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Triadic and collaborative play by gorillas in social games with objects

Joanne E. Tanner · Richard W. Byrne

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Abstract Interaction with others over objects has until recently been thought lacking in the social play of non-human great apes, in contrast to that of children; even now, only bonobos have been observed to engage in social play involving objects. Human children's triadic interactions with objects involve joint attention, showing and giving, communication that maintains interaction, and sharing of emotions and experiences. We question assertions that chimpanzees, and non-human great apes in general, lack the key characteristics of children's collaborative play. Here, we show that zoo gorillas play games that are both triadic and collaborative. These games were videotaped at the San Francisco Zoo in five different years and involved five different pairings of gorillas. The context was in most cases playfully competitive, involving objects such as balls, bags and leather pieces as foci of joint attention; the ostensible goal in most games was to gain or keep possession of a particular object. In some episodes, roles as possessor or pursuer of an object were exchanged many times; in others, one gorilla retained possession of an object but encouraged pursuit from a partner. Through gaze and gesture, gorillas invited others to: share interest in and attention to objects; share patterns of play; and re-engage after breaks in play. Sometimes, gorillas would assist others in their efforts to engage in collaborative play: older gorillas encouraged younger partners by 'self-handicapping' their own actions. Collaborative games may occur later in the ontogeny of gorillas than in humans, and depend on the challenges and artifacts available in a particular group's habitat.

Keywords Great ape · Communication · Object play · Triadic interaction · Joint attention · Intersubjectivity

Introduction

The development of joint attention to outside entities that begins around 9 months of age in humans has been suggested to be a uniquely human process (Tomasello et al. 2005; Tomasello 2008). Often, joint attention is considered to be related to the acquisition of language, but recent studies have shown that joint visual attention can be dissociated from human vocabulary acquisition in some cultural settings and in atypical human development (Akhtar 2005; Akhtar and Gernsbacher 2007). Human infants are seen as progressing through several stages of attentional engagement (using definitions paraphrased from Tomasello et al. 2005; Tomasello 2008): *dyadic* (interaction with and responsiveness to another individual); *triadic* (shared goals and perceptions with other individuals regarding outside entities); and *collaborative* (shared goals and intentions including coordinated action plans, with complementary and potentially reversible roles). Attempts to re-engage a recalcitrant partner in a particular kind of interaction are considered evidence of shared goals: the goal being to engage in the activity together (Tomasello et al. 2005). Since it is unlikely that we can ever know in any objective manner the precise intentions, perceptions or goals of animals (or even young human infants), the Tomasello criteria

J. E. Tanner · R. W. Byrne (✉)
Centre for Social Learning and Cognitive Evolution and Scottish Primate Research Group, School of Psychology,
University of St. Andrews, Fife KY16 9JP, Scotland, UK
e-mail: rwb@st-andrews.ac.uk

Present Address:
J. E. Tanner
3071 Dover Drive, Santa Cruz, CA 95065, USA
e-mail: gorilvr@cruzio.com

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for 'triadic' and 'collaborative' engagement will be somewhat reshaped for our purposes here.

Dyadic interactions are commonplace in many species of animal; shared attention during social play with objects has been observed in some canid, psittacine, and corvid species (Burghardt 2005; Diamond and Bond 1999; Fagen 1981). However, the manner in which the non-human great apes (hereafter, apes) engage in triadic and in particular collaborative interactions has become a topic of broad research interest (Carpenter et al. 1995; Gomez 1991, 1994, 1996; Leavens et al. 2008, 2009; Leavens and Racine 2009; Melis et al. 2006; Pika and Liebal 2006; Pika and Zuberbuhler 2007; Tomasello and Rakoczy 2003; Tomasello et al. 2005; Tomonaga 2006; Warneken et al. 2006, 2007). Orangutan object play seems to be discussed rarely and if so, any information is found in anecdotal form. Our discussion will thus chiefly be limited to African apes. Though we include apes in various captive settings, we do not discuss symbol or sign-taught apes, as their abilities may not be relevant to the natural propensities of apes that have not experienced extensive interaction with humans.

Most social interaction involving objects has been proposed in apes to be competitive, in contrast to the human case, since competition for food and sexual resources is an important part of ape life (Hare and Tomasello 2004; Tomasello et al. 2005). In human children, cooperation is manifest at an early age in playing social games, and the play context has been examined in both species of chimpanzee, using humans as partners. Warneken et al. (2006), studying chimpanzees (*Pan troglodytes*) in an experimental situation pairing humans with zoo chimpanzees in cooperative activities devised by humans, found that their subjects "…were uninterested in the social games," and that when the human partner withdrew from a game, no chimpanzee made any communicative attempt to re-engage the partner. In contrast, Pika and Zuberbuhler (2007), studying sanctuary-raised bonobos (*Pan paniscus*), described non-competitive games between bonobos and humans in which the apes showed joint attention to outside entities and used a variety of actions to attract a reluctant partner back to the game. In the games they describe, the possibility of competition was absent: in two of the games, the "object" shared was water, where splashing was the desired result; in the others, the human and the bonobo were physically separated by fencing so competition over possession of an object was not possible.

Social play with objects has also been observed between bonobos in the wild, at the Wamba site, with extensive observations by Ingmanson (1996). She found that 45% of the 47 bouts of object play she observed during 270 h of observation targeting object play were social play with objects. Social object play began around 3 years of age when infants began to leave the mother for play with peer groups. Ingmanson makes a division of such play into two categories, "play directly with an object and play where the object functions as an intermediary (Ingmanson 1996, p. 200)." Direct object play consisted of activities such as wrestling with an object, tug-of-war and keep-away. In other play, an object, usually a small stick, was used as an initiator of play, or in chases to indicate the leader who was "it." The possession of the stick was not an issue; play partners would stop to wrestle, dropping the stick, and play would resume only when one animal picked up the stick and ran off. Thus, the stick appeared to be a social tool or means of communication that play was the activity to occur. Play with an object as intermediary was more frequent than play directly with an object.

Tomasello et al. (2005, p. 686), referring to chimpanzees, state: "They do not look to others and smile in order to share experience triadically, they do not invite others to share interest and attention via declarative gestures, they do not inform others of things or help them in their efforts, and they do not engage with others in collaborative activities with shared goals and joint intentions." This is surprising considering that bonobos do seem to utilize many of these elements mentioned; however, a major species difference may not be involved because, the Warneken et al. (2006) study notwithstanding, there exists early evidence of chimpanzee object play with mutual visual attention in a natural setting. Plooij describes a chimpanzee "individual takes an object… and starts running away from another individual while looking back at him or her. This other may then rise and run after the first individual…" (1978, p. 122). Triadic interaction in non-play contexts in chimpanzees has been widely reported, as early as the Crawford (1937) study; and see Leavens et al. (2009) for a thorough review of deixis. Collaborative hunting, social alliances and territorial patrolling are also well-known examples of shared activity in chimpanzees in the wild (Goodall 1968, 1986; Boesch and Boesch-Ackermann 2000). Warneken et al. (2007), in an experimental setting, found that young chimpanzees helped human experimenters to gain out-of-reach objects without reward, exhibiting spontaneous helpful behavior. Social play, our focus here, seems unlikely to be an area of exception regarding shared interaction; perhaps chimpanzee social play with objects has been under-reported.

Here, we report the first data on triadic and collaborative interaction in social games among western gorillas (*Gorilla gorilla*) not influenced by human participation. For gorillas, several reported anecdotes have suggested that playful interactions with objects may be a fertile area for detection of shared attention and collaborative activity. Schaller describes a frequent "king of the mountain" game played by juveniles using a stump or a bush as a central location defended by the current protagonist (Schaller 1964). Redshaw and Locke (1976) describe the play of two 3-year-old nursery-reared male gorillas "able to initiate and

maintain as well as construct a considerably complex set of games using both fixed and moveable apparatus. The favorite object of the moment is a 'bread tray' which they use as an obstacle around which to chase: both of them replace this in an upright position if it should fall during their energetic games (1976, p. 84)." Dian Fossey writes: "The fruit (mtanga-tanga, a hard grapefruit sized fruit) served as a football, soccer ball or baseball for all of group 5's young, according to which type of game was initiated…" "…Effie's young did go out of their way to climb high into trees supporting the fruits and knock them to the ground for play purposes (Fossey 1979, p. 79)."

Gomez (1990, 1991, 1996) illuminated the development of joint visual attention in gorillas by charting a zoo nursery-reared female's successive attempts to solve a problem of opening a latch too high on a door for her to reach. The gorilla's solutions involved a human companion and progressed from forcefully dragging the human to the door where the gorilla could climb on him (at age 1 year), to the use of a tactile gesture of pulling him gently by the hand while alternating her gaze from the human's eyes to the latch or simply waiting for the human to act while looking from the human's eyes to the latch (age 18 months onward). At this stage, the gorilla also used gestures and vocalizations to ensure the human's visual attention before engaging in a request. Gomez points out that this use of eye contact did not really make any difference in the success of a request; but joint visual attention meant that the person, even in refusing a request, would continue attentive engagement, exhibiting emotional expressions both facially and verbally, and so might the gorilla before giving up (Gomez 1991, 1996, 2004). In this way, both parties gained information about each other's mood and what opportunities might exist in the current context for further mutual influence. Gomez leaves open the question of whether gorillas might use referential gestures with *each other*; that is, seek to direct others toward targets, with the aim of getting them to do something in relationship to a target. In our previous study of the gesturing of gorillas (Tanner and Byrne 1996, 1999, 2006; Tanner 2004), we have noted that in their gestures gorillas do 'point out' locations and body parts to each other in the course of their interactions.

Gomez (2004) suggests that apes may also direct others' attention in ways different from human children's referential gesture. In human children, gaze following, mutual gaze and gaze alternation between a social partner and an object have been supposed to be benchmarks of the developmental stages leading to full triadic engagement. There are other ways to share attention, however, even in humans. Studies of "normal" development in children of European cultures may have overshadowed interest in other ways of attending, such as awareness of vocal and postural cues, and tactile and vocal contact that maintains interactions (much of this work summarized in Akhtar and Gernsbacher 2007, 2008). Research on apes indicates that they may also, in addition to gaze direction, share attention in unsuspected ways, like whole-body orientation (Menzel 1973), vocalization (Gomez 2004) or production of other sounds such as beating or pounding (Tanner 2004). The face to face interaction of human mothers and infants, often cited as deficient in quality in apes (Carpenter et al. 1995), is virtually absent in some human cultures and may be related cultural norms as well as to infant-carrying methods; Gusii mothers in Kenya only looked toward their 9- to 10-month-old infants in 1% of their acts toward them in contrast to 43% of the acts of Boston mothers (LeVine et al. 1994, p. 197).

In studies of the development of intersubjectivity in human children, interaction between mother and child has been the usual focus. In the present study, we report on evidence of joint attention, triadic interaction and collaboration between gorillas in play settings that include both adult and juvenile subjects. The previously published studies on ape triadic play have involved chimpanzees or bonobos interacting with humans. There has been little study of gorilla triadic cooperation or collaboration in any setting, our own gesture studies notwithstanding, and there is not experimental evidence as there is with other apes. In our current study, in any case, there was no human involvement or encouragement, only expression of natural behavior among gorillas. The spontaneous activity we observed was not subject to external rewards nor constrained by physical barriers, as in the Pika and Zuberbuhler (2007) bonobo study, that might generate directed attention-getting activity such as pointing (Leavens et al. 2005, 2008).

Methods

Subjects and setting

At the time of the observations presented here (1989–1995), the subjects were members of a stable social group of seven gorillas, all of whom had spent all or most of their lives at the San Francisco Zoo. The individuals who took part in the seven scenes described were the following: male Kubie between ages 13 and 20 years; female Bawang between ages 9 and 12; female Zura between ages 7 and 12; and male Shango (offspring of Kubie and Bawang) between ages 3 and 6. Kubie and Shango were mother-reared in the San Francisco troop; Bawang and Zura were reared in zoo nurseries at Cincinnati and Columbus Zoos, respectively, and transferred to San Francisco Zoo before each reached age one and a half years. All are subjects of previous observational studies, particularly of gesture (Tanner and Byrne 1993, 1996, 1999; Tanner 2004).

The San Francisco Zoo's present gorilla enclosure has been this group's home since 1980. It has an outdoor area of 2,300 square meters, measuring 38 by 50 meters at maximum dimensions, covered with grass and other vegetation. Large, climbable live trees are present, as well as several dead trees, large stumps, and two artificial rock "hills" including arches and cave-like areas. The enclosure is below ground (i.e. viewer) level, except for one windowed viewing area where gorillas and humans can interact face to face. The circumference is surrounded by a concrete drainage ditch.

The scenes presented here show interaction over burlap bags, leather pieces, and hard rubber balls. In this group, "Boomer™" balls of several sizes had been available for play since JET began observations in 1989. The female Bawang and her first offspring, Shango, both interacted with balls regularly. Shango had been exposed to ball use from birth; Bawang played with balls frequently in his presence, both indoors and out: rolling, bouncing, and balancing upon them in solitary play. Shango was an "only child" until the birth of a brother four and a half years later, and a ball became his constant companion, carried with him much of the time. His solitary play with it was extremely varied: dribbling it ahead of him, tossing, bouncing, throwing, balancing his body on it, and juggling with both hands and feet. Zura also interacted with balls, mostly carrying or throwing them, or using them to sit or stand on in order to access out-of-reach objects. The oldest gorillas (Bwana, Pogo and Kubie) were all adults when the balls were introduced and did very little ball play (personal comm., gorilla keeper Mary Kerr). Pieces of heavy, cowhide leather were also introduced to the enclosure, replacing heavy burlap bags that had been provided until one gorilla ingested bag material and developed a digestive ailment. Gorillas moved these leather pieces around for use as seats on the sometimes wet grass or hard rock areas, and also frequently used them in play.

Data recording

In the course of a study of gestural communication among gorillas, JET videotaped play sessions that involved the attention of two gorillas to a single play object. Seven sessions ('games') were chosen for study here (see Table 1); these were the most extensive instances of triadic play, though not the only ones, found in JET's video corpus. The length of a game was defined by the start of interaction over an object and the end was when both gorillas left that object completely to go onto other activities. The stated length of each game (Table 1, column 1) is the time of the uncut video that was filmed; however, actual interaction time may have been longer because the camera was sometimes stopped when there was no action occurring. Video of all the games is posted on JET's website http://www.gorillagestures.info and can by request to the first author be made available on a DVD with the time numbers used in this analysis. Also, on the website can be found descriptions and video examples of gestures mentioned in this analysis.

Analysis

From repeated viewing of video, the 7 sessions were each written up in narrative form (see "Appendix") in terms of the same set of aspects: *the theme of the game*, *starting the game*, *maintaining engagement*, *re-engaging after pauses in game*, *ending the game*, *indications that the game focused on a particular object*, and *gestures used*. These descriptions are not intended to be complete accounts of all interactions, but rather present each game in terms of comparable descriptive categories.

We focused on behavior that has been considered indicative of triadic and/or collaborative engagement when seen in human interaction, including behavior considered significant for triadic play in previous studies with chimpanzees and bonobos (Warneken et al. 2006; Pika and Zuberbuhler 2007). We define these descriptive categories, below, in terms of comparable gorilla behavior that we observed; categories are not necessarily mutually exclusive. We have altered some terminology that is of questionable usefulness because of its cognitive assumptions and used simpler behavioral terms. Within narratives, instances of each category are each indicated by the two-letter code and a numerical time indication from the source DVD.

Joint activities JA

Gorilla play partners engage in joint activities with a shared object and appear to have shared goals, though competitive ones. For example, they might compete to retain possession of a particular ball and promote the continuation of the game through exchange of roles (as possessor or chaser) of the object. A key indicator of the mutuality of play schema is that the same game "topic" is resumed even after substantial pauses in action where continued possession of the object in question does not appear to be urgent.

Gaze alternation GA

A gorilla moves its gaze from play object to partner and back, or from partner to object to partner. More alternations may occur in some cases.

Gestures used during a game GG

A gorilla uses gestures that regulate and maintain action during the game.

Table 1 Summary of gorilla social games

Game, date, length in minutes players, play object	Shared activity that defined a game Code JA* Type of interaction	Number of changes in possession of object	Gaze alternation(s) between object and partner Code GA*	Gestures used during games Code GG*		Other-oriented actions with objects (show, display, give) Code OA*
			A number after a time notation indicates the number of gaze alternations beyond a minimal 3-part Partner–Object–Partner or Object–Partner–Object; i.e. +5 would mean OPOPOPOP or POPOPOPO	Total number of gestures–gesture types in order of frequency. *Indicates a frequent gesture that has been shown to motivate play in previous studies by Tanner and Byrne (1996) or Tanner (1998) when used by a particular individual. +Indicates a gesture found by Genty and Byrne (2009) to regulate play; individual usage not specified.		
Game 1 2/27/89 27 min Kubie, 13 Zura, 7 burlap bag	Both participants attempt to gain or retain possession of burlap bag Asymmetric roles, control by Kubie	11 seizures by Zura but not complete possession of bag	Kubie (between bag and Zura)** 0.21(+7) 1.47 (+2) 2.22 (+1) 3.12 (+2) 3.45 (+5) 12.18 (+3) 12.30 (+1) 13.27 24.20 (+1) 25.27 (+2)	Kubie 45 Zura 47	Kubie: **head nod-14, *armswing under-11, *tap other-8, *armshake-4, hand below (between legs)-1, *chest fist pat-1, head turn-1, elbows hit knees-1, down-1, pat off-1, *+chest beat-1, +backhand pound-1* Zura: **armshake-16, hide playface-3, tap teeth-3, +chest beat-3, +body beat-3 (crossed arms on shoulder and upper arm-2; stomach-1, wrist glance-3, hands behind back-2, below (hand between legs)-2, rub lip-1, +slap other-1, down-1, foot back-1, bite finger-1, go-1, pat off-1, come (extended palm)-1, +backhand pound-1, circle hands-1, +slap surface-1, tap other-1*	3.45 rips bag noisily with gaze alternation 12.41, 26.19 K wraps bag around waist as Z looks on 17.20, 22.02, 24.19 K shakes bag in front of Z 17.03, 24.10 K wads up bag and holds it close to chest when Z approaches
Game 2 6/24/90 18 min Kubie, 14 Bawang, 9 burlap bag	Participants exchange possession of burlap bag Collaborative	14	Kubie (between bag and Bawang) 30.30 (+2) Bawang (between bag and Kubie) 30.15 32.21 33.23	Kubie 36 Bawang 33	Kubie: **+chestbeat-10, *head nod-5, head twirl-5, +body beats-5, +hit head (backhand)-3, *brush hand toward (tactile on other)-2, chest knock-1, fold arms-1, clap-1, *down (tactile)-1, *armshake-1, head shake-1* Bawang: *+body beat-18, clap-4, head twirl-2, fist to mouth-2, hands shield head-2, pat off-1, +slap surface-1, head shake -1, clap feet-1, down-1*	27.42 B puts bag over her head then K approaches to play 28.12, 29.57, 30.16 B gives bag to K 29.58, 42.40 K puts bag on his head 30.04, 33.51, 41.40 K puts bag on B's head, she takes it 30.32, 33.48, 41.10, 42.00 K twirls bag in mouth 31.04 K spreads bag out over chest and head, beats on it 31.38 B shakes and twirls bag in mouth 32.22 B twirls bag in mouth, lets it drop, K takes it 32.42 K rips bag and covers head entirely with it 36.51 K spreads bag out over chest and beats on it 37.22 B shakes bag in mouth 39.29, 41.29 K shakes bag in mouth

Table 1 continued

Game, date, length in minutes players, play object	Shared activity that defined a game Code JA* Type of interaction	Number of changes in possession of object	Gaze alternation(s) between object and partner Code GA*	Gestures used during games Code GG*		Other-oriented actions with objects (show, display, give) Code OA*
Game 3 8/31/92 9 min Bawang, 12 Shango, 3 ball	Both participants attempt to gain and keep possession of ball Collaborative	5	Shango (between ball and Bawang) 45.30 (+1) 50.04 (+3) 51.40 (+1)	Shango 1	*+slap rock-1*	45.31 (1x), 45.40 (4x) bounces ball with sound effect, looking down at B in grotto below 45.46 stands on ball and slaps rocks above, B gets up 50.03 S holds ball out with hand on it 51.40 S holds ball on feet, looking toward B 51.53 S runs toward B with ball, rolls it past her
Game 4 2/25/94 14 min Kubie, 18 Shango, 4 leather piece	Both participants attempt to gain or retain possession of leather piece Asymmetric, control by Kubie	4	Shango (between leather and Kubie) 53.32 Kubie (between leather and Shango) 54.22 1.00.53 (+2) 1.01.01	Kubie 3 Shango 2	Kubie: **turn around (tactile)-1, *armshake-1, +slap rock-1* Shango: *+pat ground-1, +slap leather-1*	(No obvious displaying of leather by K to S)
Game 5 3/18/94 8 min Zura, 12 Shango, 5 several balls	Alternating the role of sitting, standing or beating on a ball, and inviting partner to approach Collaborative	7	Shango (between ball and Zura) 1.10.17 (+1) 1.11.19 1.12.14 (+2) 1.13.15 (+1) 1.13.31	Zura 7 Shango 8	Zura: **armshake-3, +beat on ball-2, +chestbeat-1, away-1* Shango: *+beat on ball-4, +slap ball-2, clap-2*	1.07.40 S throws 2 balls simultaneously past Z 1.11.16 S rolls, bounces and drums ball repeatedly in his hands in front of Z 1.12.16, 1.12.34 S drums on ball, watching Z 1.13.34 S sits on ball and slowly slaps sides, looking at Z 1.14.37 S drums on ball as he rolls it away from Z
Game 6 20 min 6/2/95 Zura, 12 Shango, 5 ball	Both participants attempt to get and keep possession of ball Collaborative	9	Shango (between ball and Zura) 1.15.20 1.25.54 1.26.04 (+4) Zura (between ball and Shango) 1.15.16 (+1) 1.25.15 (+1) 1.25.36 1.27.04 (+1)	Zura 6 Shango 2	Shango: *tap other-1, +slap stump-1* Zura: **armshake-2, +chestbeat-1, +slap stump-1, +slap ball-2*	1.15.20 with gaze on S, Z throws ball in front of him into drainage ditch 1.23.45, 1.24.17, 1.24.40, 1.25.01, Z makes noise with ball and approaches closer and closer to S while he sits and plays near Kubie (not all on camera at same time) 1.25.10 Z holds ball up in front of S 1.26.03 S rolls ball slowly on ground toward Z, stops the ball in front of him until Z moves then he scoops it up quickly and throws into ditch 1.27.02 as S watches Z moves away slapping ball, continues as he approaches
Game 7 6 min Kubie, 20 Shango, 6 leather piece	Both participants attempt to get or keep possession of leather Collaborative	4	Shango (between leather and Kubie) 1.35.57 (+3) 1.36.07 1.38.30 (+1) 1.39.11 1.39.19 1.39.42 (+2) 1.39.50 (+1) 1.40.08 (+5) 1.40.33 1.40.45 1.41.10 (+1) Kubie (between leather and Shango) 1.36.38 (+2) 1.37.50 (+1) 1.40.45	Kubie 20 Shango 5	Kubie: **+chestbeat-6, head twirl-2, circle hands-2, *head nod-2, punch at (away)-2, *armshake-2, head shake-1, down-1, +body beat (lap)-1, clap-1, brush between legs-1* Shango: *+chestbeat-2,+beat leather-1, +slap leather-1, clap-1*	1.36.01 S puts hand on leather while gazing into K's face 1.39.35, 1.40.00 S displays leather in mouth 1.40.38 S bites, shakes, leather and spreads it out in front of K, S puts hand on it 1.41.16 S folds leather, spreads it out in front of K, claps and jumps onto the leather

* Code for this behavior in narrative descriptions

** Numbers are time of occurrence in accompanying video

Other-oriented actions with objects OA

A gorilla gives or displays with a target object to a partner; "display" implies action beyond, but including, the showing of an object, i.e. twirling, shaking, ripping or bouncing, sometimes involving a sound effect.

Help others HO

A gorilla effectively assists a partner in its effort to participate in joint action during a game, by altering its pace to synchronize with the partner's abilities or by physically assisting the other.

Re-engage partner RE

After a partner has stopped participating entirely or moved away, the other gorilla actively approaches and invites renewed interest, through gestures or by giving, showing or displaying with the object that has been the focus of the game.

Results

Table 1 outlines the occurrence of the most frequent of the target categories of behavior; for a fuller picture of the co-occurrence or behaviors and flow of action, the reader is referred to the narrative descriptions in the "Appendix".

Activities defining the game: shared goals

Each game was defined by shared, goal-directed behavior (Table 1): that is to say, a game was identified if, without *both* participants sharing certain goals, a game would be impossible. For instance, while both might strive to gain possession of an object, each gorilla's individual aim is evidently to continue the game jointly, rather than simply to win. In all cases we analyzed, "winning," did indeed not seem to be the goal of either individual, but rather the maintenance of the particular kind of interaction. Shared goals also seemed present at a more detailed level within these games: see "Appendix" for these cases in the narrative descriptions, coded JA.

In most of the games, each gorilla held possession of the target object at different times (the number of role reversals, i.e. changes of possession of object, are also given in Table 1). In games 1 and 4, one of the gorillas retained the play object almost exclusively but encouraged interaction by showing off the object to the other gorilla, promoting continuing engagement with the object.

Gaze alternation: looking back and forth from another to the play object

We recorded gaze alternation, minimally, when a gorilla looked at a play object, then to the face of the play partner, and then back to the play object (OPO); or looked at the face of the play partner, back to the play object, then to the face of the play partner (POP). However, longer sequences of alternating gaze were also noted; as many as five back-and-forth alternations were observed (see Table 1).

Gaze alternation was seen to a greater or lesser degree in all games analyzed (Table 1). In Game 1, the gestures *arm-swing under* and *head nod* (Tanner and Byrne 1996) were often used consecutively by Kubie, standing on a piece of leather and moving his gaze to that object below him. We may have underestimated the frequency of gaze alternation in Game 2: the gorillas' positions, seated in close face to face proximity, meant that gaze alternation required little more than slight eye movement. Often, one gorilla's back was turned to the camera, or the bag was held up obscuring one of the gorillas' faces, or one or both gorillas were partially obscured by the rocks and sometimes were lying down.

Use of gestures

Gestures were recorded in all games analyzed (see "Appendix", where gestures are italicized in the narrative descriptions, and Table 1, where those used in each game are listed). The number and variety of gestures recorded inevitably depend on the definition of gesture: we used Tanner and Byrne's (1996): "discrete, non-locomotor limb and head movements that appear to be communicative;" or when tactile, "transformations of purposive behaviors so that they are no longer mechanically effective." However, actions performed with an object in hand, forceful actions and whole-body actions have also been defined as gestures by others (e.g. Pika et al. 2003; Genty et al. 2009); so by those standards, we have considerably underestimated the number of gestures. The two games in which both gorillas were older adolescents or adults (games 1 and 2) showed the highest frequency of gestures, with a similar number for both partners. In Tanner and Byrne's (1999) previous gesture study at the San Francisco Zoo, the young adult gorillas gestured far more than juveniles or the oldest gorillas.

Tanner and Byrne (1996) and Tanner (1998) studied the nine most frequent gestures of two of the gorillas also studied here: adult male Kubie and adult female Zura. For male Kubie, all were significantly associated with the occurrence of body contact play within 5 s of a visually received gesture, or in the case of a tactile close gesture, movement of the partner in the direction of the gesturer's movement, or for audible gestures, a high rate of change of gaze direction

or of current activity. For Zura, who when playing with Kubie was usually the subordinate partner, not all of her gestures had the same effects as Kubie's, but several did. Those same play-promoting gestures by Kubie and Zura were found in the games presented here: in Table 1, we have marked with an asterisk (*) where these same two individuals used gestures we have previously analyzed. These gestures were among those most frequently performed by the two and presumably were used for the activation of play in the games in which they were used.

Genty and Byrne (2009; see also Genty et al. 2009) used a different definition of gesture and thus split and lumped gesture types differently than Tanner (1998, 2004); only a few gestures from their large corpus can be compared here. However, some of the gestures they found to regulate play were also among the gestures in the games we describe here. Those were *chest beat, body beat, slap object, drum object* (the latter two are our *slap*, or *beat* object), and *punch object* (our *knock* or *backhand*). These are indicated in Table 1 with a plus sign (+). Genty and Byrne identified the functions of these gestures by overall usage by gorillas at four different study sites; thus we can reasonably say that these gestures also functioned in the San Francisco group to regulate and re-engage gorilla play partnerships.

Showing, giving, displaying: other-directed activities

In treating cases where a gorilla "displays" or gives an object to the partner (see Table 1), we are following up on Tomasello et al. (2005; Tomasello 2008) "informative actions." Tomasello (2008, p. 85) considers informative actions to be early evidence of a motive to help others, and in the play setting such actions serve to show awareness of the other individual's possible interests and needs. Because we cannot, however, know of informative intentions through observation alone, we prefer to call such instances "other-directed activities." Since these actions include an object, they generally do not overlap with gestures as we define them here. Game 2 gives particularly clear examples of exchanges between partners where one gives the bag to the other, rather than the other taking it by force. Many of these exchanges are preceded, accompanied by, or followed by gestures, including chest or body beating, or clapping, often simultaneous with the action and often synchronous between partners in its timing. In Game 3, 3-year-old Shango unsuccessfully attempted to get his mother to play again after she had been distracted by another gorilla, by making three different attempts at attracting her with the ball (see Table 1 and "Appendix"), changing his first actions to different ones when initially unsuccessful. In Game 4, Shango pursued the contested piece of leather avidly, though Kubie did not particularly seem to be showing it off to Shango. Being much larger, Kubie could simply sit on the leather; but in fact, he encouraged pursuit by moving and running away with the leather whenever Shango pestered him. In Game 5, several smaller balls were involved as well as a larger one which can be sat or stood upon. The small balls were shown or thrown toward the partner: this did not lead to play with those balls, but rather seemed a signal (as per Ingmanson 1996) to start wrestling play or to go to the large ball as 'home base.' Game 6 included lengthy pauses in which one of the pair completely disengaged from the game; yet the game resumed when one gorilla showed, threw, beat, or approached with the ball. During some of these pauses, the ball lay nearby, but only when one gorilla picked the ball up and displayed it to the other did the game restart. In beginning Game 7, Shango put his hand on the leather while staring intently at Kubie's face for several seconds. He could thus monitor Kubie's reaction to an attempt to get hold of the leather, but might also be indicating the option of starting the game by an indicative gesture to the leather (see Leavens et al. 2005, 2008 on conditions conducive to ape pointing).

Helping others to participate in joint action

Evidence of a gorilla slowing its pace or otherwise helping a younger gorilla was only obtained in two games, where there was a wide age disparity between partners. In Game 3, 12-year-old Bawang played with 3-year-old Shango. Early in the game, Bawang twirled as she ran with the ball, slowing her pace as Shango pursued, then she walked, not ran, back to the rocks; a little later, she twice stopped and waited for Shango to catch up. She also appeared to give Shango a push up as he tried to get up on the rock table. Later in Game 3, Shango seemed to be trying to make it easy for Bawang to rejoin the game after she had been distracted by an intruding Zura: he held the ball out with his hand on it as Bawang came walking by; and when she was next to him, he removed his hand and let the ball roll slightly toward her. (This attempt at getting her to re-engage, if that is what it was, was unsuccessful.) In Game 5, 12-year-old Zura played with 5-year-old Shango. When Shango rolled the ball ahead of him at a run, Zura followed, twirling slowly and armshaking, then mildly accelerated to a playful lope, always pacing herself to stay behind Shango. Though such self-handicapping is not unusual in animal play in general, it seems worthy of noting here since in human child development responsiveness to the partner is a characteristic not only of dyadic interaction but contributes to maintenance of collaborative play.

Attempts to re-engage when one partner stops participating

Instances of attempts to re-engage in a game when a partner stopped participating occurred in all games, in some cases

even after one or both of the participants had left the play scene for a minute or more. Gestures, gaze, and other-directed actions with an object were all used in these situations. Given their abundance and variety, we have not attempted to quantify the frequency of attempts at re-engagement, but refer readers to the narrative descriptions where each game description has a section entitled "Re-engaging after pauses in the game" ("Appendix"). Here, we present only a few examples in which re-engaging acts such as gestures are italicized (see "Appendix" for video reference numbers).

Game 3

After Shango climbs to the rock "table" with the ball Bawang remains below sitting on the ground. Shango *noisily bounces* the ball on the rock then stops, facing Bawang, and they mutually gaze for about 10 s. He *bounces* the ball a few more times, then stands bipedally on the ball, stretches both arms up and *slaps* the rock wall above. At this, Bawang stands up bipedally and grabs at the ball, but misses because Shango snatches it right up. He rolls the ball off the rock, then he jumps off himself and grabs the ball from the ground; pursuit from Bawang follows.

Game 4

Toward end of the game, Kubie takes the leather to the top of a rock formation and there is a substantial pause when Shango stays below. But Shango eventually climbs up, reaches up from below and *slaps* the leather K is sitting on; action soon resumes.

Game 5

Shango and Zura wrestle and chase, both leaving the area where the large ball is. Shango returns, running while looking back at Zura, to *beat* and sit on the large ball. Zura comes near and pauses behind a tree. Shango gets off the ball and *beats* on it. Keep-away and wrestling follow, then both leave the ball again. Zura runs off, then Shango goes to the ball and after looking back twice at Zura and *putting his hand on the ball*, he climbs up on it. They sit a while a little way apart, then Shango looks over at Zura and *slaps* his hands on the ball 10 times. Shango moves the ball next to a tree, keeping his gaze on Zura, and as he climbs up on the ball Zura approaches *armshaking*. Shango jumps off the ball, and they wrestle.

We would also draw attention to Game 6, in which Shango left his ball game with Zura on five occasions to go sit or play with 18-year-old male Kubie. Other interruptions also occurred, when both partners went indoors together or when Zura went indoors alone. Nevertheless, and even though some of these interruptions were minutes long, mutual play with the same ball resumed and continued throughout a 20-min episode (see "Appendix" for detail of re-engagement activities). Because the partners returned to the same manner of play after each pause, it seemed to indicate that both had a concept of this particular game and continued it.

Discussion

During episodes of social play with objects, the gorillas studied here showed abundant evidence of behaviors that in human children are taken to indicate triadic or collaborative interaction. Other behaviors seen in children (pointing, for example) were rare or absent, but sharing of attention occurred in numerous ways nonetheless.

Gaze alternation between a play object and a partner was frequent; in addition, gorillas sometimes laid a hand on an object while holding the partner's gaze. Such gaze alternation does not unambiguously signal joint attention by both participants towards an object: instead, alternating gaze might function to get a partner's attention and direct it to an object, to check a partner's level of attention or interest in a particular object, or simply to check a partner's proximity or movement toward an object. However, gaze alternations by the playing gorillas often consisted of several cycles of alternation; and in these cases, shared experience is more clearly implicated because repeated glances are not necessary simply to check the partner's interest or mood. Deliberate gaze aversion was also an important part of play. Often, the aim seemed to be to achieve surprise, by deception: where one gorilla would look off vacantly in a direction away from the play object, then suddenly snatch it up, or slowly approach obliquely or from behind. As with iterated gaze alternation, these patterns clearly suggest a 'triadic' focus of attention on both partner and object.

Gesture was utilized in all the games to encourage ongoing action and to regulate the tempo of the game when a gorilla so desired (see Genty et al. 2009 on the regulatory properties of gorilla gesture). Some games involved substantially more gesturing than others, particularly the two games where both partners were adults. The adult gorillas in this group performed more gestures in general, and a greater variety of gesture types, than the juveniles (Tanner and Byrne 1999).

We recorded numerous instances where one partner re-engaged another in the same game after a break in play, sometimes even when the partner had already begun to interact with a different gorilla or had completely left the area. Re-engagement, just like continuing engagement, was often stimulated by gesture, gaze, or by or actions with the play object. The gorilla's expectations were particularly

clearly indicated in the many cases where an object was deliberately held up and shown to the social partner, or sometimes shaken or thrown. When a partner did not respond readily to such encouragement, an increasing variety of gestures and enticing actions was used, as has been reported in orangutans attempting to communicate to human partners (Cartmill and Byrne 2007); see particularly Game 6 around 1.27.00. In several cases, an older gorilla appeared to slow its pace or style of locomotion, specifically when playing with a younger gorilla, apparently thereby enabling it to participate.

The gorilla games we studied were mostly 'competitive,' in the superficial sense that the game was a series of interactions over possession of objects; however, "winning" did not seem to be the point, but rather continuation of interaction over the object. A particularly telling illustration is found in Game 6 (1.16.55). Here, competition to keep possession of a ball occurred in spite of the fact that the gorillas had run to an area where there were two other balls of the exact same size; the gorillas completely ignored the other balls to continue pursuit of the ball one of them had been holding. The *collaborative* nature of the competitiveness in these games is also shown by pauses during the games, where partners seemed to agreeably rest, sitting near each other with the ball or other object nearby but with neither touching it. Suddenly one or the other gorilla would resume the game by snatching up the ball. As in Ingmanson's (1996) bonobo observations, the object sometimes seemed to be an intermediary tool to keep the play going, rather than something to be played 'with.' This is quite different from the competitiveness seen in the same gorillas, for instance, in the pursuit of highly desirable food such as apples scattered in their enclosure. In such cases, where the aim was clearly to gain the most food, no pauses occurred until the food was all captured (JET, personal observations). In one game, there was not even much semblance of competition: Game 2, between two preferred mates, Kubie and Bawang, who eventually produced three offspring. The passing back and forth of a burlap bag was mostly spontaneous and was accompanied by synchronicity in gestures and body-beating rhythms.

There were frequent role reversals between partners in some games, but other games were asymmetric in that one partner retained the object of interest most of the time. All the games we studied were *triadic*, with the participants appearing to share perceptions of and attention to outside entities; and most were also *collaborative*, with shared behavior patterns, coordinated action, and complementary and reversible roles. However, in two of the games, partners played asymmetric roles; thus, these games were not fully collaborative. In human children, triadic interactions appear at 9–12 months, and collaborative interactions at 12–15 months (reviewed in Tomasello et al. 2005), whereas the gorilla interactions we recorded took place between juveniles and young adults or between a young adult and a juvenile. Though JET has observed this group of gorillas over a period of nearly 20 years, triadic interaction between a mother gorilla and a very young infant in a play setting has not been seen. The earliest evidence of triadic interaction in play with an object in the current study is Game 3, where a gorilla mother played a ball game with her 3-year-old son. The same juvenile went onto play triadic and collaborative games with various other partners when he was aged 4, 5, and 6(see Table 1). It may be that the competence underlying triadic and collaborative interactions develops more slowly in gorillas than in humans.

Even allowing for such a developmental delay, our results for gorillas contrast sharply with those reported for chimpanzees interacting with humans in play with objects. Warneken et al. (2006, p. 641) state that "…chimpanzees were uninterested in the social games" in an experimental situation pairing humans with zoo chimpanzees; such was certainly not the case for gorillas playing with gorillas, here, nor in the bonobos playing with human partners described by Pika and Zuberbuhler (2007). In Warneken's data, "as an experimental manipulation (pairing human adults with human children as well as chimpanzees), in each task the adult partner stopped participating at a specific point during the activity. All human children produced at least one communicative attempt to reengage him, perhaps suggesting that they were trying to reinstate a shared goal. No chimpanzee ever made any communicative attempt to reengage the partner." Gorillas, as we have shown, utilize many varieties of communication to keep a partner engaged. We therefore cannot accept Warneken and co-authors' interpretation of their chimpanzee/human comparison "as evidence for a uniquely human form of cooperative activity involving shared intentionality (Warneken et al. 2006)" given the bonobo and gorilla evidence. We do not suggest that gorillas and humans are identical in their cooperative tendencies or intersubjective tendencies: gorillas do not smile and may seldom inform others about states of the world through declarative gestures. But, as we have shown, gorillas certainly can act to share experience triadically, and do engage with others in collaborative activities, inviting them to join in, helping them in their efforts to do so, and working to re-engage them by gesture and action if they desist.

It has been argued that intensive human-rearing allows non-human great apes to acquire parts of the human-unique cognitive competence, by cultural learning (Call and Tomasello 1996); but in the current case, this possibility is unlikely. Our two male subjects (Kubie and Shango) were reared exclusively by gorilla parents; the two females (Zura and Bawang) were zoo nursery reared with the intent to return them to gorilla families as soon as possible, which in both cases was achieved before 2 years of age. Possible

human influences on the two female subjects were not present for the male subjects, yet both males and females participated in collaborative play; and in two games analyzed here, both play partners were males.

Historically, it has been more typical for an ability claimed 'uniquely human' to be reported in the chimpanzee, and only later discovered to be a shared competence of all great apes (Byrne 1995). In the case of triadic play, the gorilla and bonobo show abilities sometimes thought unique to humans, but the chimpanzee's (and orangutan's) competence in this area is in question. Considering chimpanzee cooperative behavior in settings other than play (see "Introduction"), perhaps there just has not been enough observation. In addition, earlier chimpanzee studies such as that of Crawford (1937) hint at spontaneous abilities to encourage and engage a chimpanzee partner in a cooperative task through gesture, gaze and vocalization; recent replication by Melis et al. (2006) demonstrates the importance of social relationships in success at such tasks. In these studies, the task was provided by humans, but the social communications necessary for success were devised by the chimpanzees. This cooperation in mutually beneficial tasks should carry over to the context of play. Thus, because each of the three studies of great ape game-playing used a different social setting for their observations, firm conclusions about the evolution of intersubjectivity among the African ape species would at this point be premature.

Another unsolved question is how common or general we can expect triadic games and collaborative actions to be, among ape groups. At present, we do not know the answer and finding out will likely require long-term observations, since in our zoo group such games were not a daily occurrence and perhaps will only be seen when the social and physical setting in a zoo is conducive to such interaction. At the San Francisco Zoo, the gorillas grew up with a great deal of experience with the play objects we have described: e.g. the use of a ball was something with which all the gorillas were very familiar. Surely, the final quality and nature of apes' social interactions will be affected by the setting during their developmental years. Regularly available play objects to explore, plentiful space in which to move those objects, and familiar conspecifics with whom to interact are all factors favoring an ape's use of its cognitive abilities in social play.

In summary, gorillas engage with conspecifics in collaborative social activities involving objects; when they do, they perform many types of behavior that in humans are criteria for triadic interaction and experience-sharing. We hope that our observations encourage further study of the nature of social play with objects in a variety of species. Many conclusions about what animals do not do, in contrast to what humans do, are probably premature. We believe that observation of spontaneous interactions between members of the same species often tell us more about animal cognition than human-designed activities in laboratory settings.

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Appendix: Narrative descriptions of Games

Key engaging actions, including gaze and gestures, are italicized in the descriptions; key behaviors selected for analysis are indicated within narratives by the following codes (see "Method: Analysis for definitions"): Joint activities JA, Gaze alternation GA, Gestures used during game GG, Other-oriented actions with objects OA, Help others HO, Re-engage partner RE.

Game 1: 2/27/89

Excerpts from a 26.42-min episode. Kubie (K), male, age 13; Zura (Z), female, age 7.

Theme of game: (JA) Kubie, to retain possession of a burlap bag, Zura, to grab it. K tries to get Z to come and engage physically with him without leaving his burlap bag "base" for the duration of the episode. Z has a perch of her own on a rock perhaps 3 feet away to which she regularly retreats as her home base.

Starting the game: Scene begins with Z on a burlap bag, then tugging on the burlap bag as K puts his fists on it on the ground. He stays on it when Z lets go of it to wrestle; when she retreats to her perch he spreads the bag out carefully and stands on it quadrupedally.

Maintaining engagement: K stays on a neatly placed burlap bag as he entices Z to him from her rock perch with gestures and display; they intermittently wrestle. (OA 12.41; GG 0.52, 1.06; GA 0.25, 1.47, 2.22, 3.12, 3.42, 12.18, 12.30, 13.27, 24.20, 25.27) K turns Z around and pushes her back into her rock perch at 3.07 (JA; awareness of Z's home base as well as his.) Z *hides her playface* several times at the beginning of the interaction (0.13, 00.26, 0.49), regulating the onset of contact (as in Tanner and Byrne 1993). Another regulatory action by Z occurs at 9.10; Z places K's hand on the ground and holds it, presumably to keep it still instead of continuing wrestling, then presents her rear to him and he puts his hand to her rear.

K keeps at least one foot on the bag or holds it in his hands at all times and straightens and smoothes the bag between rounds of wrestling. Z gestures, frequently

armshaking, several times *presents her rear*, and makes several "sneak attacks" from behind as she persists in trying to snatch the bag, more and more frequently as the game progresses.

Re-engaging after pauses in game: (RE) Z goes away from K and turns her back, 3.15. At 3.45, K rips the bag open noisily (OA); Z runs past him to top of rocks, he grabs at her as she goes past but misses; he rips the bag more and spreads it in a semicircle around himself. Z stays on top of rocks and *chestbeats* several times, looking down where K is; at 4.48, K gestures from below. There are many short pauses where one or the other gorilla gestures from its base and then both resume activity around the bag GG, RE 5.19; 6.14; 8.32, 8.50; OA 12.41. After a rather long break, at 17.03, Z *armshakes, chestbeats*, and goes to K who immediately picks up his bag and hugs it protectively. After a break, when K has run from the rock play area to the grassy field, he returns to the rocks "wearing" the bag across his back, only picking it up with his hands when he returns to the rocks and Z, and then shakes the bag in front of her (OA, 22.02).

Ending the game: 24.56 Z is seen on top of the rocks. (GA 25.17) K carefully rearranges his bag in a semicircle around him, knocks on the rocks and looks up at Z and down at the bag. He waits, at 26.02 does a bipedal *jump, roar* and *chestbeat*. He looks up at Z again and waits; he sits, wraps the bag around him (OA 20.10) and looks up again. Zura does not return.

Indications that game focuses on a particular object: K always stays on or holds the bag. When Z's attempts to grab the bag accelerate, he holds onto bag instead of sitting on it. Z gets a grip on the bag 11 times and several tug-of-war sessions ensue, but she never gets full possession. K positions the bag within Z's reach, or *shakes it* in front of her (OA, 22.02, 24.19), or rolls it up and holds it protectively to his chest upon her approach (OA, 17.03, 24.10).

Game 2: 6/24/90

Excerpts from an 18-min episode. Starts 26.44, ends 44.10 on DVD. Kubie (K), male, age 14; Bawang (B), female, age 9.

Theme of game: (JA) Interaction with a burlap bag, non-competitive exchange of the object.

Starting the game: Though there has been playful interaction between Kubie and Bawang for at least 15 min prior to this episode, the bag game starts when K leans over the rock "table" with bag in hand, then drops it to put his hands on B. She sits back, picks the bag up, and *puts it over her head and wiggles around beneath it* (OA 27.42). K climbs off the table and starts to gently wrestle with B who is still under the bag. She removes the bag and hands it off toward K who takes it (OA 28.12), manipulates it a bit and then puts it over his hand and *pats B's head* with it while she *beats her stomach*; then he *play bites her head*. The bag cannot be seen for a while, though K seems to be wrestling something on the ground, possibly the bag or B's foot. The bag reappears, pushed by B toward K (OA 29.57); he puts it on his own head and shakes it (OA 29.58), then gently *smacks B's head with bag and she takes it* (OA 30.04), then pushes it toward K again (OA 30.16). The game continues with the bag being a prominent part of the action. The entire episode takes place in an enclosed area of the rock structure. The camera angle means that sometimes faces are obscured.

Maintaining engagement: The two gorillas sit very close, face to face, the whole time. There is turn-taking with the bag and with many of the gestures and other actions (JA). The bag seems to be passed voluntarily from one to the other (OA 28.12, 29.57, 30.04, 30.16, 31.43, 32.28, 33.20, 34.27, 38.28, 40.18): one gorilla will push it toward or put it on the other, or take it from the other without objection. The bag is displayed in repeating ways like *twirling in mouth* (OA 30.32, 31.38, 32.22, 33.48. 41.10, 42.00)*, head shaking* (31.38, 37.22, 39.29, 41.29) *and head covering* (27.42, 29.58, 31.04, 32.42, 33.51, 41.40, 42.40), and gestures of several kinds are shared and exchanged by both gorillas. There is much synchronization of actions, with rounds of simultaneous *chestbeating, stomach,* and even *foot beating*; and one round of beating is synchronous between partners even though K has put the bag completely over his head (32.37). A repeated element of the game is that after a bag display K playfully *hits at B's head*; she several times anticipates this by *shielding her head with hands* before K brings his arms down to hit (JA 30.39, 31.55, 32.28).

Re-engaging after pauses in game: (RE) At a brief pause, K *head nods* abruptly, directing his gaze from B to the bag, then shakes it (GG, GA 30.30; GA 30.15, 32.21, 33.23); B joins in simultaneous stomach beating and foot clapping. First baby Shango, then the older female Pogo, strolls by and peers into the game area. K and B mostly ignore Shango but when Pogo pauses in front of them, K stops playing and stares (35.38). B after a few seconds *beats playfully on his back*, and he rolls over with a *play-face* and starts wrestling gently with B again.

Ending the game: B rather abruptly leaves the rock area (43.02) and goes to sit in the doorway to the indoor quarters. (This appears to be related to an appearance at 42.10 by Pogo, who has been "babysitting" Shango; after this, B looks out toward doorway several times and seems distracted.) K continues to sit in rock grotto and *shake bag* and *chestbeat*, then goes out of grotto and looks toward B, bag still in his hand. She proceeds across grass followed by baby Shango, and the game never resumes.

Indications that game focuses on a particular object: Possession of a bag is exchanged 14 times between K and B and continually incorporated in displays and gestures. At several points, both cooperate in holding shaking a bag together (JA 30.20, 40.00).

Game 3: 8/31/92

Excerpts from a 9-min episode. Starts 44.10, ends 52.50 on DVD. Bawang (B), female, age 12; Shango (S), male, age 3.

Theme of game: (JA) To get and keep possession of a ball.

Starting the game: Shango appears with a ball, then disappears behind a rock formation followed by Bawang who was seated there. B emerges with the ball in one arm, *running and twirling whole body* with other arm as pivot, with S in close pursuit. The twirling serves both as a self-handicapping device slowing her down (HO 44.40) and allows B to meet S's gaze regularly.

Maintaining engagement: B goes up onto the rock "table" with the ball, looking back at S. S climbs up on the rock, B goes down the other side and disappears behind the rock arch, comes back up on the table rock again looking back at S, jumps down again and into the arch. Each time B goes onto the rock table, she stops, *looks, and seems to wait a moment* for S to catch up before going on (HO 44.50, 45.03). She seems to stage the game to allow mutual participation.

Re-engaging after pauses in game: (RE) After another disappearance behind the rocks where he appears to be grappling with B, S emerges with the ball and climbs up on rock table (G 45.30). Bawang does not prevent him climbing up though she easily could do so and even appears to help him (HO 45.27). She remains below his higher rock; he bounces the ball then stops, facing B, and they mutually gaze for about 10 s. He bounces it a few more times with audible noise, then *stands bipedally on ball*, *stretches both arms up* and *slaps upper rocks* (GG, RE). At this, B stands up bipedally and grabs at the ball, but misses because S snatches it right up. He rolls the ball off the rock, jumps off and grabs the ball on ground but B grabs him by the foot and he loses the ball; she wrestles with him and she gets the ball. (see next section for more re-engagement attempts.)

Ending the game: The game seems to end when B is distracted by another female, Zura. Z pokes at B (46.25) and B runs after her. S takes the ball and makes unsuccessful attempts to re-engage B with the ball game: S carries the ball with him down to the other end of the yard where B is and eventually (49.54) does a *running* display in front of her *carrying the ball in one hand and dragging a branch* with the other (RE), then stops and sits looking at her as she approaches, holding the ball and moving gaze twice from her to the ball (GA 50.04). As she gets close to him, he places a hand on top of the ball jiggling it slightly, still looking at her (GG 50.03), and as she comes right next to him, he removes his hand and lets the ball move slightly toward her, practically offering it to her (HO 50.07). She is still distracted and when she goes on past him, he immediately gets up and leaves the ball. A little later, B passes near S again; he lies on his back near Pogo with the ball held in feet, GA 51.40. When she passes by, again ignoring him, he *claps* both hands audibly on the ball and *runs toward her holding the ball, rolling the ball ahead of him* as he passes her (OA, RE 51.53). A moment later, they can be seen wrestling, with the ball on ground nearby. The camera leaves B and S but the ball can be heard bouncing on the rocks and can be seen there a moment later as S and B wrestle nearby. At this time, Zura retrieves the ball, ending S and B's interaction with it.

Indications that game focuses on a particular object: S lets the ball go and wrestles with B. They stop a moment, he seems to push her back, then runs to grab for the ball again. He has a hand on it for a brief moment but B takes it and they wrestle some more; during wrestling S reaches out and touches the ball a few times. When B uses both arms to wrestle, she keeps the ball between her feet.

Game 4: 2/25/94

Excerpts from a 14-min episode. Starts 52.50, ends 1.07.13 on DVD. Kubie (K), male, age 18; Shango (S), male, aged nearly 5.

Theme of game: (JA) Kubie: to retain possession of a piece of leather, Shango to grab it.

Starting the game: S runs up and grabs at K's leather, 52.51. K pulls it away, S runs and hits at K's hands and sits on the leather. K drags it away though S remains crouched on it for a moment, then K moves it away and stands on it himself.

Maintaining engagement: After K sits for a while, S *runs at him with a branch, hits him with the branch then with his hands.* K moves the branch, ignores S and continues to sit. S *looks at the leather, then up at* K (GA 53.32). When S *stretches out his hand and pats the ground* (GG 53.35), K runs away with leather, spreads it flat in drainage ditch, stands on it and fends off S's charge. S sits down nearby, both eat something in ditch for a moment, then K suddenly runs with the leather, *looking back at S* (GA 54.22). S chases, making several grabs at leather, K fends him off, finally stops by trees and sits on the leather, spreads it out flat, continues to push away approaches by S for several minutes. Finally, K gives him a shove away, grabs the leather and runs to a table-like rock, pursued by S. K lies on the leather and again fends off grappling by S. When K leaves the leather on rock momentarily to pursue S, S

makes an end run behind him and almost pulls the leather away (57.07) but K snatches it from him. Similar activity around a leather "base" continues for duration of episode. When Kubie leaves the leather for a moment, he alternates his gaze between S and the leather, 3 times (GA 1.00.53, 1.00.56, 1.01.01). At 1.01.02 S briefly gets possession of the leather piece, but K takes it back within seconds.

Re-engaging after pauses in game: (RE) The pauses are with the two gorillas in very close proximity and often gazing face to face; there is never a real interruption where one tries to leave the game. After moments of pause where K simply stands or sits on the leather, either S runs at K or K runs off holding the leather, thus encouraging more play (RE). Toward end of game, K takes the leather to the top of rock formation, and there is a substantial pause when S stays below. But he eventually climbs up, reaches up from below and *slaps* the leather K is sitting on (1.06.04).

Ending the game: Precise ending of game is not known because the camera quits at 1.07.13, but this is where K returns to the exact spot where game started, and we see S run away from the area.

Indications that game focuses on a particular object: In spite of K's keeping close possession of the leather most all of the time, S is continually grabbing at it. S wrestles and chases K but whenever possible seizes the leather. Whenever K moves, he keeps the leather with him. The few times he leaves it, S attempts to run straight to leather and touch it. (JA)

Game 5: 3/18/94

Excerpts from 8-min episode. Starts 1.07.14, ends 1.15.09 on DVD. Zura (Z), female, age 12; Shango (S), male, age 5.

Theme of game: (JA) To possess a ball, sitting or standing on it.

Starting the game: Game grows out of individual play with large and small balls. Shango throws 2 small balls together in front of Zura (OA 1.07.40). Z stands on the large ball and *chestbeats* and *beats* on it (1.07.53), but there is no response from S. After S uses the large ball as a seat and *beats* on it (1.08.45), Z runs in, and S jumps off ball when he sees her coming. He rolls a smaller ball away and plays with it. Then the larger ball becomes a mutual focus for both S and Z.

Maintaining engagement: Z *sits on ball, beats on it* (GG, 1.10.03) as S makes a twirling approach, jumps off when he gets near. S sits next to ball and *beats on it*, looks at Z and back to the ball twice (GA 1.10.17) as she moves closer, then S *stands on ball* and *claps* with *playface* as Z sits nearby. She does not react and S starts to *roll the ball* away. Then Z follows, *twirling* slowly and *armshaking* (self-handicapping?), then mildly accelerates to a playful lope (HO 1.10.41) behind S who is rolling the ball ahead of him. Z gets the ball and *sits on it*. S spins away and gets a smaller ball, stands *rolling, drumming, and bouncing it in his hands* in front of Z (OA 1.11.16, GA 1.11.19) then squats on a stump, ball held by his feet, his back to Z. Z then stands quadrupedally on a large ball, balancing, and *beats on the ball* (GG, 1.11.39). S turns and *throws* his small ball at Z. She *chestbeats, cross-armshakes;* S *claps*, they make eye contact and run in circle around large tree in keep-away chase.

Re-engaging after pause in game: (RE) S and Z wrestle and chase, leaving area where the ball is. Watching Z and waiting, at 1.12.18 S returns, running while *looking back* at Z to *beat* and *sit* on large ball (OA 1.12.16, GA 1.12.19). Z comes near and pauses behind a tree, S gets off the large ball and *beats* on it (OA 1.12.34). With more keep-away and wrestling, both leave the ball again. Z runs off, S goes to the ball and after *looking back at Z* 2 times (GA 1.13.15) and putting his hand on the ball, he *climbs up* on it (GG). Both sit a while a little ways apart. At 1.1.3.31(GA) S *looks* over at Z then *slaps* her hands (GG, OA 1.13.34) on the ball 10 times. S sits on the ball and slowly slaps its sides, looking at Z. S moves the ball to a tree, keeping his gaze on Z; and as he climbs up on it (1.13.52), Z approaches *armshaking*. S jumps off the ball and they wrestle. Z throws him off and walks away, S goes to the ball and takes it to the same spot by tree, *sits on* it again then *runs off rolling* it, with 2 audible *slaps* when Z approaches (OA 1.14.37)

Ending the game: The ball rolls away to edge of moat when S and Z wrestle and can be heard rolling off the edge. Kubie runs up and he and Shango play, Zura remains at a distance.

Indications that game focuses on a particular object: actions performed directly upon the ball are frequent in this game, unlike other games where simply holding onto the ball was the point. Examples are *beating or slapping on ball, rolling in hands, rolling on ground, bouncing, standing* or *sitting* on a ball. Unlike other games, three balls were objects of play though a large ball was the most prominent. Action upon a ball seemed to be a catalyst for further play action (JA).

Game 6: 6/24/94

Excerpts from a 20-min episode. Starts, 1.15.10, ends 1.35.40 on DVD. Zura (Z), female, age 12; Shango (S), male, age 5.

Theme of game: (JA) To get and keep possession of a particular ball.

Starting the game: Zura picks up the ball, keeping eyes on Shango, who looks back at her. Z *throws the ball* down a slope into the drainage ditch, *looks toward the ball, then S, looks away, then back at S* (OA, GA 1.15.20). S's *gaze follows the ball, then he looks at Z, then toward ball, then at Z*

again (GA). They wrestle for a few seconds before S races ahead of Z into the drainage ditch, *turning his head 4 times to watch* her pursuit. Z regains the ball down in the ditch.

Maintaining engagement: Z stands still in drainage ditch holding the ball (1.15.59); S rolls down the hill right into her. They wrestle but Z keeps the ball in her hands. When Z lets the ball roll away (1.16.50), S makes a sudden run, grabs the ball and runs off. At the other end of the field, Z regains the ball (1.16.57). After this, there are many interruptions (next section) but the competition for the ball is returned to after each one.

Re-engaging after pauses in game: (RE) S leaves the game 5 times to go sit and/or play with 18-year-old male Kubie, and other interruptions occur when both go indoors, and when Z goes indoors alone.

1.17.54 After S leaves the game to play and sit with Kubie for about 2 min, Z takes the ball to other end of enclosure. S *runs toward her*, rolling with a branch part of the way. Z moves behind rock structure with the ball; he follows her while she runs, always keeping the ball in one hand.

Z re-engages S when he is sitting with Kubie by *running toward S with ball* (OA 1.23.45); when he still stays with Kubie, she *armshake*s with one hand, while the ball is in the other, loping toward S with a slow bipedal gait. She stops again, he continues to play with Kubie. A *chestbeat* and *ball sound* can be heard but not on camera. Zura waits, then *chestbeats,* and *slaps stump* looking toward S, who is seen to be rapidly approaching (OA 1.24.17, 1.24.40, 1.25.01); they chase but he stops and sits down several feet away; she *holds out the ball* (OA 1.25.10) while twice *alternating her gaze* (GA 1.25.15) between the ball and S. Then Shango gives a chase again, regains the ball and throws it into the ditch, where Z takes it. 1.25.36 GA as she looks back 4 times at Shango while running up the hill with the ball.

Zura remains seated when S gets the ball again; S *looks back at Z* (GA 1.25.54) while walking slowly off with the ball, then obliquely approaches her and *alternates gaze* 4 times between the ball and Z (GA 1.26.04) as he rolls the ball just ahead of himself; he stops with ball on ground and *waits gazing at Zura* until she suddenly moves, then Shango quickly *throws the ball* (OA) ahead of himself into the ditch again and rolls behind it.

S is with Kubie again, Z has retrieved the ball and sits on a nearby rock holding it. She drops it on the ground with an audible bouncing sound, which seems to get S's attention (OA 1.27.02), then *looks back* at S (GA 1.27.04) while she moves with ball toward the original game location at a large stump. S approaches; Z keeps *looking at him* as she simultaneously walks away bipedally*, slaps the ball, armshakes*, and *slaps the ball* (GG). They chase around the stump, Z holding the ball. They sit and they wrestle; Z still keeps a hand on the ball. 1.28.57 S goes to sit with K again.

Ending the game: S follows Z behind rock formation, and ball sounds can be heard but not seen. S emerges alone, runs behind rocks one more time, but Z is not visible. After this, he goes to K again and does not return to ball play.

Indications that game focuses on a particular object:

1.16.55 While S is running from Z, dribbling the ball that Z eventually takes possession of, they pass close by two other balls of the same size that either gorilla could have easily reached if the goal was simply to possess a ball. However, they ignore these other balls; focus remains on the particular ball being used in the game (JA).

1.21.25 The game is mutually interrupted when both gorillas go indoors. The ball will not fit through the narrow opening of the sliding door. A gorilla hand is seen reaching through the door holding onto the ball even when the ball is outside and the two gorillas are inside.

1.22.15 Both gorillas abandon the ball for a moment after S dislodges the ball, which was stuck in the door opening. He leaves it; Z is not in view. Z appears and retrieves the ball (1.23.00) after S has moved to the other side of the enclosure.

1.26.08 S leaves the ball on the ground near him. Looking at Z, the moment Z makes a move he suddenly scoops the ball up and throws it ahead of him.

1.27.20 Both gorillas let the ball roll away when they wrestle, but Z retrieves the ball, and both rest close together. There are two additional gentle wrestling bouts where the ball is left momentarily, but Z puts her hand on it when each bout pauses.

1.30.00 Z goes indoors alone leaving the ball outside of the doorway gap. S is playing with Kubie. Z comes out and retrieves the ball (1.33.42). S is seen to be approaching rapidly as Z goes with the ball behind the rocks.

Game 7: 6/2/95

Excerpts from 6-min episode. Starts 1.35.41, ends 1.41.29 on DVD. Kubie (K), male, age 20; Shango (S), male, age 6.

Theme of game: (JA) To keep or get possession of a piece of leather.

Starting the game: After play that includes wrestling, simultaneous *chestbeating,* and *branch display*, S stands quadrupedally (1.35.49), *stares directly at K, then twice alternates gaze* (GA 1.35.57) from K to a leather oval on the ground in front of K. *Holding his gaze on K*, S sits down and *puts hand on* (GG, OA 1.36.01) the piece of leather. K *looks down at the leather*; S *sits still with his hand on the leather holding his gaze on K* for 2 more seconds. Just when K puts his hand out onto the leather, S snatches it up. Kubie does not react. 1.36.07 GA twice more as Shango appears to watch for a reaction from Kubie.

Maintaining engagement: When K looks away, S spreads the leather out then folds it and puts it in his mouth

(1.36.12), *head shaking* and *beating the leather*. K joins in with *head twirling* and *hand circling*, a little leafy branch in mouth. Both are *looking at each other*. K stands up bipedally, grabs the leather from S and puts it in his own mouth (1.36.20).

Re-engaging after pauses in game: (RE) Both pause and look out and away from each other (1.36.25). *Gazes meet* again and K *headnods* and *armshakes* with the leather in his mouth (OA 1.36.30), then throws the leather behind him and starts toward S punching fist toward him *(away)* twice. S backs away, watching, then runs away. K returns to the leather (GA 1.36.38, twice) and sits on it. S approaches again, dragging a branch past K while *watching him carefully*, then with a *playface* makes a play attack on K from behind and they wrestle (1.36.50). K stays on the leather, *rolling around*. (GA 1.37.50, 1.38.30) After more play with *chestbeating, clap, jump, twirling, headshaking* and branches, they separate. K moves away toward trees and sits, and S goes to K's leather seat area (GA 1.39.11, 1.39.19), *picks up the leather, puts it in his mouth and shakes it, spreads it out, puts in his mouth* again and stands bipedally *nodding* and *beating on the leather,* (OA 1.39.35) then *sits on the leather.* K first looks away, then toward S as his display continues. When S stops, he looks toward K twice, and again a few seconds later (GA 1.39.42, 1.39.50). When S starts display again (OA 1.40.00), K approaches at a run and S leaves the play area, taking the leather with him, but drops it a few feet from the play area, meanwhile *turning to look* at K and back down at the leather several times (GA 1.40.08-1.40.33).

Ending the game: K stands quadrupedally in the play area staring at S, *gaze is mutual*. S moves closer to K, holding the leather, *shakes and bites* it, then spreads the leather out (OA, RE 1.40.38) looking fixedly at K (1.40.40) until both look down at the leather (GA 1.40.45), then K reaches out to the leather. S pulls the leather back and K does not attempt to approach further but instead sits back down on another piece of leather. While K is looking (GA 1.41.10), S alternates gaze repeatedly between K and the leather, *folds the leather, spreads it out, claps, and jumps onto the leather* (OA, RE 1.41.16). After this, Shango still keeps gaze tightly on K but he makes no response.

Indications that game focuses on a particular object:

There is a second similar sized piece of leather at the "home" play location where K is sitting or standing, but throughout, the gorillas focus only on one particular piece of leather. Near the beginning of the game (1.36.00), sitting near K, S *keeps a hand on* this piece of leather that is on the ground next to K. K reaches out for it but S is alert and pulls it back quickly. K continues to sit and S keeps the leather right next to him with hand on it. A few seconds later (1.36.20), K stands up bipedally and grabs that leather from S and puts it in his own mouth.

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