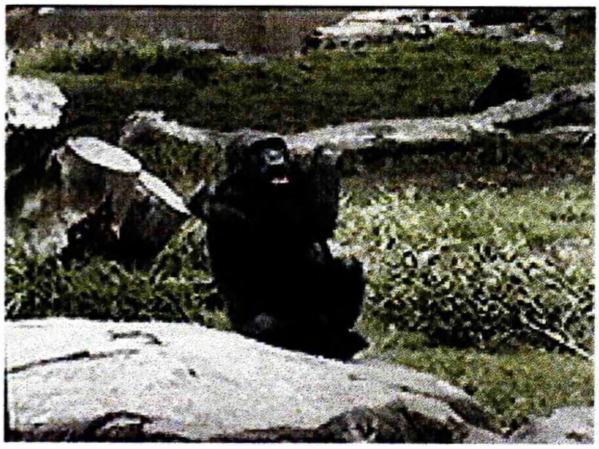
Example of coding:
Segment 1:
A) swing arm up 5
B) hide eyes 4
C) slap cheek 1
D) slap shoulders 5
E) rub stomach 5
F) slap top of head 5
G) thumb extended from fist pulled away from under upper front teeth 3

Results

Immediate imitation

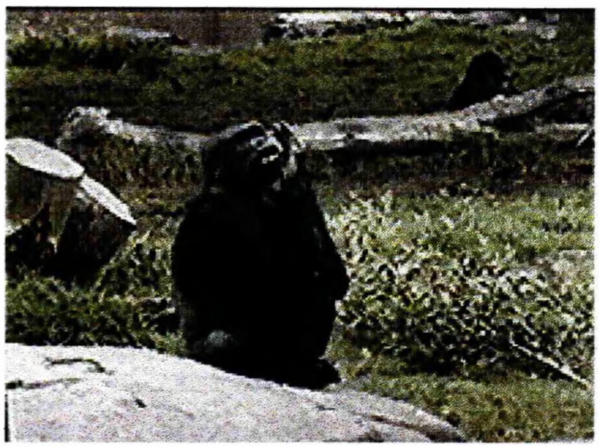
Both coders rated a considerable number of Zura's actions during each segment that immediately followed the relevant demonstration as facsimiles of the demonstration (rated 1-3 on Test 1 or 1-4 on test 2). Few or none of her actions in control segments

a) *slap shoulders*: JET demonstrates on tape ZVH30, first at time 50.10, then 50.34



Zura's action at 50.45; she uses crossed arms

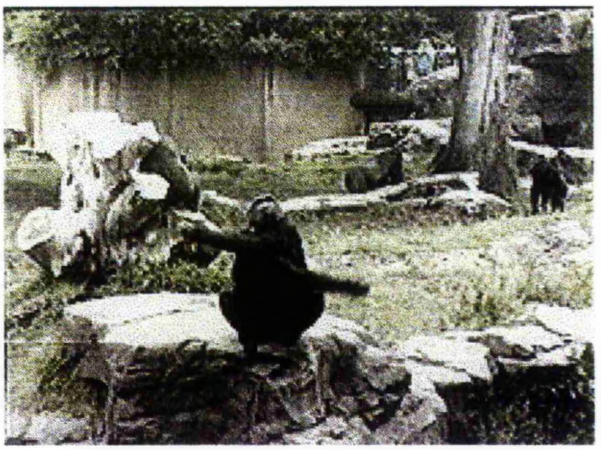
b) *slap cheek*:: JET demonstrates on tape ZVH30, first at time 48.15, then 49.30



Zura's action at 49.38

Plate 8.1. (from video) Joanne's action; to right, subsequent action by Zura

c) *swing arm up:* JET demonstrates on tape ZVH31, first at time 2.37, then at 3.16



Zura's action at 3.44; she swings both arms

d) *slap top of head:* JET demonstrates on tape ZVH31, at time 1.05

Zura's action at 1.11; she uses both hands

Plate 8.1. (from video) Joanne's action; to right, subsequent action by Zura

were falsely identified as possible imitations (Tables 8.1 and 8.2, following page; see also Plate 8.1 between pages 145 and 146).

A Wilcoxon matched pairs signed rank test compared the coders' responses to real demonstrations and to the control segments for Test 1. For both viewers, there was a significant difference between the number of possible imitations seen in segments following demonstration of a gesture and the number perceived in matched control segments. On Test 2, the Sign test compared coders' responses to demonstrations and controls. Both viewers perceived at least one possible imitation in segments following demonstrations in a significantly higher number of cases than in matched length controls.

Delayed imitation

Because Zura's imitations often seemed to be delayed, and/or repeated in segments other than the one immediately following the demonstration of a particular action, I also analyzed the coders' results on Test 1 and Test 2 in a manner that took possible delayed imitation into account:

For Test 1, equal length time segments from demonstrations and controls were compared in the following way: for the first action demonstration, all the possible imitations rated 1-3 that occurred in the segment immediately after the demonstration first occurred, as well as in all the following segments, were summed. The number of times the demonstration gesture was perceived in an equal amount of control tape (in this first case, all of it) were also summed. For the second demonstration, all the possible imitations rated 1-3 that occurred in the segment after the second demonstration, as well as in all the segments following the second demonstration, were counted, and likewise in an equal amount of control tape. The length of tape in which Zura might imitate each new demonstration thus got progressively shorter, so that for the 7th demonstration only a few minutes of demonstration and an equally few minutes of

Table 8.1. Immediate Imitation Results, Test 1

Test 1: number of instances seen as imitation in segment immediately following a demonstration, with matched length controls, levels 1-3

Action demonstrated	coder JET instances after demonstration	coder JET instances in controls	coder JM instances after demonstration	coder JM instances in controls
slap cheek	3	0	3	0
slap shoulders	3	0	0	0
hide eyes	3	0	2	0
slap top of head	1	0	1	1
swing arm up	1	0	1	0
rub stomach	2	0	1	0
thumb pulled from under teeth	3	0	3	0

Wilcoxon matched pairs signed rank test
JET $p<.01$, JM $p.<.04$

Table 8.2 Immediate Imitation Results, Test 2

Test 2: whether a demonstrated action was seen at least once in the segment following a demonstration or matched length control, levels 1-4

Demonstration	JET instances after demo	JET instances in controls	JM instances after demo	JM instances in controls
1 slap cheek	y	n	y	n
2 slap shoulders	y	n	y	n
3 hide eyes	y	n	y	n
4 slap top of head	y	n	y	y
5 swing arm up	y	n	y	n
6 rub stomach	y	n	y	n
7 thumb pulled from under teeth	y	n	y	n

Sign test, $p<.05$ for both coders

Table 8.3. Delayed Imitation Results, Test 1

Test 1, matched timings, all ratings 1-3, coder JET

action demonstrated and the numbers of segments it might appear in after the demo	instances seen after demonstrations	instances seen during equal timed controls
slap cheek (7 segments)	13	3
slap shoulders (6 segments)	14	7
hide eyes (5 segments)	11	0
slap top of head (4 segments)	1	0
swing arm up (3 segments)	4	0
rub stomach (2 segments)	2	0
thumb pulled from under teeth (1 segment)	2	0

Wilcoxon matched pairs signed rank test, $p<.02$

Test 1, matched timings, all ratings 1-3, Coder JM

action demonstrated and the numbers of segments it might appear in after the demo	instances after demonstrations	instances during equal timed controls
slap cheek (7 segments)	13	2
slap shoulders (6 segments)	3	0
hide eyes (5 segments)	8	0
slap top of head (4 segments)	1	4
swing arm up (3 segments)	2	0
rub stomach (2 segments)	1	1
thumb pulled from under teeth (1 segment)	3	0

Wilcoxon matched pairs signed rank test, $p>.1$

Table 8.4. Delayed Imitation Results, Test 2

Test 2, matched segments, coder JET

Demonstration action	number of segments where action appears after demonstrations at levels 1-3	number of segments where action appears in equal controls at levels 1-3
slap cheek	4	2
slap shoulders	3	1
hide eyes	3	0
slap top of head	1	0
swing arm up	3	0
rub stomach	1	0
thumb pulled from under teeth (ASL "nut")	0	0

Wilcoxon matched pairs signed rank test $p<.03$

Test 2 , matched segments, Coder JM

Demonstration action	number of segments where action appears after demonstrations at levels 1-3	number of segments where action appears in equal controls at levels 1-3
slap cheek	3	1
slap shoulders	4	2
hide eyes	3	1
slap top of head	1	3
swing arm up	1	0
rub stomach	1	1
thumb pulled from under teeth (ASL "nut")	1	0

Wilcoxon matched pairs signed rank test $p>.2$

control tape were involved. In this way, both immediate and delayed imitations were counted.

A Wilcoxon matched pairs signed rank test compared the numbers of instances of an action seen after demonstrations to the number of instances perceived after matched length controls. For coder JET, a significantly higher number of instances of the designated action were perceived after demonstrations than in equal lengths of control tape; for JM, the independent, naive coder, the results were just below significance. Test 1 delayed imitation results can be seen in Table 8.3 (page 148).

On Test 2, only gestures recognized as imitations at levels 1-3 on a 5-point scale were tabulated, because level 5 was a "negative" rating, and level 4 weak. A tabulation system (the same as explained for Test 1 above) matched progressively shorter, but equal, demonstration and control segments. In Test 2, however, number totals represent the *number of segments* in which the demonstration action was viewed after the original demonstration. A Wilcoxon matched pairs signed rank test showed that for coder JET, there was a significantly higher number of demonstration segments where the action appeared than number of control segments where it appeared. However, for coder JM, the results did not reach significance. Table 8.4 (page 149) shows these results.

Summary of results

Both coders were in agreement that a significantly higher number of apparent imitations by the gorilla, Zura, occurred in segments immediately following a demonstration of an action, on both Test 1 and Test 2, than in control segments. This was true whether the viewers were using an identification or forced-choice rating protocol.

In tests designed to detect delayed imitations, coder JET on both Test 1 and Test 2 perceived actions resembling the demonstrated actions in significantly higher numbers for all the segments cumulatively following each new demonstration than in matched length control segments. Coder JM's results did not reach significance on either Test 1

or Test 2 by the cumulative method. Possible reasons for this discrepancy will be discussed below. The results, then, do not show delayed imitation to be a strong phenomenon for Zura, but illustrate clearly that Zura often performs imitations soon after actions are demonstrated.

Discussion

Comparing demonstrations to possible imitations is not an easy exercise. Decisions on what aspect of an action to focus upon in determining an imitation are difficult because there is a wide range of possibilities to consider in viewing any bodily action. The parameters of place, configuration, and motion are commonly used to describe signs in American Sign Language (Stokoe et al., 1965), and are used here to describe gestures (as in Table 3.2, Chapter 3). A gesture can vary in one or more of these parameters and this variation occurs along a 'sliding scale' because of the three-dimensionality of gesture. For instance, in the tests of delayed imitation, the "naive" coder JM perceived "slap top of head" in three control segments when Zura *grasped* her head with crossed arms, rating it at Level 1 in quality, as well as perceiving and also rating at Level 1 Zura's more accurate slapping of the top of her head with the palms of her hands almost immediately after a real demonstration. JET, the knowledgeable observer, did not perceive this "crossed arms grasping head" as an imitation of "slap top of head" at all when she viewed the control segments. This one interpretation by JM, however, was enough to make the results for JM nonsignificant on both cumulative tests. If this gesture is omitted, the results on the Wilcoxon matched pairs signed rank test become significant ($p<.05$ for both Test 1 and Test 2, for JM as well as JET). Therefore, there exists perhaps more evidence for delayed, as well as immediate, imitations than it appears from the initial results.

Another problem noticed only after the fact was that Zura's own "blow kiss" gesture physically resembled two of the demonstrated gestures in several features, in that all these gestures were performed at the head area; "blow kiss" and "hide eyes"

both involved covering part of the face with a hand or hands; and "blow kiss" and "thumb pulled from under teeth" (ASL "nut") both involved pulling a hand away from the mouth. This was confusing to both coders, especially because the test tape was necessarily played with the sound off so the sound that was an integral part of "blow kiss" was not audible. The similarities were also possibly confusing to Zura, who by responding with "blow kiss" to "hide eyes" or "thumb pulled from under teeth" could actually *have been imitating* the demonstrated gesture to the best of her ability. Unfortunately, the spontaneous nature of the experiment made it impossible for me (JET) to give more lengthy or careful thought to choice of demonstration items.

The positive results of the analysis for "immediate" imitations, though, allow us to infer that at least some gorillas have the ability to replicate gestures that are not common in their species' behavioral repertoire, after observation alone. If gorillas can replicate performances by a human, they should be able to replicate gestures performed by other gorillas, potentially bypassing learning through a "conventionalization" process. The fact that in the zoo setting they rarely seem to actually do this requires further consideration. Imitation of a gesture made by another would seem to require mental processes similar to those needed to make the iconic representations of motion that have been observed in the zoo study group. However, these iconic representations were of proposed real, functional activity, not of abstract motion that may have no practical meaning for the gorilla. Imitation for "no reason at all" may not be particularly useful or interesting behavior for most gorillas.

Zura may be more responsive to gestures from a human because of her early orientation toward humans, and she may find participation in imitation games with zoo visitors to be rewarding in that she gets prolonged human attention. None of the other gorillas in this group respond to human gesturing or attempts to interact in the active way that Zura does. A further possibility is that because her early interactions with humans during her nursery rearing were extensive, she better understands

"conversational" exchange than other gorillas who have not experienced such interaction. Apes who have had interaction with humans have been found to respond differently from those who have not in several cognitive areas (Bard & Vauclair, 1984; Savage-Rumbaugh, 1984; Tomasello et al., 1993; Call & Tomasello, 1996). We cannot, however, eliminate the possibility that other zoo gorillas may well be able to imitate just as Zura did, if the opportunity and motivation (on the gorilla's part) for a similar test were available. San Francisco Zoo policy does not encourage such intervention, however, making further experiments of this nature unlikely.

The next chapter looks at how gestures are used in strings or sequences in social interaction, and at solitary repeated sequences of behavior. The formation and repetition of sequences, gestural, or otherwise, tie into questions about the memory capacity that would be necessary for imitation of complex chains of action.

Chapter 9
Strings of gestures and exchanges of gesture between gorillas

Introduction

Analysis of individual gestures does not give a complete picture of the quality of real-life gorilla interaction; gestures often appeared in continuous sequences that I will call *strings,* and both single gestures and strings often occurred in a conversational manner in gestural *exchanges,* with "turns" taken alternately by each of two gorillas. More than half of the gestures Kubie performed during Study Period 1 were part of strings; he performed 109 strings of gestures with a total of 316 gestures used in the strings, that varied in length from 2 to 8 gestures. During Study Period 1, Zura performed 81 strings containing 183 gestures within the strings, with length varying from 2 to 4 gestures. I will here present specific examples of strings of gestures and gestural exchanges that appeared in Study Period 1, the period in which Zura and Kubie had the greatest quantity of gestures and when a nearly equal number of gestures was performed by each gorilla. With the assistance of what has been learned in the previous chapters about specific gesture types and their functions, I try to interpret some of these strings and exchanges to illustrate that this is an important area for further study. These exchanges and the strings that compose them illustrate a complexity in the gorillas' communication that data about single gestures cannot demonstrate.

The gorillas' exchanges negotiate not only their preferences in play activity, but also fulfill a variety of functions semantically. The impact of single gestures or even strings of gestures can be modified by other gestures. In addition to those exchanges that seemed clearly to carry messages about matters such as the timing, location, initiator, and type of play, there were strings of repeated actions that seemed more akin to "display," where another gorilla was not directly involved. Other strings were

"games" created by an individual gorilla. Such repeated strings may show memory for sequential order that is a prerequisite for program-level imitation, the type of imitation found in some apes and in humans that makes the learning and transmission of complex activities possible (Byrne & Russon, 1997). Following definitions of terms, I will provide examples of strings and exchanges that illustrate the various elements mentioned above.

Definitions

A "string" is defined 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 string follow upon each other without any pause longer than a 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. "String" 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, alternating, by more than one gorilla. As for a string, the gestures in an exchange follow upon each other without any pauses longer than 1 second.

Gestural exchanges

Two examples of gorilla gestural exchanges, containing strings of gestures by both individuals, are transcribed below (Example 2 is illustrated in Plate 9.1, opposite p. 159).[1] Through these exchanges, Kubie and Zura negotiate the nature of the play in which they will subsequently engage. As was typical in their interactions, Zura in both

[1]Other examples of the interplay of gestures between gorillas and/or gestural strings may be found in the descriptions of interaction in the study of Zura's *hide playface* in Chapter 6; in the footnote to page 78, Chapter 4; and in Appendix 2, the transcription of interaction between gorillas at the Rio Grande Zoo.

instances is hesitant about cooperating fully with Kubie. Though both gorillas emit play signals, each has a slightly different idea about body movements, location, and type of play. After several seconds of gestural exchange along with other communicative movement and facial expression, play proceeds with both gorillas willingly involved.

I notate the gestures and a contextual description along a timeline. This is followed by a narrative account that will be a rich interpretation, predicated on the principle that some of the gorillas' gestures can be interpreted as iconic, even in cases where there has been only a small sample of a particular gesture type. Iconicity may be the key that can bring us closer to "translating" ape communication, thus it seems worthwhile to attempt this with strings of gestures where not every gesture is one previously analyzed. For example, *bite* (on finger) was used by both Kubie (16 times during Period 1) and Zura (14 times during Period 1). I have observed this gesture as a play signal in other gorillas, including mountain gorillas in the wild, all in situations where the gorilla was inhibited from actually biting a potential play partner (see *bite* in Table 3.2, Chapter 3, for sources). For Kubie and Zura, in the majority of cases real biting on the other's body followed after *bite*. 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 will interpret *bite* finger as an iconic depiction, involving both tactile and visual elements, of real biting.

Semantic classification of gestures

Gorilla gestures can be used for request and response (as in Examples 1 and 2) and appear sometimes to be indicators of agent (actor), object (patient), action, and location. Such elements are sometimes combined in one continuous gestural motion as well as used separately. Some gestures may also act as negatives that can alter the course of proposed action. A string of gestures Kubie used in another interaction with Zura follows in Example 3; here I describe the type of semantic function some gestures appear to perform in this particular context. I use relational terms rather than

grammatical parts of speech, following Goldin-Meadow & Mylander's (1984) and Greenfield & Savage-Rumbaugh's (1990) examples, since it cannot be assumed that gorilla gestures function in the frame of human grammar. Example 3 was a continuous string on the part of Kubie except for the pause noted.

Audible gestures such as *pound* often seemed to be "pointing" gestures indicating a location; they can also be interpreted as simply attention-getting actions drawing the receiver toward play. The standard test for human, or silent, pointing (gaze alternation between receiver and target) is of questionable value here because the audible quality makes the receiver's gaze unnecessary; however, "pointing" through sound rather than vision is a possibility. This interpretation seems worth considering because the receiver, Zura in this case, often proceeded to the location pounded upon rather than making contact with the signaler, sometimes even after the signaler had moved away from it. 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 (Schaller, 1963; Fossey, 1983; Mori, 1983; Fay, 1989) and perhaps serves the same function there. Percussive sound perhaps is more efficient, both energetically and in sonic projection, than vocalization. Humans in the same habitats have discovered this to be the case; West Africans have used drumming for long distance communication for all of their known history.

The agent/object (sometimes called actor/patient) relation occurred in the form of strings like Kubie's frequent *tap other, armswing under*, designating Zura as the desired actor, to take action upon him, Kubie, as object of action. Another string by Kubie is a variation: *armswing under, chest fist pat, tap other, armshake, head nod.* Here the order is *action, object, agent, action, action.* By far the most frequent kind of strings were those that seemed to declare Kubie's request for an action on Zura's part, and these were often followed by her approach to him, unless one of the gorillas

Example 1 (May 3, 1989): 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 videotape	Kubie's gestures	Context and comments	Zura's gestures
1.40.51			*armshake*
1.40.52		Kubie gets a playface.	*down*
1.40.53		He makes and holds eye contact with Zura.	*taps foot*
1.40.54		He begins to pull Zura down by her foot but she turns away, struggling from his grasp.	
1.40.55	*around*	With his tactile gesture *around,* she returns her gaze to him.	
1.40.56	*bite* finger		
1.40.57	*knock fists*		*bite* finger
1.40.58	*extend hand*		
1.40.59		Contact, with wrestling and biting play, follows.	

Narrative version, with hypothetical interpretation: With her *armshake*, Zura calls Kubie's attention to her motivation 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 have eye contact, he then indicates his own play intention with a *bite* on his finger, *knocks his fists*[2] together and *extends his hand* to Zura. Zura *bites* her finger in agreement, and contact follows in wrestling and biting play.

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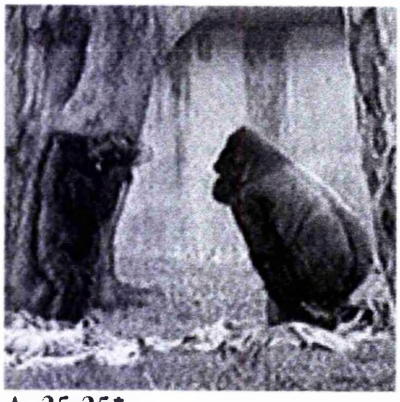
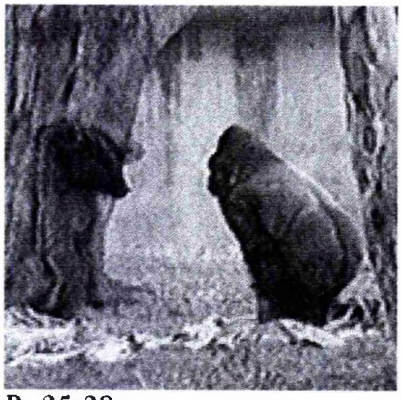
[2]The *knock fists* gesture is one not frequently seen; however, in all instances I observed, it was followed by a coming together of receiver and signaler, which it can be interpreted as iconically portraying. This happens to be the sign for "with" or "together" in American Sign Language.

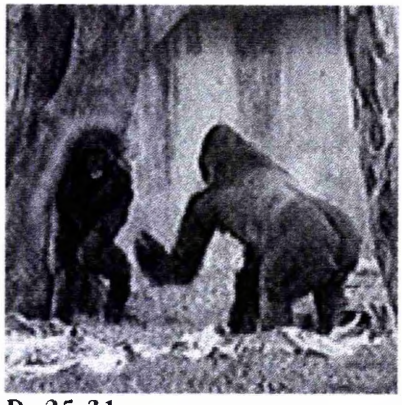


A. 25.25*
Zura: *slap* tree+*armshake*
Kubie: *hands behind back*

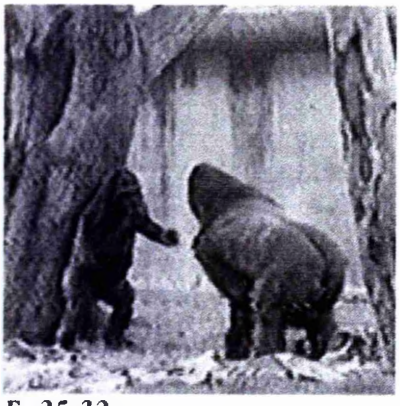


B. 25.28
Zura: *hide playface*
Kubie: *head nod,*
hands behind back

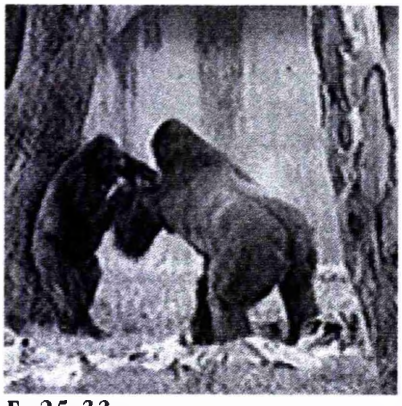
C. 25.30
Kubie: *tap other*



D. 25.31
Kubie: *armswing under* (come)



E. 25.32
Zura: *hide playface*
Kubie: *armswing under* (hand arrives between legs), *head nod*



F. 25.33
Kubie and Zura make contact and wrestle

Plate 9.1. (from video) Series of gestures by Kubie and Zura, Study Period 1
* time on videotape in minutes and seconds

Example 2 (May 31, 1989): 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 (See Plate 9.1, opposite):

Time on videotape	Kubie's gestures	Context and comments	Zura's gestures
25.25	*hands behind back*	Zura stands up by tree.	*armshake* (right hand) *slap surface* (left hand, on tree trunk)
25.26	*head nod*	Kubie, facing Zura, has playface.	
25.27	*head nod*		
25.28	*hands behind back*		*hide playface*
25.29	*armswing under*	Zura removes left hand from tree with the *down* motion, other hand continues to hide playface until Kubie knocks it away at 25.32.	*down*
25.30	*tap other*	Zura's left hand continues motion to under her body.	*armswing under*
25.31	*armswing under*		
25.32		Kubie knocks Zura's hand away from her face, but she resumes hiding it.	*hide playface*
25.33	*head nod*	At Kubie's gesture, Zura approaches and they begin sparring play.	

Narrative version, with hypothetical interpretation: Zura proposes a new start of play with an *armshake*, indicating the tree as location by *slapping* it. Kubie wishes 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 string of inviting gestures and finally, after he knocks Zura's hand away from hiding her face, she approaches to participate in sparring play.

Example 3 (January 24, 1989): Zura leaves the table-like rock where she has been sitting opposite Kubie, at the rock formation where they often play.

Time on videotape	**Kubie's gestures**	**Context and comments**	**Zura's gestures**	**Possible gesture function and mode of depiction**
26.50	*pound*	on table-like rock, with playface		LOCATION (deictic)
26.50	*chest pat*	(after these first 2 gestures, 3 second pause while Zura retreats)		AGENT (self-deictic)
26.56	*body beats*	on his stomach; Zura watches		LOCATION (self-deictic)
26.58	*pound*	on rock, as she turns head and vision away		LOCATION (deictic)
26.59		Zura looks toward Kubie again	*bite finger*	ACTION (iconic depiction)
27.00	*bite* finger	as Zura approaches		ACTION (iconic depiction)
27.01	*pound*	on rock, as Zura arrives at the rock		LOCATION (deictic)
27.02	*head nod* (twice)	as play starts; then begins to play bite Zura's stomach	*armshake*	ACTIONS (iconic depictions)
27.03		resisting Kubie's play biting	*hide playface*	NEGATIVE (canceling signal)

Narrative version, with hypothetical 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*, that Kubie repeated. 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 (perhaps it was too rough), indicating her reluctance by *hiding* her *playface*.

interjected a negative action. In a few cases where Kubie made an approach, he overrode a negative from Zura. For instance, in another string Kubie gestured *tap other;* Zura, *hide playface,* holding the gesture and backing off; but Kubie continued with *armshake, armswing under, come, armshake,* and then approached and made contact himself.

Negative gestures

I attempted to test the function of "negative" gestures, i.e., those that seemed to be related to stopping or avoiding contact play, by the following procedure. I hypothesized that strings of gestures resulting in "no contact" (no contact within 5 seconds, as in previous tests) would contain, or be interrupted by, negative gestures by either gorilla more often than strings resulting in "contact." Gestures I suspected or knew to be negative were *hide playface, pat off, backhand, wrist glance,* and *away* (Table 3.2, Chapter 3, describes these gestures).

I sorted Kubie's gestural strings 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 strings 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 could not be part of the scheme. I then counted the number of Kubie's gestural utterances in each group that contained a "negative" gesture by either Kubie or an interjection of a "negative" gesture by another gorilla in juxtaposition with Kubie's utterance. There was a significant association between the presence of a negative gesture in a string and decreased probability of subsequent contact (Table 9.1). This result may help explain why the effects of gestures analyzed singly were not more consistent: in some cases gestures requesting action were juxtaposed with a negative from the other gorilla, or even from the gesturing gorilla, and these "negatives" were not originally considered in determining the function of accompanying gestures. Besides gestures, of course, other

factors such as facial expression may also modify a message; bared teeth or a tense face might suffice to discourage play. Yet even with such negative messages, one gorilla may still sometimes over-ride the other's negative and attempt to play.

Table 9.1 "Negative" gestures

	contain negative gestures	**no negative gestures**
sequences with contact following	11	67
sequences with no contact following	21	10

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

Repeated gesture strings and other repeated sequences

The repetition of strings is of interest because it has cognitive implications indicating planning and memory capacity; the string must be held in some working memory in order for it to be accurately repeated. The examples here illustrate memory for sequences that are not innate gorilla behavior (as is, perhaps, the 9-part male display sequence, described by Schaller, 1963),[3] and have no known functional end. Such sequential memory capacity would be necessary for the related capacity to imitate complex sequences performed by others.

Gesture strings in display

Usage of gestures in "display" performed at a distance from another gorilla did not have the same consequence as when gestures were used as a close-range invitation for play or sexual positioning, usually resulting in contact. Though a long-range display might

[3]The degree of innateness in the display sequence can be questioned. Schaller notes that the nine actions that constitute the display series may be performed "...individually or in numerous variable combinations of two or more, though there is a definite tendency for some to precede others and for several to be united in a series. The whole sequence is given infrequently and then only by silver backed (mature) males" (Schaller, 1963, p. 222).

eventually lead to contact play, these displays seemed primarily performances for their own sake. They occurred in the presence of another gorilla, and were repeated, often with variations, without any attempt to make closer contact. The setting for a session of this kind of display is fully described in Appendix 1 as the game "Nest and mountain trading." An excerpt:

> toward the end of the session they remained apart, but engaged in extended exchanges of audible gestures, with Kubie near his nest performing elaborated, structured displays... Zura occasionally joined in, remaining on the rock "mountain," beating her chest or other body areas, and using the artificial rocks to produce extra sound effects by foot-stamping. At times the sound and gestural displays were exchanged in conversational fashion...

Kubie's gestural strings in this situation repeated, with expansions, a chain of 3 to 5 different elements 5 times, with pauses of several seconds and interjections by Zura occurring in between strings. A transcription of these repetitions follows; first, a fuller description of the form some gestures took here:

shake head: from side to side, with burlap bag in teeth
head nod: repeatedly, with bag in teeth
wring bag: in arms
pound fists: in lap
chestbeat: form varies slightly each time

Example 4:
Each line beginning with a capitalized gesture is a string, followed by a pause (a connecting slash denotes simultaneous actions).

For the first four strings, Kubie is seated:
Shake head/chestbeat, clap
Shake head/chestbeat, wring bag, clap
Shake head/chestbeat, head nod , clap
Shake head/chestbeat, shake head, pound, fold arms, clap
Shake head/chestbeat (stand bipedally), *twirl whole body* (quadrupedally), *chestbeat* (bipedal), *bow down/nod/shake head* (bipedal), lie down on ground

Each string begins with a *shake head* and *chestbeat*, and ends with a *clap*. Before each *clap*, Kubie would fling the burlap bag in his mouth over his shoulder, so it would not be in the way of a resounding clap. Each new string extends and varies the previous string while retaining the beginning and ending elements, except for the final string and the longest expansion, that ends with an elaboration other than the *clap*. The set described above was followed, after longer pauses, by two other shorter sets of strings incorporating similar elements in slightly different ways, including further chest beating participation by Zura.

These strings may also be notated in a way that simply shows the number of different elements and their ordering:

A/B C
A/B D C
A/B E C
A/B F G C
A/B H B I/E/A J

Similar displays from Kubie occurred when Zura disappeared from an area in the rock formation where they had been playing. Kubie seemed to be looking for her, *backhand* pounding on the rock wall behind which she had gone. He finally, slowly and carefully, ripped open one of his burlap bags so that it was one single layer large rectangle, then draped it over his head and *chestbeat* twice, ripped the bag some more, then held the bag in his mouth and performed the following strings. Here head twirling followed by chestbeating was the theme upon which variations occurred.

Example 5:
Each line is a new string, separated by a pause from the previous one.

head twirl, chestbeat, head twirl, chestbeat, cross arms, chestbeat
A B A B C A
head twirl, chestbeat, cross arms, clap, clap
A B C D D
head twirl, chestbeat, (lie down) *chestbeat, brush alternating hands between legs rapidly, head waggle with bag in mouth, chestbeat* (slow)
A B B E F B

Plate 9.2. Shango's game in the drainage moat

Another repeated sequence performed by Kubie involved an object in the context of "display." This sequence was deferred repetition; it was seen repeated identically twice, but the observations were two months apart. The day of the second observation, Kubie repeated *part* of the full sequence two more times about an hour and an hour and a half after the first performance. Because my observations were made only once a week, it seems probable that he might have performed this sequence more often than I observed.

Example 6:
A: moves a rubber tub from a different location to
B: a location under a rock ledge
C: turns the tub bottom up
D: climbs up on the rock ledge
E: stands bipedally in a crouched position for a moment
F: stands upright
G: chestbeats with vocalization
H: jumps up and off the ledge
I: lands on the tub, which makes an impressive sound

Repeated sequences in solitary games

Though not composed of gestures, a solitary "game" Shango created at the age of 5 consisted of a "string" of behaviors that show the same kind of repeated structure with variations as do previous gestural examples. Shango was in the moat with his ball; there was a rubber tub at the upper end, and a pile of branches a bit further down the slight incline of the moat (Plate 9.2, opposite). He repeated the following set of actions at least five times, repeating all steps in the same order each time:

Example 7:
A: sets ball in motion down hill
B: rolls self down hill ahead of ball as ball follows
C: grabs and tosses branches while rolling self down hill in front of ball
  C1: (optional subroutine) if ball stops, rolls self back up hill to ball
D: catches ball and dribbles ball back up hill
  D1: (optional) or sets ball rolling up hill, runs ahead of it and rolls uphill ahead of ball
E: tags the rubber tub at top of hill
  E1: (variation) jumps on rubber tub
Then, begins whole set (A-E) over again from A.

Later, in play at age 6 with his younger brother nearby, Shango invented another routine involving first spinning his whole body upon, then slapping, a large piece of leather. These sequences occurred approximately a minute apart.

Example 8:

1. AB spin (slow), spin (fast)
2. AB spin, slap

(immediately after Shango, his little brother Barney slaps the leather in the same place)

3. AB spin, slap
4. CAB 2-hand backhand on leather, spin, 2-hand slap
5. AB spin, 4 slaps
6. AB spin, slap
7. DAB chestbeat, spin, 2-hand slap

The two basic elements, spinning and slapping, were retained in the same order throughout. However, the slapping varied in number, as well as in whether one or both hands were used, and additional gestures were included in some sequences.

Summary: repeated sequences

Kubie and his son Shango both performed sequences of actions that they repeated, often with variations. Table 9.2 summarizes the number of unvarying elements and number of repetitions for each group of sequences.

Table 9.2. Number of Elements and Repetitions in Sequences

Gorilla and Example	Unvarying elements	Number of repetitions
Kubie; example 4	3	5
Kubie; example 5	2	4
Kubie; example 6	9	2 (deferred)
Shango; example 7	6	5
Shango; example 8	2	7

The sequences of both Kubie and Shango that were the longest (9 and 6 elements) involved objects and several locations. Possibly the objects incorporated in these games and their customary uses helped support memory of the actions involved. The sequences that primarily involved gestures (though an object was incorporated in each) were shorter but had more repetitions. In all sequences, variations were added that would seem to require longer holding in memory of the "theme" actions, which were in all cases always repeated in the same order.

Summary and discussion

Kubie and Zura, the gorillas upon whose gestural utterances I have focused here, used gestures in sequences with other gestures more often than alone. The examples in this chapter show that the reason for this is probably more than re-emphasis of a single message. As well as expressing requests for action in general (example: *armshake*) or approach (*extend hand, head nod)*, gestures may more specifically indicate direction of movement (*down, around*), type of activity (*bite, tap foot*), agent of an activity (*tap other*), and location of activity (*slap* tree, *pound* rock). Gestures alternated between gorillas in dialogues that negotiated decisions on type and location of play. A gesture was often a response to a partner's gesture, not just an expression of the gesturer's immediate desires.

Gorilla gestural sequences appear to contain some of the structural elements described by Greenfield and Savage-Rumbaugh (1990) for the pygmy chimpanzee Kanzi's gestural-lexigram constructions. I have already noted in Chapter 4 that Kubie's *tap other/armswing under/(touch between legs)* sequence expresses a complete agent/action/location statement in a single gestural motion. In addition, eye contact and facial expression make such statements even clearer. When eye contact is not available, sound can be added to gestures.

A gorilla's own messages can be altered, or another gorilla's message protested, by negative gestures. Gestures appearing to be negatives were Zura's *hide playface* and

gestures such as *away, pat off, wrist glance,* and the forcible *backhand.* Again, facial expressions, such as a tense- or pursed-lip face or the avoidance of eye contact, can fortify a gestural message. Whether negative gestures are performed to change decisions about activity or simply reflect lower motivation, they carry a message that can be read by another gorilla.

Sequences of action, gestural or otherwise, may be relevant in probing cognitive capacities of gorillas. Some strings of gestures and/or actions were repeated with the same elements in the same order, with minor variations. These were not functional activities or typical gorilla behaviors. Variations on a theme are typical in play activities, and in a conservative interpretation could be considered to be errors or memory failures. Here, however, the *theme itself* consisted of more than one action, always in the same order, or a "program" of action, that did not change or fail regardless of other enhancements. A telling detail is that in Kubie's display to Zura, where each string ended with a *clap* (Example 4), he would before the clap always carefully toss over his shoulder the burlap bag held in his teeth that he used in the previous display element. He knew the clap was to be next in the sequence, and was planning, or "clearing the stage," for it.

Complex activities and higher level skills composed of many subroutines are seen in great apes and humans, and the imitation of such complex sequences has been shown to be an important kind of imitation, of which great apes seem to be capable (Byrne & Russon, 1997). Though imitation of complex sequences of one gorilla by another has not been observed in this zoo group, the capacity to reproduce one's own sequences implies that this should be possible. A repertoire of self-developed skills, and self-repetition of existing skills, may be necessary before it is possible to repeat similar actions of others. Following this line of thought, imitation of a novel program, or sequence, composed of familiar actions may be less demanding than exact reproduction of a single anatomically and neurally unfamiliar action.

The next chapter will explore the relationship of the gesture of zoo-dwelling gorillas to the spontaneous gesture of a gorilla taught American Sign Language. This will shed more light on the similarities and differences in the cognitive processes of apes of the same species who have developed with very different environmental inputs.

Chapter 10
The spontaneous gestures of zoo-living gorillas and sign-taught gorillas compared

Introduction

In this chapter, I will explore the relationship of the spontaneous gestures of the zoo-living gorillas I have studied to those of sign-taught gorillas. Both zoo-living and sign-taught apes create gestures other than the obviously species-typical, and, for signing apes, other than the taught signs they regularly employ. I have illustrated that zoo-living gorillas use iconic gestures; in both species of chimpanzee as well, iconic gestures have been observed in both untaught captives (Kohler, 1925; Yerkes, 1943; Hayes, 1951; Savage-Rumbaugh et al., 1977) and chimpanzees trained in symbol systems other than sign language[1] (Savage-Rumbaugh, 1986; Greenfield & Savage-Rumbaugh, 1990). Signing apes of course also create iconic gestures; signing apes however, but not zoo captives, spontaneously invent gestures to represent objects they have not been provided signs for, that they use repeatedly and consistently (Gardner & Gardner, 1971; Patterson, 1980; Patterson & Cohn, 1990; Miles, 1993, 1996).

The only gorillas who have been extensively taught a sign language are Koko (a zoo-born female lowland gorilla) and Michael (a wild-caught male lowland gorilla), who at present reside at the Gorilla Foundation in Woodside, California. Koko was born at the San Francisco Zoo on July 4th, 1971, and is the full sister of Kubie, one of the subjects of my zoo observations. Koko's exposure to American Sign Language (ASL) and constant human companionship began at the age of one year under the tutelage of Francine Patterson, who was at the time a graduate student at Stanford University.

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[1] It would be of great interest if the researchers working with these apes would describe their gestures in more physical detail. They then could be compared with those of signing apes and apes not taught any symbol system.

Koko was simultaneously exposed to a variant of American Sign Language and human (English) speech. Further detail of Koko's and, later, Michael's education, and the entire ongoing project can be found in Patterson (1978, 1979, 1980), Patterson & Linden (1981), and Patterson & Cohn (1990).

In this chapter I survey gestures Patterson and Cohn (1990) list as invented by Koko, with particular attention to those that appear to be iconic, and note the types of iconicity that Koko uses in comparison with zoo gorillas. I assess these modes of representation in terms of their order of appearance in Koko's individual development, and assess how far zoo gorillas progress similarly in their development of gestures. I then compare the contexts of usage of those gestures that take the same form in both zoo gorillas and Koko to learn whether "meanings" or functions of such gestures are universal or variable. Utterance length is another feature of gorilla gesture for which data is available; I compare average utterance lengths of two zoo gorillas and two signing apes. Commonalities and differences found between zoo gorillas' gestures and a signing gorilla's invented signs highlight shared cognitive features, as well as areas in which an expanded ability to create descriptive gestures may be related to enriched environment and communicative exchanges with humans.

Invented gestures in Koko, a signing gorilla

Most of Koko's and Michael's earliest taught vocabulary that reached formal criteria[2] of frequent usage was composed of iconic signs[3], in contrast to the vocabulary of deaf

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[2] Two sets of criteria were used: the *emitted* criteria accepted as a vocabulary item each use of a recognizable sign used spontaneously in an appropriate context; the *Patterson* criteria accepted a sign only if it was observed and recorded by two different observers to be used appropriately and spontaneously on at least half the days during a period of a month.

[3] Bonvillian and Patterson (1993) distinguish three classes of representation, adapted from Stokoe et. al. (1965). A "sign that closely resembled its referent that had a clearly apparent or transparent meaning was classified as *iconic*. An example would be the sign BABY, which consists of an imitation of the action of cradling a baby in the signer's arms. A sign that represented a relatively minor feature of the

human children. As the gorillas' vocabulary increased, the proportion of iconic signs decreased, though it remained higher than that of the human children studied by Bonvillian and Patterson (1993). Bonvillian and Patterson, however, acknowledge that the design of their study does not allow us to discern the influences on early vocabulary of sign input from humans. Also, some iconic signs may represent aspects of the referent that would not be recognizable by the learner as iconic.

In summarizing the first ten years of Koko's vocabulary development, Patterson and Cohn (1990) list Koko's entire vocabulary during these ten years and indicate which of those signs were not taught, but invented by the gorilla. These spontaneous inventions were not a result of deliberate human reinforcement of chance novelty; invented signs were often not initially comprehended by Koko's human companions and were often ignored or misunderstood until repeated context made her meaning clear. Thus Koko's invented signs might be expected to be free from human influence in choice of referents. Once acknowledged by humans as part of her vocabulary, invented signs were neither discouraged nor encouraged, but accepted as part of Koko's repertoire of signs. The invented signs have not been studied in terms of their iconic qualities; I will attempt to do so here. In some cases, the inventions were for actions, concepts or objects for which Koko had not been taught a sign; others were for actions,

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referent and whose meaning was not immediately apparent was categorized as *metonymic*; an example would be the sign COOKIE. This sign represents the process of cutting out a cookie from cookie dough. One of the signer's hands (performs the cutting action of an imaginary cookie cutter on the palm of the other hand). Finally, a sign that had no discernible tie to its referent was considered *arbitrary*" (Bonvillian & Patterson, 1993, p. 324). In my survey here of invented signs, I classify metonymic signs as iconic. I find the distinction between the two classes to be arbitrary, even in the examples presented. Because my interest here is in the thought processes leading to the physical representation, I consider any sign that describes the physical form of an action or object to be the result of some kind of process of iconic representation. I then distinguish subcategories according what aspect of an object is chosen to be represented, or whether instead an action upon an object is chosen for the representation.

concepts, or objects for which she had been taught a sign but for which she strongly seemed to prefer her own invention.

With the help of unpublished video (demonstrations by Patterson and Chan, 1991) and lists of Koko's sign lexicon as well as published physical description of earliest signs (Patterson, 1978), I categorized according to type of iconicity or other form of reference, 50 signs that Patterson & Cohn (1990) characterized as invented by Koko. Not included are those listed as "natural" (Patterson & Cohn's term for "signs" they suspected to be species-typical) or "modulated or compounded" (*modulated* means modifying the taught articulation of a sign; *compounded* means combining taught signs). The total corpus of 50 signs, with descriptions and categories, is listed in Appendix 3. Table 10.1 (next page) summarizes the referential categories of Koko's invented signs and their types of iconicity or other modes of depiction; Plate 10.1 (opposite page 174) illustrates some of Koko's invented signs.

Of Koko's invented signs during the first ten years of her life, approximately three-quarters involved an iconic mode of depiction.[4] Among these, approximately 70% involved depiction of action, either of an action itself or of a customary action upon an object.[5] About 40% represented an object by depicting an element of the shape of the object. Of the 50 invented signs, 60% involved a relevant location on the body; that is, the gesture not only depicted a shape or action but also was signed on the location

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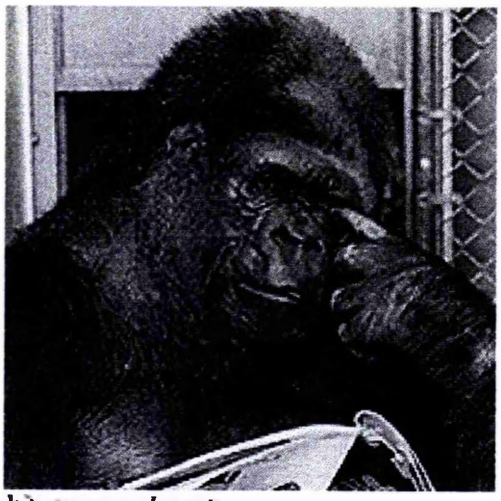
[4]It is, of course, possible that humans have missed out on understanding and interpreting some of Koko's signs, especially the non-iconic. Because iconic signs are easier for us to attempt to translate, they might be over-represented in summarizing Koko's vocabulary.

[5]Some action mimes listed as representing objects might seem to be just as well translated as signs for actions, not for objects. However, Koko often used them to request the object in question (by accompanying pointing or reaching and eye contact), thus indicating that an object was the referent of the action. In some cases, however, the signs might be interpreted either way; in American Sign Language, many signs can represent either an object or an action depending on inflection or repetition.

a) *browse*



b) *eyemakeup*

c) *bite*

d) *unattention*

e) *barrette*

Plate 10.1. Some signs invented by Koko
(all photographs by Ronald Cohn, copyright The Gorilla Foundation; used with permission)

Table 10.1. Koko's Invented Signs (First 10 Years)

Total invented signs	50
Signs for objects	27
Signs for actions	17
Other signs	2 for qualities (*smooth, obnoxious*)
	2 for states (of attention)
	2 deictic or pointing out focus of attention
Mode of iconicity (The following categories are not mutually exclusive. There is overlap in percentages because a few signs involved elements both of object shape and of action.)	
iconic for the shape of an object	15
iconic for an action (but not necessarily representing an action; may represent an object by depicting action upon or with that object)	27
performed on usual body location of referent	30
total invented signs involving iconic description	38

where an object was usually worn or placed, or where an action was performed. If those signs that did not specify a location that was clearly relevant to the referent are included, for 80% of the invented signs her hands touched her body.

Though Koko's invented signs were predominantly signs for objects, more than half of these objects were not represented by depicting their shape, but by an action performed upon or with them. For instance, modeling *clay* was signed by a motion of rolling the palms together, as when rolling out clay; a hand *puppet* by the motion of putting the puppet on the hand. Action-depicting signs, whether for objects or actions, often were made on the part of the body where the action normally occurred or was desired to occur (e.g., *strangle*=one open hand placed over the other, on own neck; *eyemakeup*=index finger strokes horizontally across eyelid; see Plate 10.1b, opposite page 174). Thus, iconic inventions included depiction through shape, action, customary

location, or a combination of two or three of these aspects. Shape, however, was least prevalent; action and location depictions were the most frequent.

Some of Koko's inventions were not iconic; one was a deictic (pointing) sign that indicated the location of an object (Koko's early "notice" sign, glossed as *bird* because she co-opted this sign and used it in a deictic manner). Another sign simply located a referent on the self (e.g., *body hair* indicated by grasping hair between the fingers). Koko also invented signs that involved crossmodal transfer of English sounds to a sign;[6] for instance, blowing hard at someone to express that they *"blew it";* she was quite familiar with this expression as it was used frequently in the spoken English of her companions, often to scold her. In this example, the "sign" is itself a sound, accompanied by characteristic body posture and facial expression. Some inventions were "blended" from several taught signs (i.e. *apricot* = the sign for "peach" made with an "A" handshape like *apple*). A few were of unknown or indiscernible origin (like Koko's "*lip*" in reference to human females, performed by rubbing an index finger horizontally on her lips; this is perhaps related to *lipstick*, a similar motion performed with the thumb).

Many other sign inventions were created by Koko after her first ten years that have not been formally described in academic publications. Some of these are described in articles in the Gorilla Foundation's semi-annual *Journal.* Signs now regularly glossed as *above* and *below,* whose meaning at first eluded researchers, have become a standard part of Koko's repertoire (Patterson & Tanner, 1988). These depict spatial location by moving a flat palm forward off the top of the head (*above*) or moving a flat

[6]A study of Koko's response to alterations in vowels or consonants in spoken words illustrated that Koko can accurately perceive the sounds of human speech (Goodreau, Patterson & Tam, 1996; Patterson & Goodreau, 1987; Goodreau, 1987.)

palm from between the legs when seated (*below*).[7] Koko has also continued to transfer sounds of human speech into signed form, as in her frequent sign for vegetable "browse" (see Plate 10.1a), a term not used with her until a recent change in diet, and for which she was not given a sign. She places a fist on her *brows*, with the motion of the sign for "lettuce" in American Sign Language (Menendez & Patterson, 1994).

Michael, the Gorilla Foundation's male gorilla who was taught sign language beginning around age 2 to 3 years, also invents signs. Koko subsequently adopted some of these for her own use. Signs invented by Michael but co-opted by Koko during the first ten years of the project were *hit-in-mouth, hit-in face,* and *pull-out-hair*, all mimes of the described actions.

From action to object in the invention of gestures and signs

Action and location, the preferred features depicted in Koko's iconic invented signs, are also the features of behavior and the environment that were commonly depicted in gestures of the zoo gorillas in my study. Thus, for both signing and non-signing gorillas, *action* (synonymous with "behavior" of animals) and *location* (as the beginning or ending point of action) seem to be the most basic building blocks for iconic and deictic expression, respectively. The transition from describing an action or indicating a location to describing an object should then be minimal, because action and location of an object can be employed in describing it gesturally, as in many of Koko's inventions; the outlining of action is not far from the action of outlining an object. Table 10.2 (next page) illustrates a progression from depiction purely of action, to object depiction with signs or gestures.

Zoo gorillas have been observed to create only depictions of action of the self or another gorilla, and gestures of similar types have, though very rarely, been observed in

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[7]This depiction of the concept that something is located below something else is interestingly a directional reversal of Kubie's frequent *armswing under* gesture.

Table 10.2. From actions to objects in gesture and sign invention

Sources: Appendix 3; Chapter 3 ,Table 3.2; Patterson & Cohn (1990)

what sign or gesture describes	**how described**	**where depicted**	**example (English gloss)**	**physical description**	**this type invented by which gorillas?**
action of self anticipated	traced	in space	*down*	arm moves down from above head in space	in wild, zoo, signing
action desired of other	traced	in space	*armswing under*	arm swings from space in front of body to between legs	in wild, zoo, signing
action desired of other	traced	on body of other	*turn around*	on other's waist, arm moves from one side of body to other	zoo, signing
action desired of other	mimed	on own body	*tickle*	index strokes underarm or sole of foot	zoo, signing from age 1.2 years
object	hand shape	on own body	*bracelet*	cupped hand pats wrist	signing from age 2.8 years
object	action on or of an object mimed	with own body	*clay*	flat hands, top hand moves back and forth over other palm	signing from age 3.8
object	tracing of shape of object	on own body	*eyeglasses*	index fingers trace lines from eyes to back of ears	signing from age 6.1 years
action upon objects	action on or of an object mimed	with own body	*grate*	fist moves across palm of other hand, miming motion of grating a vegetable	signing from age 6+ years
object	hand shape only	in space	*pickle*	thumb and index extended from both fists held in space in front of body	signing from age 6+ years
object	tracing of shape of object	in space	*thread*	two little fingers touch then move apart horizontally	only when taught by humans

the wild (see Schaller, 1963). Koko moves further with her invented signs: from depicting social action to reproduction of behavioral action upon objects, then actual tracing of the outline of an object, then use of a "still" image to convey a representation of an object. Thus there are links moving from pure behavior to representative action to non- action representation of objects.

The developmental progression of sign creation in Koko's own ontogeny can be found in chronological records of her first invented signs (Patterson, 1980); Table 10.2 is ordered in this progression. "Invented" signs by Koko for the first three categories of "action" signs are not found in available records; this is probably because such signs, if not taught, may have been considered "natural" gestures. Koko's earliest recorded invented signs, *blow* and *tickle*, depicted actions desired of another and appeared during her second and third months of sign instruction, when she was just over a year old. The earliest appearance of *blow* was putting her index finger to another's mouth when the person stopped blowing, perhaps simply pointing; Koko appeared to want her to continue blowing. Koko then began to request the action *blow* by holding a finger up to her own mouth, transferring the features of another's body to her own. *Tickle* was likewise indicated by miming the action desired of another on her own body. Her next sign was a deictic sign, performed with two index fingers held together at the tips. This sign indicated interesting objects out of reach, but was glossed *bird* because it originated in imitating elements of a teacher's *bird* sign. Subsequently, however, it was employed for many referents other than the bird the teacher had originally been pointing out.

Koko's next invented sign did not appear until over a year later, during which time her ASL signing progressed rapidly. This next sign, at age 2 years 8 months, was *bracelet,* performed by a cupped hand patting the wrist, first used requesting a new bracelet she was shown. This was her first sign created for an object, and involved a handshape depiction as well as contacting the part of her own body where the object

usually was worn, thus perhaps involving a tactile element as in her earlier signs such as *tickle*. She later extended the use of the *bracelet* sign, referring to a hand puppet on a companion's hand as well as using the sign for bracelets. Soon her next invention, *bite,* appeared (see Plate 10.1c, page 174). She placed the side of her hand in her mouth to request biting play from a companion. Like her earliest inventions, *bite* reproduced the action desired of another on her own body. At age 3 years, 8 months, a new type of depiction appeared: Koko's sign for *clay.* Koko requested clay by miming the customary action performed on the object, rolling a ball of clay between the hands.[8]

During Koko's first five years, all her iconic inventions were like those already described in their modes of depiction: reproducing a desired action of another, reproducing the action of or upon an object, or placing an appropriate hand shape on her body. At age 6 years a new mode of depiction appeared: tracing the shape of an object. Koko invented a sign for *eyeglasses,* where index fingers traced a line from the eye to the back of the ears.

Koko had a total of 15 inventions describing objects that involved describing the shape rather than the action of an object (Table 10.1, page 174). A form of active "tracing" of the form of an object was used in five cases; in ten cases, her depictions of shape were produced instead by a descriptive hand shape (i.e., extended finger for a straight or narrow object, cupped hand for a rounded object, index and thumb extended for a small rectangular object) placed on an appropriate body location. Among Koko's 50 inventions from her first 10 years (listed in Appendix 3), all signs that depicted an *action* iconically were performed on appropriate body locations, and nearly all that depicted a shape were also performed touching her body. One notable exception was her sign for *pickle* (described in Table 10.2), with appropriate hand

[8]This could be interpreted as requesting the activity of playing with clay or requesting the object itself, but Koko did use such signs to request objects.

shapes in the space in front of the body. The only category of representation not found among Koko's invented signs during her first ten years is the tracing of an object in space away from the body, though she uses such signs when taught. (*Thread*, a taught sign used in her invented compound sign for *dental floss*, is such a sign). Whether the tracing of a shape or use of a "frozen" hand shape is the more abstract method of depiction is an open question, but hand shape depiction appeared earliest for Koko. However, Koko used both tracing and hand shape modes of depiction in taught signs before using similar modes in created signs, and might well have had both at her disposal but not had the occasion to use them. Therefore, order of appearance might be related less to development than to need or opportunity. Nonetheless, the developmental order of the modes of representation in Koko's signs moves from depicting on her own body actions desired of another, to creating the shape of an object on her body, followed by miming the action performed with or on an object, and then later by tracing the outline of an object, again on her body. Tracing shapes away from the body or describing an object with a hand shape held away from the body were the rarest of her ways of representing objects.

Another notable aspect of Koko's invented signs for objects is that nearly all of her 27 object signs were for referents that she could, and presumably did, touch and handle. The four exceptions are notable in that they are among her more "abstract" or arbitrary signs: *woman, man, long-hair, filmers/reporters* (see Appendix 3). All these exceptions refer to humans or aspects of human appearance. *Long-hair* refers to long-haired humans, and traces the hairline of a human's long hair on her own body; *filmers/reporters* is likewise a tracing sign on her body, delineating the straps of camera equipment. Such "tracing" signs were her latest to appear, only after 6 years of age. *Woman (lip)* and *man (foot)* are non-iconic, as far as humans have been able to determine, and also appeared after age 6. They possibly drew upon characteristics of men and of women that were particularly salient for Koko; however, like many signs in

human sign languages, they are opaque and arbitrary to anyone without an intimate knowledge of their origins (see examples in Kendon, 1988; Armstrong et al., 1995). *Woman (lip)* is an index finger rubbed horizontally back and forth across the lips. Interestingly, this is similar to another earlier sign of unknown origin, glossed *note,* which she performed before pointing to something of interest; this *note* sign dropped out of her vocabulary after early years. *Man (foot)* appeared after she began to take sexual interest in a human not amongst her caretakers, a laborer who wore heavy boots. It has been speculated that Koko was using the boots as a point of reference; however, a "natural" gorilla gesture, observed several times in the zoo female Zura, is turning the rear toward and extending a *foot back* to another gorilla, a mounting reference possibly derived from a signal commonly used by a mother for a youngster to get on her back. Zura sometimes tapped the sole of her extended foot with her index finger as part of this signal, sometimes only tapping the foot without presenting the rear, in the context of sexual play. This *tap foot* is identical to Koko's *man (foot)* sign, which she used frequently in the context of human men, but not, for instance, for a "family" member such as her "surrogate father" Ronald Cohn. If this derivation I suggest is correct, it would be an example of an adaptation of a "natural" signal to a different context (as in Table 10.3, p. 184).

Varying gestures or signs for the same function or referent

As well as inventing signs for referents for which she had not been provided with an ASL sign, Koko replaces some of her taught signs with invented gestures for the same referent, perhaps because her own versions are more meaningful to her when clearly iconically related to a referent or touching her body. Also, as previously noted, she

seems to prefer signs without intricate hand configurations[9] and signs that touch her body. An example is her usage (a cross-modal transfer) of *knee* (tapping a finger on her knee) for "need," for which she had a taught sign; the ASL version of "need" is performed with a crooked index finger moving downward in the open space in front of the body. Another invented sign which makes use of gorilla anatomy is Koko's exaggerated version of *frown,* where she uses her hands to pull her lower lip down rather than simply tracing downward lines at the corner of the mouth as in ASL. In many ASL signs she retains the motion and place of a sign but changes or simplifies hands shape; in some she retains motion and hand shape but changes the place, usually to her body or a surface in her environment such as wall or floor.

Within the San Francisco zoo group, I found that several different gestures could iconically depict desire for another gorilla to approach, though they might indicate approach to different body locations; these were *head nod, armswing under, slap top of shoulders, extended palm.* Similar variation in signals (though not in gesture) can be found in the wild; some well-known examples of behaviors differing in ape populations isolated from one another are the differing grooming handclasps and courtship displays (such as leaf-clipping) of separate chimpanzee populations hundreds of miles apart in Africa (McGrew & Tutin, 1978; Nishida, 1980; Ghiglieri, 1984). Though apes in different populations may create their own versions of functionally similar behaviors, in monkeys similar gestures seem to be shared by all members of a species, thus are presumably genetically prescribed (Kummer, 1995; but for local variations in baboon gestures, see Ransom, 1981).

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[9]American Sign Language has nineteen primary handshapes plus twice as many variations; a deaf human child untutored in sign language created nine handshapes (Goldin-Meadow, 1984). Untutored gorillas perhaps have three: open palm, fist, knuckle hand.

Gestures found in both signing gorillas and zoo gorillas

The number of "natural" or "species-typical" gestures of gorillas may have been underestimated in both quantity and function. Patterson & Tanner (1988) list untaught gestures of Koko's that duplicate gestures described earlier for one or more of the gorillas at the San Francisco Zoo. Table 10.3 (next 2 pages) lists "natural" gestures of Koko that have also been observed in zoo gorillas or in the wild. Fuller physical descriptions and details of which zoo individuals used each gesture can be found in Table 3.2, Chapter 3. There are a few gestures listed here that overlap with those listed among Koko's invented gestures from Patterson and Cohn (1990); at the time of observation, these were not known to be used by other gorillas. Though not all have been seen in all gorillas, most have been observed in more than one zoo gorilla. Some of the gestures have not been reported in gorillas other than Koko and the San Francisco Zoo gorillas and may be similar because of the capacity of gorillas (and other apes) to form iconic gestures, rather than being strictly "innate." Similar gestures have been observed in other ape species, and often have different functions both in different species and for individuals within a species (see Table 3.2, Chapter 3, for examples both in gorillas and other apes). Functions of many gestures are similar for both Koko and the zoo gorillas, but there are also some differences. All the gestures are social in function, used in interaction with other individuals to regulate actions and locations of action.

Length of utterances in zoo gorillas, a signing gorilla, and a signing chimpanzee

I have shown that within gestural strings (defined in Chapter 9) Kubie and Zura used gestures that seemed to express relationships of actions, locations, and agents. A comparison to the "strings" of signing apes may thus be appropriate, though the number of "vocabulary" items the signing ape has to choose from is far greater than that of the

Table 10.3. Koko's untaught gestures seen in other gorillas

(Koko's usages partly from Patterson & Tanner, 1988)

Koko's untaught gestures also observed in other gorillas	**Koko's usage with Gorilla Foundation gloss**	**Usage at San Francisco Zoo**	**observed in other zoos or wild? (see Table 3.2 for sources)**
armcross	(glossed as *catch*) used in activities involving tossing and catching of objects; chase games, playing hard to get; also requesting embrace or desirable objects	play contexts; function otherwise unknown	zoos and wild
armshake	(glossed as *play* or *hurry*) invitation to play; also expression of excitement or impatience	play invitation, readiness for activity; sometimes warning or threat (only used this way by one individual)	SF Zoo, not in wild
armswing under	(glossed as *walk-up-bottom*) sexual solicitation or request for tickling of bottom	invitation for contact in sexual play	SF Zoo, not in wild
away	(glossed as *stop*) to stop advance of another individual	agonistic contexts, avoidance of contact	zoos and wild
backhand	(glossed as *darn*) expresses annoyance or frustration	gaining attention in play situations, also used in agonistic display or protest	zoos and wild
bite	in playful excitement, referring to biting	in play, before or after biting play	zoos and wild
chestbeat	excitement, agitation, but also in a more controlled form glossed as *gorilla*	excitement, agitation, attention getting	zoos and wild
circle hands	(glossed as *gentle*) request for gentle behavior	unknown, but seen in play contexts	zoos and wild
clap	playfulness or excitement	in play, often solitary and before performing a physical action like jumping or balancing	zoos and wild
deictic gestures	(glossed as *me, you, that, there, your*) designating the listed referents; Koko performs with extended index finger. *Your* is performed with outstretched palm, may designate another's property or turn for action.	designating other or self as object or agent of action; also designating locations. Performed with open hand, knuckles or fist. Glossed as *chest fist pat, tap other, pound, extended palm*	zoos and wild

Table 10.3, continued

Koko's untaught gestures also observed in zoo gorillas	**Koko's usage with Gorilla Foundation gloss**	**Usage at San Francisco Zoo**	**observed in other zoos or wild?** (see Table 3.2 for sources)
extended palm (could be included with deictic gestures)	(glossed as *come-gimme*) requesting objects or the approach of other individuals	invitation to contact or request for food	zoos and wild
facewipe	(glossed as *toilet, b.s.*) expression of disbelief, uncertainty or annoyance	annoyance, avoidance	SF Zoo
foot	designating the body part, also referring to human males	seen in a zoo gorilla, a variation of *foot back* sexual invitation performed by tapping the foot with the hand	one SF Zoo gorilla
hand between legs	(glossed as *below*) performed seated; hand moving out from under body designates location below or under another object. When forceful slapping motion, a masturbation activity.	play, sexual invitation (usually patting motion)	SF Zoo, Rio Grande Zoo
hands behind back	(glossed as *walk-up-back*) requesting companion's fingers "walked" up back, tickling	inviting play activity or approach from companion seated behind self	zoos
head nod	(glossed as *yes*) agreement, assent	inviting approach or visual attention of other gorilla	one SF Zoo gorilla, wild
head shake, head turn	(glossed as *no*) dissent	head shake used in playful contexts; head turn sometimes avoidance of eye contact or possibly request for change of direction	zoos and wild
knock, pound	attention getting, or cross-modal transfer of English "obnoxious"	getting visual attention in playful contexts	zoos
slap surface	(glossed as *pound*) play invitation or challenge; referential use to request pounding on back	play or chase invitation; attention-getter	zoos and wild
up	for movement upward; when small, a request to be picked up	request or intention to move upward	zoos and wild

zoo subjects. The available data on mean utterance lengths of Koko, Kubie, Zura, and a signing chimpanzee, Nim, are shown in Table 10.4. I have been unable to find a definition by Terrace of what is considered a single "utterance," but will presume it is about the same as a "string" for Kubie or Zura. Patterson (personal communication) confirms that her definition of an utterance is virtually the same as mine for a string.

Table 10.4. Utterance lengths of apes

Subject	age in years when utterance length sampled, sex	rearing environment	mean length of utterances	range of utterance length
Kubie gorilla	13-year-old male	zoo, mother reared for two years until she died	1.5	1-8 gestures
Zura gorilla	7-year-old female	zoo born, early rearing by humans, then introduced to a different zoo gorilla troop	1.2	1-4 gestures
Koko gorilla	5-year-old female	zoo born, mother reared for a few months, then human reared with intense sign language exposure from age 1 year	2.2	1-8 signs
Nim chimpanzee (*Pan troglodytes)*	3-4 years old, male	human reared with intense sign language exposure from 2 weeks old	1.5	1-16 signs

The mean length of Kubie's gestural utterances during Period 1, which was of about a year's duration, was 1.5 gestures; Zura's mean utterance length for the same period was 1.2 gestures. The average length of the chimpanzee Nim's utterances by month was 1.1–1.6 signs, averaging 1.5 signs, during the final two years of Herbert

Terrace's project at Columbia University, which ended when Nim was not yet four years old (Terrace, 1979). Koko's utterance length between ages 2 to 5 years from ranged from 1.1-2.2 depending on month (Patterson & Linden 1981), topping out at 2.2 at age 5 years. Though Kubie and Zura were older when sampled than Koko or Nim, their utterance lengths are comparable to those of the signing apes. Data on utterance length at an older age for Koko is not at present available.

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 significant drop in quantity when a disturbing event occurred (Patterson & Linden, 1981). This was also the case for Kubie, as we have seen in the huge drop in gesturing during Study Periods 3 and 4 (Tables 3.1 and 3.3, Chapter 3).

Discussion

A gorilla tutored in sign language and zoo-dwelling gorillas both create signs or gestures that iconically depict action, but some of the invented signs of a signing gorilla also refer to objects. Many of the invented signs or gestures of both the signing and non-signing apes have iconic characteristics. I have noted several different ways of forming iconic descriptions; gestures describing similar actions therefore may vary within and between different groups of apes. On the other hand, some gestures that are physically very similar are shared between signing and non-signing apes; these may be hitherto little known "natural" (species-typical) gestures elicited by a relevant social environment, or might be iconic gestures that are similar in appearance because they describe similar material.

The fact that some of the gestures performed by signing apes resemble those of apes in the wild 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 (Pinker, 1994; Wallman, 1992). The accumulation of evidence does not

support Pinker's and Wallman's idea that signing apes do not really use sign language but only adapt their "natural" gestures. "Natural" or species-typical gestures are of course used by symbol-taught apes, but they may elaborate upon them and have opportunity to use them in a greater variety of contexts than do apes in the zoo or the wild. In addition to innate species-typical gestures, it should not be surprising that apes with different upbringings might invent gestures similar to each other's, given a common iconic ability, similar anatomies, and similar material to describe. Most important, though, signing apes do use a large vocabulary of standard sign language in addition to "natural" gestures and their invented gestures. Even when modified by ape hand anatomy, much of it is nothing like their "natural" gestures. Gestures resembling American Sign Language signs are not spontaneously formed by untaught apes, who use an extremely limited number of hand shapes compared to apes taught ASL.

The iconic gestures a signing ape creates are more numerous and elaborate than those of zoo captives, probably because of intensive exposure to symbolic modes of communication and interaction with humans. Recent findings show that "human enculturated" great apes develop the ability to imitate goal-directed actions and show perspective-taking skills, such as mirror use and referential pointing, whereas other individuals of the same species may not (Parker et al., 1994, presents extensive discussions of these topics). Such skills are frequent in humans and would be likely to be more utilized in apes with a good deal of exposure to humans. Iconic representation is, after all, related to imitation in that it is a form of mime, and often requires the taking of another's perspective (Mitchell, 1994; Byrne, 1995).

Signing apes and zoo captives have in common the way that they form their own gestural creations; action and location are the most prevalent descriptive elements used by both, even in inventions of the signing gorilla Koko that represent objects. This may be because of the gorilla's limited comfort with intricate hand shapes utilized in human sign language that would more precisely describe object shape, but are not suited to

gorilla anatomy. Alternatively, however, preference for action as a descriptive mode may be related to cognitive processing; the brain has specialized cells for visual reception of hand and limb movement, which respond most strongly to hand-object interactions (Perrett et. al, 1989). In Koko's own development, actions were depicted much earlier than hand-shape descriptions, and tracing of outlines of objects was latest to appear. In all these modes, the performing of invented signs was usually on appropriate locations on the body.

Tracing a shape in space is cognitively very close to drawing or writing (as noted by Edwards, 1979). Koko is able to paint depictions of objects that are correctly placed in their relative spatial and size locations and to select appropriate paint colors, but her paintings are not always detailed in reproduction of shape (for a photograph of a painting and its model see Patterson, 1985). Because the tracing of shapes for Koko seems to be most comfortably and extensively performed on the surface of her own body, there might also be a tactile element involved in some of her signs; the hand shape for *glasses,* for instance, might involve a tactile memory of touching the frames of glasses on one's head, or for *scarf,* the feeling of a scarf covering her head. Koko, in her learned ASL signs, was taught numerous signs for objects which were not touchable, or could not be touched by her: examples might be *clouds, sun, tree, house.* It is my impression that terms such as these are not among those incorporated into her most frequent spontaneously used vocabulary items. A survey of her learned ASL signs in this regard would be a valuable future project.

Though a tactile element is part of many of Koko's invented gestures, the input used to produce some of these signs was purely visual and involved transfer of a feature observed on someone else onto herself, as in her sign for *filmers/reporters* (tracing the outline of the straps of camera bags). Transferring features observed on someone else to one's own body is rather like touching oneself on a location observed in a mirror. For humans, feeling that one is actually tracing the outline of an object in a tactile manner

when putting it on paper has been shown to produce accurate and natural artistic depictions, even by those with no artistic training. However, most people instead perform the intermediary step of mentally representing, or visualizing, an object to oneself, *then* drawing it on paper (Edwards, 1979). In the zoo gorillas, tracing of motion on another gorilla's body is a frequent medium of requests for action. This tactile propensity may underlie many of the inventions of both the zoo gorillas and Koko. But if a model object is not present when Koko traces a shape on her body, the object must first be mentally represented, unlike immediate drawing from a model. The model was present when Koko first invented her "tracing" signs, but she also used them later in the absence of the original model.

A possible indicator of memory for complex sequences is the length of gestural utterances. If utterance length is related to memory capacity, this should be constant for apes whether sign-trained or zoo-living and this may be the case. The mean length of utterances is the same for zoo gorilla Kubie (in gesture) and for chimpanzee Nim (in signs). Koko, in sign, makes longer utterances than Kubie or Nim, and zoo subject Zura has the lowest utterance length. For both captive and signing apes, social and physical changes led to fluctuations in utterance length and overall quantity of gesture use.

Comparison of the spontaneously invented signs of a signing gorilla and gestures of zoo gorillas shows a continuum of representation, where a signing gorilla moves further than the zoo gorillas along a line that proceeds from behavior directed at immediate goals, to representation of desired action, to representation of objects. The same kind of sequence of types of representation is found in invented gestures developed over time by one individual signing gorilla. This kind of continuum might arguably duplicate a plausible sequence in the development of language early in hominid history. In the final chapter, I will elaborate on some ways ape gesture and human language might be related to each other.

Chapter 11
Summary of research and final discussion

Overview of the study

Analysis of data on visual communication of the gorillas at the San Francisco Zoo, collected throughout seven years of observation, has made it possible to address questions that arose the first day I watched the gorillas Kubie and Zura engaging in gestural dialogues. *What* were they doing? At this time, when my only previous close acquaintance with gorillas had been with signing gorillas, Kubie and Zura's behavior looked to me as if they were using some sort of sign language, but it was one with an unfamiliar vocabulary. Yet these gorillas had no exposure to or training in sign language. Still, it seemed that they were using their limbs to communicate information to each other that appeared important for them. I soon found that very little literature existed on any kind of gestural or other visual communication in gorillas, except for some information on chestbeating and male display. Yet Kubie and Zura's gesturing was elaborate and complex. If such behavior had not been noted by anyone before, perhaps it was not universal gorilla behavior. *Why*, then, did these two individuals at the San Francisco Zoo gesture so copiously? I determined to find out, and began the investigation that has culminated in this dissertation.

Classification and function of gesture

The question of *what* the gorillas were doing turned out to have several different facets. Gesture can be defined in many ways, so I began by sorting out several modes of non-vocal communicative action that could broadly be defined as gesture. Communication that is *audible* as well as visible is the most familiar to all students of gorilla behavior; chestbeating, knocking, slapping, clapping and pounding have been described for many gorillas and are generally accepted as species-typical actions. All the gorillas at the San Francisco Zoo certainly engaged in these behaviors. But several gorillas also made *silent*

gestures with their limbs in the space in front of their bodies, silent gestures on their own bodies, and gestural motions of the head. These silent gestures were performed when the gesturing gorilla already had a companion's attention and gaze, and promoted physical contact with the companion, in the form of wrestling and other touching. Further, when the gorillas were already in close contact they often touched each other's bodies in non-forceful ways, drawing a hand down or across another's body, or gently pushing or pulling. These *tactile* gestures promoted further cooperation from the gorilla receiving the touch. The receiver did not need to see the gesture, but still usually moved in the direction that a gesture delineated on its body. This resulted in bodies in position for mating play and "estrus checking," where a gorilla touches the ano-genital area of another gorilla and makes an olfactory inspection of the fingers.

What the gorillas were doing, then, was truly communicative, and communicative in specific ways. Tactile gestures drew paths of motion, and the silent gestures in space and on a gorilla's own body also depicted motion, usually toward the gesturing gorilla. Head motions also could be defined as gesture; they seemed to draw the other animal's vision toward the gesturer, or sometimes to one side or away from the gesturer. All these gestures seemed to be *iconic,* in their outlining of and thus depicting motion; I recognized them as such partly because of descriptions in the literature of similar gestures by chimpanzees and especially by pygmy chimpanzees (Savage-Rumbaugh et al., 1977). There were similar results for pygmy chimpanzees and gorillas in adjusting body position in sexual contact play, when iconic gestures took place in similar contexts. Other gorilla gestures seemed to be deictic, pointing out specific locations on the gesturer's body (between the legs, or on the shoulders), or in the environment. Gorillas "pointed" with a fist or knuckles rather than an extended index finger, and such gestures were sometimes audible. Equivalent gestures with a deictic or "pointing" function again had been reported in pygmy chimpanzees (Savage-Rumbaugh et al., 1977). Not all gorilla gestures were iconic or deictic; but audible gestures such as

chestbeating that are species-typical for gorillas were also subject to much variation and invention. For instance, one of Zura's gesture categories that I labeled *body beats* consisted of gestures that were variations of the motion and hand shape of chestbeating, but were performed on parts of the body other than the chest.

Although I first concentrated on understanding *what* the gorillas were doing, it eventually became clearer *why* they were gesturing. The gesturing was quite context specific, occurring in play in general as well as sexual play; this became evident when after two years of copious gesturing, Kubie's gestures stopped: play ceased and so did gesturing. At this time Bawang, the female who had previously been Kubie's preferred mate, came back to estrus cycling after being either pregnant or nursing for several years. Kubie's now serious behavior in pursuit of his mate (in the presence of an older male competitor) did not in any way resemble his behavior with the younger, inexperienced female Zura. I also witnessed several real matings of Kubie and Bawang toward the end of this period of pursuit. These observations, together with reading the literature and my observation on video of matings in other zoos and in the wild, indicated that mating between experienced partners did not involve inviting gestures by the male; instead, subtle signals by the female such as body posture or branch tossing led directly to intercourse. In contrast, every observation of gesture by the hands and limbs, in San Francisco as well as in other zoos, took place in playful and exploratory situations. In captive pygmy chimpanzees, as with these gorillas, the partners in gesturing consisted of a less cooperative partner and an older, more experienced partner (Savage-Rumbaugh et al., 1977). Gestures seemed to be used to work out a "problem" situation where a cooperative routine needed to be established. Further, in the San Francisco Zoo, where my observations were made, there were challenges for the young male silverback that do not exist in many other zoos (Kerr, 1993); there was another older mature male in the group, and several easy escape routes existed for the females if they did not want to be around the older males. The older male was readily

attracted by any noise on the younger gorillas' part, and would interfere in their play; thus silent signals were especially useful. All these factors help to explain *why* gestures might have been particularly necessary in negotiating social relations in this particular setting.

Development of gesture over time

The long-term nature of my observation allowed me to learn that gesturing of an iconic or deictic nature may be a developmental phenomenon; it appeared only at adolescence in the individuals I observed. Further, little gesturing of any kind was done by the oldest individuals in the group. When gorillas gestured, it served a social purpose related to cooperation and coordination, for gestures were rarely seen in situations like feeding conflict or dominance contests, where simpler, more direct, actions like approaches and stares seemed to serve. This basis for gesturing is perhaps not unique to the group I was observing. Captive chimpanzees presented with tasks requiring cooperation spontaneously used gestures to coordinate their activities (Crawford, 1937; Savage-Rumbaugh, 1986), and wild chimpanzees silently regulate their behavior in cooperative hunting through touch and eye contact (Goodall, 1986). Additionally, signing chimpanzees have been recorded to sign spontaneously to each other when humans were not present: the great majority of their communication in this case was social, involving adjustment of motion around their environment and contact, approach and position relative to others, but very little signing was about food or aggression (Fouts & Fouts, 1989).

Gorillas in my study group varied in repertoires of gestures; some gestures were shared with other gorillas, and some were unique to individuals. Nonetheless, the gorillas seemed to have developed a mutually *understood* system of communication, This was particularly striking in Kubie and Zura's interactions; their gestures often alternated in a turn-taking "conversational" manner and seemed to be used to make decisions about type, timing and location of play as well as simply promoting contact.

Kubie used most of the same repertoire of gestures he used with Zura in interaction with two other females in the group during other time periods years apart. His most frequent gesture types were all used regularly over a period of more than seven years, though proportions varied of the different gesture types used with each female. Apparently the different recipients were able to interpret his actions and responded favorably often enough so that it benefited each pair to establish such communication. The females too used idiosyncratic gestures of their own. Those gestures unique to one gorilla or another seemed to be related to individual differences in goals in play and different levels of interest in sexual activity. I have discussed in Chapter 4 several possible theories for how comprehension of gestures might be established between different individuals without a long learning period. I found that explanation by "conventionalization" or "ontogenetic ritualization" does not seem to fit, because new pairings of partners appear to so readily understand each other's gestures.

The fact that gorillas shared some but not all of the same gestures brings up the question of *how* gestures are initially established in a gorilla's repertoire. Though the capacity to imitate nonfunctional limb motions has been demonstrated in the chimpanzee, and orangutans imitate programs of several actions (Custance et al., 1995; Russon & Galdikas, 1993), imitation has not been formally demonstrated in the gorilla.[1] A spontaneously formulated experiment with Zura showed that she was capable of imitating human "gestural" motions that were not among her regular repertoire. Another indication of the gorilla's capacity to remember and reproduce actions comes from the observation of repeated sequences of actions, gestural and otherwise, by other gorillas in the group. Though they involved the imitation of self, not another, these

[1]Such extensive observations and so many anecdotal descriptions exist regarding the imitative abilities of signing and highly human-enculturated gorillas that some basic imitative abilities should probably be accepted for these individuals.

sequences show that the memory capacity necessary for reproduction of complex activities is available for the gorilla.

Other evidence speaks against imitation as a way of learning gestures. Though the gesture *armshake* was used by several members of the group, Kubie's son Shango, who at an early age watched many of the play sessions between Kubie and Zura during which armshaking was frequent, has never developed armshaking as a part of his gestural repertoire, and it has only very rarely been observed in his mother, Bawang. Many of the other gestures shared by two or more gorillas in the group are ones that are generally accepted as species-typical.

The process through which Kubie and Zura's gestures, whether shared or unique, first developed cannot be known directly because of lack of earlier data; but other inquiries can provide various kinds of indirect information on the development of gestures. The question of *when* gestures develop was addressed through observation of two infants (both males) born into the group. For both, the earliest gestures were audible ones produced by contact with a surface (ground, rock, tree or own body). New gestures appeared as the older brother, Shango, increased in age; as he became older, he began to use tactile gestures, but at age 6 still used neither silent gestures in space nor self-indicating gestures, as the young adults did. The earliest information available on Shango's father, Kubie, showed that nearly all his adult repertoire of silent gestures and tactile gestures was present at age 8, in the context of sexual positioning and sexual play with an older and uncooperative female. The great majority of Kubie's gestures at age 13, when I began regular observations, still took place in the context of play and sexual play with another uncooperative, but this time younger, female. Gestures between a adolescent male/older female pair observed at a different zoo (Appendix 2) were also in the context of negotiating for cooperation, along with mutual avoidance of an older silverback. When Kubie gestured in play with his sons, particularly with his older son at ages 5 and 6, silent and tactile gestures were less

common, and chestbeating and pounding gestures predominated for both father and son. Throughout the study there was very little gesturing between any other same-sex pairs, except for occasional display and threatening gestures. Therefore, it seems reasonable to theorize that silent and tactile gestures develop to further male-female relationships, and become prevalent when the need to facilitate these relationships arises.

Gestures and the playface

It was impossible to observe visual communication without noticing the relevance for gorillas of facial expressions and postures. Though these were not the focus of my research, it was important to distinguish the functions of gestures from other expressions. In particular, the topic of the function of the playface arose in the course of the analysis of gestures. I wanted to discover whether it had a function similar or different to that of some gestures. A playface frequently appeared simultaneously with some gesture types, but with other types it seldom appeared. Kubie had several gesture types with which the playface appeared more than half the time; these were all silent, visually received gestures that were frequently followed by contact with Zura. For Zura, the playface appeared less frequently with gestures; but when it did appear, it was with the same gesture types with which it also appeared frequently for Kubie. (An exception was Zura's gesture *hide playface,* that by definition included the playface; this combination was treated separately in Chapter 6.)

The idea that the playface was related to imminent contact was suggested by the fact that contact was more highly associated with the playface, whether appearing alone or with gestures, than with gestures alone. However, a direct approach by a gorilla almost always *preceded* the appearance of the playface alone (i.e., with no accompanying gestures), whereas gestures, alone or with the playface, were almost never preceded by approaches. Thus it appears that the playface is not a signal but a *response*, perhaps automatic, to an approach about to achieve contact. Gestures,

however, were often performed when no approach was imminent, and then were sometimes responded to by approach; gestures appeared to be enticements or invitations rather than responses. A further study of Zura's approaches to Kubie confirmed that in her own approaches, the playface occurred when her approaches were swift, open and direct, but seldom occurred when the approach was slow or out of Kubie's line of vision (thus perhaps not meant to be seen). The playface therefore seemed to be a response related to mutual recognition of impending contact, but not simply associated with approach per se. (Kubie seldom made "deceptive" approaches to Zura, so the same analysis could not be applied to his approaches and playfaces.)

The playface, though apparently an involuntary response, did potentially signal to another gorilla that contact was imminent. For Zura, contact with Kubie was not always desirable for numerous reasons; it could draw the attention of the other silverback, and Kubie, who was much larger and heavier, had the advantage when contact was made and sometimes played roughly. Thus for Zura, in spite of motivation to join in play, sometimes it seemed more desirable to avoid contact. She developed a way of canceling the motivation shown in her playface by using her hands, under more voluntary control than her face, to hide the open-mouthed facial expression. Some of her other gestures also seemed to be used deceptively, in that she would often make a gesture associated with play and then run away or hold back. Thus her rates of contact after gestures were lower than Kubie's, though for Zura a gesture such as *armshake* was still followed by a relatively high rate of contact compared to other of her gestures.

Invention of gestures by a signing gorilla: comparison to zoo gorillas

The formation of iconic gestures, for the zoo gorillas, involved tracing paths in space or on another's body with a hand or limb, or miming on one's own body an action desired of another. These are not the only kinds of iconic depiction possible, however. Other kinds of iconic representations are used in human sign language, and many of these are also found in the kinds of gestural inventions a signing gorilla, Koko of the Gorilla

Foundation, creates. These include miming the action that takes place upon, or is performed with, objects external to the body; the tracing of the shape of an object on one's body or in space; and the use of different hand shapes to represent similar object shapes, whether on the body or in space. For a signing gorilla, signs that make tactile contact with the body seem to be favored; I found that contact with the gorilla's own body was present in the great majority of the gorilla's invented signs, and taught signs were often reinvented in a form that touched her body.

The inventions of a signing gorilla and the gestures of zoo subjects had many features in common in physical formation, context, and function. Because all gorillas perhaps share basic representative abilities that include an understanding of depiction of motion, it seems likely that gorillas, whether captive or free-living, might arrive at similar forms of representation. To date there is no comparable body of information on gestural communication by gorillas in the wild. However, the data from this zoo group, along with information about gesture invention by Koko, a signing gorilla, allows some conclusions to be drawn about gestural communication that can most likely be generalized to other gorillas and other great apes. The results can also be applied in reviewing hypotheses about the evolution of communication and language, as I do below.

Discussion

The concept of gesture revisited

Research throughout this century has continued to reveal the special nature of the intelligences of the great apes. Communication has become an area of particular interest because of its bearing on the question of how early hominids might have developed language. Visual communication rather than vocal is the medium in which apes seem to approach most closely toward some aspects of language; apes have more voluntary control over, and more cortex area devoted to, the hands and limbs than to tongues,

vocal tracts, and facial expressions. The proficiency of all apes in learning human manual sign languages or other symbolic systems is well established and has renewed interest in the question of how apes use visual communication in their native settings or in captivity when not taught. Relatively recent acceptance by linguists that human sign languages are real languages just as spoken languages are has also increased interest in the visual communication of apes, and has brought about the realization that such communication provides insights about ape cognition.

The working definition of gesture used by Armstrong et al. (1995) in their work on the relationship between gesture and language is "a functional unit, an equivalence class of coordinated movements that achieve some end" (borrowed from Studdert-Kennedy, 1987). As in human sign language, a gorilla gesture will often move abruptly into another gesture without pause, or a gesture will gradually change its form until it becomes a different gesture. As with the real action that gestures represent, there is a constant flow of change, as input from the environment and other gorillas affects activity. Sequences of action in ape gesture such as Kubie's *tap other/armswing under/touch between legs* combination, a complete *agent/action/location* statement, provide an illustration of how the rudiments of syntax could have arisen from the action-based ordering of hominid manual-brachial gesture, as suggested by Armstrong et al. (1995). In this view, "language" might be the predecessor rather than the consequence of ordered programs of thought; action expressed in a social context is *de facto* communication. In my gorilla examples, action in the form of gesture has already taken on some characteristics shared with language such as:

(Language characteristics and definitions from Hockett, 1963, pp. 63-4; italicized comments are mine.)

1) semanticity (...ties between signal elements and features in the world; ...linguistic forms have denotations):
Iconic gestures are tied to, i.e. represent, real actions.

2) discreteness (the possible messages in any language constitute a discrete repertoire rather than a continuous one):
"Gesture types" can be separated and categorized, and the gorillas recombine them in numerous ways.

3) displacement (we can talk about things remote in time, space, or both, from the site of the communicative transaction):
Gorilla iconic gestures represent action desired in the future from another, and such action can be anticipated because it is stored in memory of the past.

4) openness (new linguistic messages are coined freely and easily, and in context, are usually understood):
Iconic gestures can potentially be created to represent any kind of motion in a three-dimensional continuum, and this motion seems to be readable by the receiver of the signal.

5) prevarication (we can say things that are false or meaningless):
Some gorilla gestures negate others (like Zura's hide playface*), and some deceive, as when Zura entices Kubie's approach with a gesture, then runs away.*

Thus, theories of language origins that see language-like gestures as predecessors of speech (Hewes, 1973, 1976; Kendon, 1991; Corballis, 1991; Armstrong et. al, 1995) appear to have support in the way that gestures are used by the gorillas of the San Francisco Zoo. Such gestures can not, of course, be "translated" as equivalents to the words of spoken languages, though it is necessary to try to give them some description in writing. They are in some ways closer to the signs of sign languages, in that signs do not always translate to words of spoken languages; one sign or gesture may encompass what would take an entire sentence in speech. One gorilla gestural string, likewise, may move in one continuous motion from the actor to the recipient, or from a location to the actor, thus becoming essentially one gesture, encompassing both deictic and iconic elements. "You come here" or "you go over there" or "you touch me on the foot" can be expressed in one continuous motion, both in gorilla gesture and in human sign

language. At the same time, though, the elements incorporated in a "gesture-sentence" can be separated and recombined, used singly or in a different combination. Speech does not combine words so seamlessly- or does it? When I say "c'mere," and most likely toss my head, raising my chin slightly, I am combining two separate words, *come* and *here*, into one vocal gesture, as well as including a facial one. It is quite likely that if I have eye contact with the person I am calling, I may also simultaneously make a manual gesture very much like one an ape might make, without consciously thinking about it. Human language can not be defined in terms of words alone, except on paper, a form in which it has existed only for a few thousand years in only a few cultures. Speech and gesture, on the other hand, have been inseparable as means of communication for unknown thousands of years. I find the gestures of apes to differ tremendously from human spoken and signed language in quantity and complexity of concepts expressed, but little in intrinsic quality of expression, except for the final overlay of speech.

Gesture: from apes to humans

An anatomical characteristic that underlies the gestural abilities of all the great apes is the rotational movement of their joints, a characteristic that humans share. Ape anatomy and the correlated ability to brachiate under tree limbs, as well as bipedal and quadrupedal walking, running and tree climbing, promote knowledge of the physical world in all dimensions. The locomotory adaptations that allow movement through trees also make possible subtle gestures of the hands and limbs (Morbeck, 1994; for ideas regarding the effect of ape locomotion on cognitive ability, Chevalier-Skolnikoff et al., 1982; Povinelli & Cant, 1995). The ability to function with precision in three dimensions may underlie a shared emergent ability of the great apes to depict motion iconically. To be able to anticipate complex actions in the course of locomotion is surely important for a brachiating animal in order to safely deal with constantly changing conditions in transferring from tree to tree. In a study of orangutan locomotion in relationship to cognition, Chevalier-Skolnikoff et al. noted that it was only during

brachiation that the highest cognitive abilities were required, when the animals "co-ordinated body-gravity-force-space relationships to achieve a goal" (Chevalier-Skolnikoff et al., 1982, p. 643). Techniques included bending and swinging supple "pole trees" across gaps in vegetation to reach other trees, building momentum by swinging first in a direction opposite to the goal, sometimes first unwinding vegetation binding trees, and sometimes using two trees, or a tree and vines, in tandem. Though they are much larger and heavier, orangutans used supports that were flimsy relative to their weight much oftener than did monkeys in the same habitat, and used multiple supports where monkeys used single supports (Povinelli & Cant, 1995). Many of these orangutan actions required manipulation of trees, branches or vines as "tools," often apparently anticipating the form of the motion that needed to be produced, as it took place unhesitatingly without prior experimentation. Iconic gestures are also an anticipation of action (not necessarily the gesturer's own) that the gesturing gorilla would seem to be mentally representing, then expressing through a kind of mime or imitation of previously experienced action, just as the orangutan may imagine or anticipate a tree's motion and act in ways that finally result in movement to a goal.

Because anatomy and behavior evolve in interaction with the environment, the contexts in which gestures most frequently take place are important in understanding what their ultimate function might be. Though the gestures I have observed in zoo gorillas were at highest frequencies in play and sexual situations, and pygmy chimpanzees in captivity used iconic gestures to settle on copulatory positioning (Savage-Rumbaugh et al., 1977), the reader may recall that Crawford (1937) saw the emergence of much gesturing in an artificial context where two chimpanzees had to cooperate and coordinate their movements in order to receive food rewards. Signing chimpanzees, when observed through remote videotaping with no humans present, conversed with signs and gestures about play, grooming, and other social matters but hardly at all about food and eating or discipline and dominance (Fouts & Fouts, 1989).

What all these situations have in common is the necessity of *coordination of movement* around the environment, or *cooperation in movement;* visual and tactile gestures proliferate when maintenance of close contact with another or closely coordinated movement is necessary for interaction to be successful. Cooperation between individuals in solving tasks that require coordinated activity has been observed in apes but not in monkeys (the information on this topic has recently been reviewed in Chalmeau et al., 1997). If theories proposing ape anatomy and locomotion as drivers for representational abilities are correct, one might imagine that cooperation between the ape body and objects, consciously engendered during movement within a complex locomotory environment, might evolve into gestural reproduction of movements that promote cooperation between ape and ape in social settings.[2]

I will now discuss some of the theories and scenarios that have recently been proposed for the evolution of language, and see how my findings about the function of gesture and observations of gorilla behavior fit with these speculations. The mother/child relationship has been proposed by some authors as the source of language in hominids (Borchert & Zihlman, 1990). Though ape mothers use some signals to get their infants to cooperate in getting on their backs so that movement is coordinated with the group, I have not found mother/child communication to be a frequent context for gesture in gorillas, nor a primary context in other apes. Neither is actual copulation a frequent setting for use of gestures; for captive gorillas, though sexual positioning in play involves gesturing, actual copulation is generally controlled by the female and takes

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[2]Povinelli and Cant (1995) suggest that as gorillas evolved more terrestrial locomotion, they lost higher cognitive abilities such as self-conception, that may sometimes be "turned on" under unusual circumstances during development. Without submitting a lengthy argument in this regard, I would like to suggest that my observations reported here show related cognitive abilities in gorillas to those Povinelli and Cant demonstrate for orangutans, but that gorillas may express them in different areas such as gesture.

place after direct postural signals rather than gesturing. The more experienced the female, the less prominent such signals are (Davis, 1990). In all cases where gestures have been observed in apes for sexual positioning, one of the partners has been inexperienced and/or uncooperative.

A currently popular explanation for the origin of language is the idea that language might have replaced grooming as the social currency of choice in hominids living in large social groups (Reynolds, 1981; Dunbar, 1992, 1993). Grooming is interpreted by Dunbar, as well as many others, as a social bonding process as well as a hygienic aid. If gesture is the structural foundation on which language was built, then gesture might well have been the first "language" that began to replace grooming. Over years of observation I have seen almost no grooming of (lowland) gorillas by each other in captivity; the little observed was between females and infants. In mountain gorillas, George Schaller felt that grooming was not a prominent activity. He rarely observed grooming between adults, and never between adults of opposite sex. Because in the few incidents observed, the grooming was in places not reachable on the self, Schaller had the impression that it was functional, not social. However, in the observations of Fossey (1983, and video records) mountain gorillas, whom she reported rarely to gesture, did extensively groom each other and sometimes even form "grooming chains" involving several group members.[3] For captive apes, there may be less of a problem with bothersome parasites than in wild populations, thus captives may simply have less need for grooming. Yet, in the San Francisco Zoo, for about a year the gorillas were bothered by something that caused them to scratch themselves continually. Though they often used sticks to scratch themselves, and self-groomed, they still were not observed to groom each other with any increased frequency. It may be that there is more gesturing

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[3]Byrne (personal communication, 1996) noted that in his observations there were periods when mountain gorillas groomed a great deal and other periods when they groomed hardly at all, implying a possible correlation with weather and parasite load.

in groups of apes where there is less grooming, and this would be an interesting study if there were some way it could be carried out. The relationship of grooming, sociality, and gesturing is an intriguing one, but at present there is no controlled observational research that would unequivocally support conclusions. I also find problematic Dunbar's (1992) use of an estimate of mean group size in gorillas in drawing statistical conclusions, because recent field studies on both lowland and mountain gorillas find group size to be extremely flexible and variable. His exclusion of any data points on orangutans makes great ape data incomplete in relation to the large number of monkey species he surveys, and his explanation of "true" group size in orangutans could be applied to other primate species as well (as in Clark, 1985).

Some theorists find a connection between the development of language and the use and making of tools or the making of constructions from objects (Greenfield, 1978, 1991; Calvin, 1982, 1993; Davidson & Noble, 1989, 1993; Reynolds 1993), while some find tool use an area cognitively quite different from language use (Wynn, 1993). Others have associated language origins with extractive foraging (Parker & Gibson, 1979; King, 1994) or hunting (Washburn & Lancaster, 1968), which are also tool-related areas of activity. There is probably some validity in all these approaches, because from the ape evidence, it does not seem that the development of language-like communication must be associated with a particular domain of endeavor. All areas where coordinated action between individuals is important could be contexts for gesture, and eventually language, use. As hominids became more engaged with inanimate objects as important features in their lives and livelihoods, objects probably became a part of the communicative context, as they have become for signing apes.

If we must isolate a particular context as a driver for language, my choice would be play. The great majority of gesturing in the gorilla group I studied was in the context of active play, whether the gorillas were in close contact, moving in and out of arm's reach of each other, or interacting at a distance. Modern theories of play tend to explain

the function of play as exploration of possibilities in the environment and honing of skilled movement rather than "practice" for specific kinds of adult interactions (Fagen, 1984, 1993). Fagen (1993, p. 182) defines play as "improvised performance, with variations, of skilled motor and communicative actions in a context separate from the environment in which behavior including these actions proximately increase reproductive success." Gestures are themselves skilled motor and communicative actions that promote interaction; in a sense, perhaps gestures *are* "play". In social play, the testing of strength and balance in relationship to others is a part of exploration. Thus coordination and cooperation are needed simply to make the contact with another required in order to engage in wrestling or sparring, and in order to continue contact without bodily harm to either of the players. In play involving exploration of sexual positions and estrus-checking, keeping the other's attention and proximity requires coordination and cooperation. And at a distance, exploration of the responses of another gorilla to one's gestures, whether auditorily or visually sent and received, is another exercise of the possibilities in the environment. Gestures are links between individual animals that further the achievement of interactive skills and mutual exploration.

The various hypotheses about the function of play are not necessarily mutually exclusive. Another hypothesis about the function of play is the "social skills hypothesis" originally proposed by Baldwin and Baldwin (1974). The idea is that animals through play build up skills of inter-relating that will help them in the future. Several studies in the field found that playing animals had a larger variety of behaviors for social situations than did non-playing animals (Baldwin & Baldwin, 1973; Berger, 1980; Chalmers & Locke-Hayden, 1984). Further support for this theory is found in a study of gorillas in three different zoos (Brown, 1988) where it was found that males played with both males and females, but females seldom played together. Earlier studies made similar observations (Freeman & Alcock, 1973; Fischer & Nadler, 1978). The same was true in

the San Francisco group. It seems that play is most likely with animals with whom relationships might continue in adult years (Brown provides support for this from studies with other speices), and through these play relationships more flexibility and knowledge of the partner is gained. Zura and Kubie seemed to be attempting to develop social skills that would allow them to interact successfully, though ultimately they did not continue to interact a great deal. Perhaps Zura's social difficulties with other gorillas after early human upbringing made interacting with her more of a challenge for Kubie than interacting with Bawang, thus the extensiveness or their play repertoire, including gestures.

Play is most frequent in the young, though it can continue to take place throughout an animal's life. The long post-infancy, pre-adult stages in primates allow the context of play to expand from its initial base in interaction between parent and young and juvenile peers to a later role in relations between the sexes. If gestures are related to playful exploration, then the dearth of gestures in older individuals in my gorilla study group may be related to the cessation of this exploratory phase, and the achievement of mature skills that need no further refinement. When changes in the environment demand new skills or further exploration, play and gesture may reappear. We recall that in a social situation where cooperation was lacking and in the absence of play, Kubie's gesturing almost entirely ceased, but began again when new social relationships took precedence. The oldest female, Pogo, after a long period of solitary behavior, began to gesture a little when she played with youngsters born into the group. Schaller (1963, p.248) states that "on the whole, gorillas are not playful," and saw almost no play in animals older than age 6 years. Perhaps because captive gorillas have less to contend with in finding and processing food and keeping together as a troop, play and exploration, and likewise gesturing, are more likely to appear and reappear throughout life, in captivity; just as for humans, if conditions allow, play and exploration can

continue throughout the lifetime.[4] Under physical and mental duress or when physical survival is at stake, however, playful behavior is unlikely .

As well as sharing anatomy of the joints and limbs, humans and apes share neural anatomy as well. In a review of comparative neuroanatomical information, Preuss (1994) notes that the ventral premotor area in nonhuman primates is homologous in location, structure and function to Broca's area, long implicated as an important area for human language production. Metabolic and stimulation studies have shown that in both humans and non-human primates this area represents fine facial and mouth movements *and* forelimb movements (Preuss, 1993). Evolution may have recruited this existing motor area for language functions, suggesting why manual signs can be language as well as can speech. Speech itself actually consists of fine "gesture" of the mouth and tongue (Liberman et al., 1967; Armstrong et al., 1995).

The relationship of the hand, arm and face to linguistic and motion-perceiving areas of the brain allows profoundly deaf human children exposed to no sign language to create iconic gestures to communicate (Goldin-Meadow, 1984). All children introduce nonverbal symbolic activity into object play around age 13 months (Bates, 1979), and some children produce referential gestures before they speak words. The earliest spontaneously invented gestures of a 14 -15 month old (hearing) human child were all iconic for actions, and the earliest refer to actions in play contexts: *slide*=a hand waved downward; *swing*=torso moved back and forth; *ball*=both hands waved; *fire*=waving of hand; *night-night*=head down on shoulder (Acredolo & Goodwyn, 1990). Further, children who are encouraged to use gestures, both taught and invented, before they are able to use speech, acquire speech more rapidly and develop larger

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[4]Brown (1988) found that in three captive groups she studied, gorillas continued to play fairly regularly until at least 13 years of age. In the San Francisco group, Kubie regularly had very active play sessions with his sons at the age of 20 years, and Pogo was 32 when she began playing regularly with infant Shango.

early vocabularies, both in output and comprehension (Goodwyn & Acredolo, 1993). In all children, gestures are used in tandem with the appearance of speech but are separate from speech until around the age of two years, when iconic gestures begin to accompany speech (McNeill, 1992). From then on, gesture is inextricably tied to language production. Gestures regularly precede "simultaneous" speech production by a fraction of a second (Kendon, 1980).

When gestures accompany human speech, the same side of the brain that is dominant for language (including sign language) is the locus for the production of gestures; but there is no such lateralization for similar non-gesture movements such as smoothing the hair, scratching, or fiddling with objects (Kimura, 1973*a,b*). Kimura (1976) and Kimura & Archibald (1974) proposed that lateralization is necessary for the programming of complex movements. Another study found that lateralization was present in production of iconic gestures and in another class of physically, but not necessarily mentally, simple *metaphoric* gestures. These, like iconics, present imagery, but of abstract concepts. However, lateralization was not present in simpler gestures (*beats*) made for pace or emphasis (Stephens, 1983). Thus it is not just complexity of movement, but what a gesture represents, that is related to its being hemispherically specialized and thus more language-like. Laterality for gestures has been found in pygmy chimpanzees (Hopkins & DeWaal, 1995).

It is likely that in the history of our hominoid ancestors, the earliest iconic depictions were of action rather than objects, as we find in apes and very young children. Because such iconic capacity is present in gorillas, and probably in orangutans, given their related ability to imitate and to use human sign language (Russon & Galdikas 1993; Miles & Harper 1994; Miles et al. 1996), it was most likely present 10 million years ago in the common ancestor of hominoids. Another indication of a language-like ability in apes is the alteration of signals given involuntarily, as in Zura's hiding of her playface and other instances of ape suppression of signals with the hands (as in DeWaal,

1986). Metacommunication, or comment upon one's own communication, accomplished with the hands, illustrates the degree of neurological control that the apes have over the limbs and hands in carrying out cognitively complex tasks, and some degree of self-awareness or self-conception.

Gesture may well be the structural foundation upon which language is built, and we can find in gesture the thread of evolutionary continuity between animal action and human language. Special means of communication like Kubie's and Zura's gestures, when they occurred in our ape ancestors, would certainly have achieved increased success for individuals in social, and ultimately, sexual, relationships. Such behavior would surely have selective value, and over generations result in iconic gestures becoming increasingly frequent and complex. Through the condensation of "real" activity to something representing it, in forms progressively more removed from the original, hominid communication may have over millions of years reached the "arbitrariness" that is a characteristic of human language, But not all of human language even today is purely arbitrary. We can still see glimpses, particularly in sign languages, of the development of language from the raw materials of action. The creation and usage by gorillas of a special repertoire of gestures gives us a window into the developmental processes and environmental pressures that might have lead to further refinement of iconic communication and its eventual expansion to human "gestures of the mouth."

Conclusion

I have documented here the extent of gestural communication by gorillas. The repertoire of communicative gestures for gorillas appears to be larger than has previously been reported in any one source of observations. One reason this is so is that the potential amount of gorilla gestures is not finite, but continuously variable. This is because of the faculty that gorillas, like other great apes, possess for iconically representing action. In addition to this, gorillas are capable of pointing out location to others, and of concealing or altering information they wish to withhold from another.

It seems that the faculty for iconic, deictic, and other manual expression of information may be developed to a lesser or greater extent depending on conditions of an individual gorilla's development and on the social and environmental opportunities and constraints that arise during the course of a lifetime. The setting in which gestures thrived in my study group, interaction in play, provided the opportunity necessary for propagation of creative behavior in the form of gesture, and this was enhanced by a social situation that presented a need for problem-solving. Further study of gesture in different groups of gorillas and other apes is needed, to confirm the conditions under which such communication is most likely to be created and to flourish.

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Appendix 1

Gestures and games

The largest numbers of gestures for the play of Kubie and Zura during *Study Period 1* were recorded in play sessions that had extended game-like contexts. These games had specific locations, frames and goals, and consisted of repetition of certain kinds of acts, often with exchange of roles. There appear to be similarities to the repetitive but varied turntaking games that are contexts for the development of early human caretaker-child communication (Bruner, 1983), especially in *tree tag, nest and stump chases, rock wall keepaway,* and *nest and mountain trading*. In *mating positioning* and *bag tug*, on the other hand, separate and differing roles were maintained by each partner. Descriptions of six games follows:

Mating positioning: Kubie attempts to touch Zura's bottom and to maneuver her and himself into a dorso-ventral mating position. This appears to take place in a playful and relaxed context, though at the very end Kubie's gesturing becomes increasingly urgent. Most of this time the two are sitting near some trees in a side by side position that Zura seems to prefer, but Kubie attempts to alter the situation. This lasts 13 minutes, with 53 gestures.

Bag tug: Kubie remains in his nest of bags while Zura attempts to "steal" a bag from him. He gestures invitingly to her and then wrestles her away. She tries to elude Kubie and make "sneak" attacks to gain an advantage. Kubie does not leave his nest, keeping one foot in it even when reaching out. This game lasted over 26 minutes, with 98 gestures.

Tree tag: Play centers around two trees and a stump between them. Kubie mostly stays in one place, his nest by the stump. The goal seems to be for one to tag the other, who

avoids tagging by remaining on the other side of the tree, and, if contact is made, to wrestle a little, with Zura usually soon retreating. The direction of pursuit, around one or the other of the trees, often changes after a tag. Zura also sometimes climbs partially up a tree and Kubie will then motion her down; she also sometimes runs away from the play site when Kubie is gaining the advantage, but returns after short breaks. If Zura leaves the area he may use an auditory signal such as pounding a tree. This session lasted over 12 minutes, with 50 gestures.

Nest and stump chases: A similar game to that above but in a different location, where Kubie remains in his nest in front of a large tree. Zura often makes her retreats to a stump located a few meters away, presenting her bottom toward him at this little distance. Wrestling as well as chasing is involved. This lasts over 10 minutes, with 60 gestures.

Rock wall keepaway: This game takes play in one of the large artificial rock waterfall structures that is perhaps 4 meters high and 8 meters on a side. There is a passage in the rocks only about a meter in height through which one of the gorillas will pass, and then he or she can remain either partially or fully out of sight of the other as desired. When one is on one side and the other on the opposite side, knocking or pounding frequently occurs, that sometimes results in a chase or exchange of places. This game lasted for ten minutes, with 30 gestures.

Nest and mountain trading: In this session, Kubie's nest of bags was located in the open grass about 2 meters from the base of the other rock waterfall structure (which is of similar dimensions to the one described above). During most of the session, Zura used the waterfall "mountain" as her retreat, often climbing to the very top of it. She would approach Kubie on his nest, or he would sometimes approach her on the

"mountain". Sometimes this would culminate in chasing or wrestling; other times the two would trade places, with Zura on the nest and Kubie on "mountain," until Kubie would approach or gesture. Toward the end of the session they remained apart, but engaged in extended exchanges of audible gestures, with Kubie near his nest performing elaborated, structured displays of varied combinations of chestbeating, bag and head twirling, clapping, and spinning. Zura joined in, remaining on the rock "mountain," beating her chest or other body areas, and using the artificial rocks to produce extra sound effects by foot-stamping. At times the sound and gestural displays were exchanged in dialogue-like fashion. This lasted for 45 minutes with 165 gestures.

Appendix 2

Transcription of videotaped observations

Rio Grande Zoo, Albuquerque, New Mexico, September 16, 1992

Gorillas are:
Marcus, 7-year-old male
Tommy, 6-year-old male
Samba, 27-year-old female
Moko, 27-year-old male

gestures are italicized

11:30 a.m. Marcus and Tommy are playing in a relaxed manner in the grassy yard. The yard has a deep dry moat in front of it that separates the gorillas from the public.
11:31 Marcus and Tommy separate. Samba, from the right, walks slowly over to Marcus, who is lying on his back. As she approaches, he gets up and faces her quadrupedally. They circle around each other clockwise until they have switched positions, make visual contact, and then Samba walks away to the left.
11:32 (after camera break) Marcus has walked past Samba, and *raised a foot back* toward her in passing. They pause facing each other. Samba approaches until they are only inches apart. Marcus reaches out and *tags her inner arm, bringing his hand back to himself*, then briskly walks past her, retaining eye contact as long as possible. Samba half turns, thus maintaining eye contact, then Marcus walks on, back toward his play location with Tommy. He sits apart from Tommy and appears to be gently *pounding his lap area.*
11:34 Moko, the silverback, appears to the right. Marcus gets up and moves left, off camera. *Chestbeating* and a bang is heard. Marcus moves right again, back on camera, and it can be seen that Samba is now sitting right next to him. Tommy walks toward and past Moko, with a *headshake.* Moko a has tense-lipped face and rigid stance.
11:35 Moko walks in front of Tommy still maintaining this posture. Marcus remains seated some 15 feet to the left. Tommy then "crutch walks," swinging himself by the arms, past Moko. Moko then advances toward Marcus, who gets up quadrupedally. Moko accelerates to a run, past Marcus to Samba, who has not moved. Marcus and

Moko both stand their ground, face to face, while Marcus concentrates on inspecting a grass blade and tossing it away.

11:36 Marcus slowly walks away to the left, appearing very casual- he wanders off, not in a straight line, glancing back a few times at Moko. Moko remains near Samba. After about 45 seconds, she gets up and walks away to the right. Moko *grabs one of her legs, pushes her away* and runs off to the left. She goes behind a rock wall structure.

11:38 Samba reappears and all seems calm, with gorillas separated and feeding on grass.

11:40 Marcus moves behind a rock wall.

11:41 Tommy goes and sits on the edge of the moat a moment, then goes down in it.

11:42 Moko looks intently at the wall Marcus has gone behind, then walks toward Samba and lies down on his stomach facing her at about 15 ft.

11:43 Marcus walks to within inches of Moko's rear end and plucks grass. Moko shows no reaction. Then Marcus stands bipedally and sways, *hits toward* Moko without making contact, then moves off in front of him and past Samba. Again no reaction from Moko. As Marcus moves past Samba, she makes a small *"come"* hand gesture toward herself. Marcus proceeds past and in front of her then seats himself facing her. He appears to *pound his stomach or lap* but unclear as his back is to the camera.

11:44 Marcus *slaps the ground*, and Samba gets up and walks away from him, going behind a rock wall. Marcus remains seated, gently *pounding his stomach*, for several minutes.

11:45 Marcus climbs up the rock wall, and Samba emerges from behind it and goes to the doorway of the indoor enclosure. Marcus descends and sits, with more *stomach pounding*. Also just plays with grass, *claps*, and several times puts his head on the ground, raising his bottom. Looks several times toward Samba in doorway.

11:49 Moko walks slowly toward Marcus, stares at him for about 30 seconds, then walks past Marcus and behind rock wall and lies down.

11:51 Marcus gets up and walks purposefully into moat, and it can be seen that Samba has just preceded him.

11:58 (unfortunately the camera has been following Tommy, when it is realized that Samba and Marcus can be seen in the moat, from only one very obscure and uncomfortable angle at the window.) Marcus and Samba are seated facing each other in the moat, about a foot apart. Marcus *armcrosses* around his chest, *flings his arms out* and with a playface contacts Samba, who at the same time has *extended her arm* to him. He mouths her wrist briefly. Both pause and look up, perhaps having just noticed the camera. Then Samba *touches Marcus' side*, bringing her hand back toward herself.

Marcus *pounds his stomach*. Samba *reaches between his legs* and then he moves forward so that the front of his body contacts her side.

11:59 He has moved away a little. Samba moves herself a bit closer. Then Marcus moves behind her and *pounds his stomach*. Samba half turns toward him.

12:00 Marcus stands quadrupedally, staring at Samba, both making eye contact. He *turns his head* from her toward himself, she *motions toward herself*. He *head nods,* rises bipedally, makes an *upward* gesture, *armcrosses, upward* motion again. Samba *reaches up* to him and he sits down in front of her.

12:01 Samba lies down on her back in front of Marcus, raising her feet to her stomach. (Now unfortunately the camera moves to Tommy, who is interacting with a visitor at the window.)

12:03 The camera operator notices that Marcus and Samba are mating in the moat, face to face, and rapidly returns the camera to the moat. Samba is holding on to her feet which facilitates the position for Marcus.

(Then, the camera oprerator inadvertently switches off the camera, thinking he is switching it on. The camera is off for one minute.)

12:04 Marcus and Samba separate.

12:05 Both are sitting. Marcus has returned behind Samba and is *pounding his stomach*.

12.06 Marcus lies on his back in front of Samba, and raises his legs. An erection is visible. He grasps his penis for about 10 seconds, then Samba grasps it for a second, then he gets up and moves away.

12:08 (camera break) Tommy runs down into the moat with a minute *armshake*, towards Samba. She gestures *away.* Tommy then runs to Marcus, who *armcrosses* and *extends a palm*. Tommy contacts Marcus' palm, then runs away.

12:12 (camera break) Marcus moves up the moat to a seated position in front of Samba. For the next three minutes, Marcus alternates sparring with Tommy with *stomach pounding* in front of Samba.

12:16 Tommy has disappeared. In front of seated Samba, Marcus gestures *up, armcross, slaps her head,* and *stomach pounds*.

12:17 Marcus lies on his back in front of Samba, grasps his penis area, and *extends* the other *palm* to Samba, who does not move. Marcus continues to grasp his penis. He then *flings both grasped hands above his head,* rises bipedally moving *hands to his genital area, armcrosses* and *beats sides of arms*. Samba *extends the back of her wrist* to him. He touches it with his mouth then sits. A few seconds later, he lies on his back again, one hand at his genital area.

12:18 No response from Samba after another *armcross* and *up, other hand at genital area.* He shoves her with both hands, then moves off and *stomach pounds* nearby. Samba gets up and leaves moat. This ends the sex-related play session. After all return to grassy area, Moko reappears from behind rock wall.

Appendix 3

Koko's invented signs: first 10 years

(signs from Patterson & Cohn 1990, analysis of iconic characteristics my own).

Key: IS: iconic for shape of object
IA: iconic for an action
BL: indicates body location of referent
CMT: crossmodal transfer from English sounds
D: deictic; pointing
U: unknown derivation
FA: functional action

O: object
A: action
D: deictic

gloss in English and classification	**physical form of invented sign**	**type of iconicity or other type of reference**	**kind of representation**
apricot O	"A" handshape with motion like "peach" sign (hand brushed down cheek)	crossmodal transfer from English sound as well as compounding signs	CMT
barrette O	index finger draws line forward above ear where barrette is usually placed	draws shape of object, also places on body location	IS, BL
bird (notice) D	index fingers, held together at tips, point to location of object of interest that is out of reach	deictic	D
bite A	teeth bite side of index finger	iconic for action	IA
blew-it A	loud exhalation: blowing sound directed at offending person	crossmodal transfer from English sound	CMT
blow A	blows on index finger held vertically in front of mouth	iconic for action	IA

gloss in English and classification	physical form of invented sign	type of iconicity or other type of reference	kind of representation
body hair O	fluffing up hair on the body by rubbing both hands up and down on body	indicating part of body	BL
bracelet O	cupped hand encircles and pats wrist	iconic for shape of object, placed on body location	IS, BL
clay O	palms together, move back and forth in circular rolling motion	iconic for action, on customary body location	IA, BL
dental floss O	pick index on teeth plus *thread* sign (two little fingers touch then move apart horizontally)	iconic for shape and action, on body location	IA, IS, BL
drip-chin A	mime with index the action of liquid rolling down chin	iconic for action, on body location	IA, BL
dripping A	index imitates motion of dripping liquid on cheek	iconic for action	IA
earphones O	thumb and index of both hands move down body from ears	iconic for shape of object, placed on body location	IS, BL
eye makeup O	index finger strokes horizontally across eyelid	iconic for action, placed on body location	IA, BL
fake-sneeze A	imitates sound and motion of sneezing	iconic for action	IA
fake-tooth O	taps upper or lower rear tooth with index	body location	BL
fang (Halloween toy) O	tap lower canine teeth with hooked index fingers	iconic for shape of object, placed on body location	IS, BL
filmers, reporters O	thumb and index of both hands move down body where camera straps are located	iconic for shape of object, placed on body location	IS, BL

gloss in English and classification	physical form of invented sign	type of iconicity or other type of reference	kind of representation
frown O	lower lip pulled down over chin with fingers	iconic for shape, placed on body location	IS, BL
glasses O	thumb and index pinch at temples	iconic for shape of object, placed on body location	IS, BL
grate A	imitating motion of grating a vegetable; fist moves across palm of other hand	iconic for action	IA
hair bow O	index and thumb of both hands placed on head	iconic for shape of object, placed on body location	IS, BL
inhale A	index from mouth down to stomach	iconic for internal path of an action in body	IA, BL
kiss-hand A	kiss on hand	iconic for action	IA
long hair O	index fingers trace hairline from ears to below shoulder	iconic for shape of object, placed on body location	IS, BL
man, male *(foot)* O	taps bottom of foot with index	unknown	U
nail file O	tip of bent index moves back and forth across finger of other hand	iconic for action, placed on body location	IA, BL
note (something in environment) D	moves index horizontally across lips before pointing to something	unknown	U
obnoxious QUALITY	knock sharply on wall or floor	crossmodal transfer from English sound "nox"	CMT

gloss in English and classification	physical form of invented sign	type of iconicity or other type of reference	kind of representation
pickle O	thumb and index extended from both fists held in space in front of body	outlining shape of object	IS
poke A	jab with index	iconic for action	IA
poke-stomach A	poke stomach with index	iconic for action on body location	IA, BL
puppet O	open hand moves down over fist of other hand	iconic for action (putting hand puppet over hand), placed on body location	IA, BL
runny nose O	index traces path of liquid running from nose	iconic for action	IA, BL
scarf O	palms of open hands down sides of head	iconic for shape, body location	IS, BL
scraper O	fingers of open hand make scraping motion across other hand	iconic for action	IA
sip A	tips of index and thumb touch lips	iconic for action, body location	IA, BL
smooth QUALITY	smoothing motion of open palms up legs	iconic for action	IA
stethoscope O	index fingers in ears	iconic for shape, body location	IS, BL
strangle A	hands grasp neck	iconic for action, on body location	IA, BL
thermometer O	puts extended index finger under arm	iconic for shape, on body location	IS, BL
tickle A	index makes tickling motion under arm	iconic for action, on body location	IA, BL

gloss in English and classification	physical form of invented sign	type of iconicity or other type of reference	kind of repres-entation
turn-around A	open hand brought around from one side of waist to other on other's body	iconic for action	IA
unattention STATE	palms of both open hands placed over face	functional action	FA
under-eye makeup O	index moved horizontally under eye	iconic for action, on body location	IA, BL
unlisten STATE	palms cover ears	functional action	FA
Viewmaster O	one hand open palm like *mask*, other hand thumb and index at eye like *camera*	compound sign at body location	BL, IS
walk-up-my-back A	in seated position, hands placed behind back, palms up, and bounced	iconic for action, on body location	IA, BL
walk-up-my-bottom A	arm with open hand swings under body between legs	iconic for action, on body location	IA, BL
woman (*lip*) O	rubs index horizontally back and forth across lips	unknown derivation	U