

K. A. Bard\*†  
J. Vauclair\*‡

\*Yerkes Regional Primate Research Center, Emory University, Atlanta, Georgia 30322, U.S.A.

†Department of Psychology, Georgia State University, Atlanta, Georgia 30303, U.S.A.

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## The Communicative Context of Object Manipulation in Ape and Human Adult-Infant Pairs

The communicative style of adult primates in relation to object manipulation in infants was examined in a pilot study involving three species of primates: human; common chimpanzee (*Pan troglodytes*); and bonobo, or pygmy, chimpanzee (*Pan paniscus*). Three areas of interest in this study were: (1) whether the adults acted on objects in a manner that served to engage the infants' attention with objects; (2) the effect of the adults' object manipulations on the infants' behavior with objects; and (3) whether certain behaviors of the infants consistently preceded the communicative actions of the adults. Results indicated that the adult apes rarely acted on objects with the apparent intent of engaging the attention of the infants. In contrast, adult humans primarily manipulate objects with the intent of stimulating, sustaining or enhancing the actions on objects by infants. Infant apes respond differentially; they do not attend to the manipulations of adult apes, but they do attend to, and even manipulate, objects when interacting with an adult human. These results are discussed within the perspective of evolution and early human mother-infant interactions.

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### 1. Introduction

Considerable information has been gathered on the role of the human mother in the emotional and cognitive development of her child. The human mother is highly attentive when her infant acts or intends to act with objects (Shaffer *et al.*, 1977) which may facilitate the infant's subsequent exploratory behavior (Rubenstein, 1967). Human mothers act both to monitor and to focus their infants' attention towards physical objects (Collis, 1981; Trevarthen, 1977). Maternal stimulation, operationally defined as "maternal efforts to focus the infant's attention on objects and events within the environment" (Belsky *et al.*, 1980, p. 1169), positively influences the infant's manipulatory skills and can take many forms, such as pointing to objects, demonstrating actions, naming, instructing, etc.

Observations of apes, in particular, studies on chimpanzees by van Lawick-Goodall (1967) and Plooij (1980), have shown that mother-infant co-ordinations during the first few months of life are mediated by tactual/kinesthetic, rather than visual, means. This characteristic of the apes is in marked contrast to reports on early mother-infant interactions in humans, e.g., establishment of joint visual attention on objects (Collis, 1980).

It is well known that young chimpanzees in the wild extensively explore and manipulate objects (McGrew, 1977). The role played by non-human primate mothers with regard to their infants' manipulatory behavior is not clear. The results of a few studies on this topic (for example, Hall, 1968; Hinde, 1971) suggest that adult non-human primates do not teach their infants. Furthermore, the acquisition of complex behaviors evident in social traditions, and tool-use, seem to be realized primarily through observational learning, e.g., selective exposure to environmental stimuli (McGrew, 1977).

‡Present address, to which requests for reprints should be sent is: Dr Jacques Vauclair, Centre National de la Recherche Scientifique, Institut de Neurophysiologie—INP 9, 13402 Marseille Cedex 9, France.

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Differences in the quality and quantity of object manipulation in infants of three primate species were identified in a previous study (Vauclair & Bard, 1983). It was found that the human infant from 8–11 months of age exhibited a greater amount of manipulations with objects than did the ape infants, i.e., common chimpanzee (*Pan troglodytes*) and bonobo (*Pan paniscus*). Furthermore, the human infant demonstrated more complex levels of manipulations, such as those reflecting an investment in object–object relationships, than did the same-aged ape infants. The setting of the present study consisted of infants of three primate species that were provided with the same set of objects in a free-play situation and observed in the presence of an adult. This context was used to investigate communicative events emitted by the adult during object-oriented play.

Although the present work must be considered a pilot study, given the small sample size, three questions will be addressed within a comparative perspective. First, the communicative style of each adult was investigated, specifying the ways in which she may stimulate the infant, or herself, with objects. The second question concerned the effect of the adult on the actions of the infant. Specifically, it was asked if the adult encouraged the infant's initial contact or sustained engagement with the object. In addition, it was asked if there were differential effects on an infant's behavior based on whether communicatory events are produced by a human or an ape adult. The third inquiry concerned what, if any, kinds of infant actions precipitate a response from an adult within the context of object manipulation, i.e., does the infant effect a change in the adult's behavior with objects?

It is hypothesized that there is an interaction between adult communicative style and infant manipulatory behavior. There may be feedback systems whereby the behavioral receptivity and responsivity of the infant influence adult behavior, and vice versa. These may be apparent, especially in circumstances where ape and humans act together. For example, there may be a specifically adult human communicative style that is different from that of an adult ape, and particular types of style to which ape and human infants respond best. Thus, when an adult human attempts to communicate something about objects to an ape infant and does not receive the same responses that she would receive from a human infant, she changes her communicative style accordingly.

## 2. Method

### *Subjects*

The subjects were observed in the following groups: (1) human mother (Patti) and infant (Aleah); (2) human adult (female caretaker) and common chimpanzee (*Pan troglodytes*); (3) bonobo (*Pan paniscus*) adult (substitute mother, Matata) and bonobo infant (Kanzi); (4) human adult (female caregiver) and bonobo infant (Kanzi); and (5) common chimpanzee mother (Cookie) and infant (Chesley). Groups 3 and 4 were observed together. All humans (adults and infant) were females (the caretaker and caregiver were two different persons), and all ape infants were males. For standardization, the ages of all infants were counted in lunar months (one lunar month = 28 days). All infants were approximately the same age (8–11 months) when observed; thus, the study period was four months duration.

### *Setting*

The human (Patti) and chimpanzee (Cookie) mothers were observed in one room of their living quarters in the presence of their respective biological infants. The other chimpanzee

infant, raised in the nursery of the Yerkes Regional Primate Research Center, was observed in the playroom of the nursery in the presence of an adult human caretaker. The bonobo adult (Mataka) and human caregiver, with the infant bonobo (Kanzi), were observed in one section of the living quarters. Although the adult bonobo was not the infant's biological mother, this pair had been together since the infant was two days old, and it is likely that the female behaved toward the infant as she would toward her own offspring.

All adult–infant groups were familiar with their surroundings prior to the beginning of the study. The environments can be ranked with regard to the richness and complexity of stimuli present on a daily basis. Ranking the settings from most to least complex results in the following order: human home; indoor/outdoor enclosure of the bonobo; nursery; indoor/outdoor enclosure of the mother–infant chimpanzee pair.

#### *Apparatus*

Identical sets of objects were placed with each group for the duration of the study. The objects included a dolly, four nested cubes, two sticks, one plate and one cup (for detailed descriptions, see Vauclair & Bard, 1983). Observations were videotaped with a Sony Betamax color system. The videotapes were duplicated, and running time (minutes, seconds and tenths of a second) was superimposed in the top central portion of the image.

#### *Procedure*

The adult–infant groups were videotaped for 15-minute sessions. A maximum of 10 minutes was allowed for the infant to “warm up” (especially necessary for the nursery infant); however, as soon as the infants appeared oriented to the objects, the videotaping began. It was believed that 15 minutes represented the maximum amount of time that the infants would remain focused on the objects at one sitting and, thus, would provide adequate measures of the typical communicative style of the adults.

The human adults (mother and/or caretaker) were provided explanations regarding the scope of the study, i.e. an analysis of the levels of object manipulation performed by human and ape infants (Vauclair & Bard, 1983). However, the human adults were not instructed to act in a specific way; rather, they were asked to behave as they usually did in the presence of the infants and toys.

The initial goal was to videotape one session every two or three weeks. However, this goal was not attained for all groups and, therefore, four sessions, taped once per month, are considered for analysis.

Each videotape was viewed and the coding system was applied. Each time the adult contacted an object, this event was noted. The behavior code that best described the entire event was recorded. However, if the entire event was clearly a string of more than one type of behavior, then each part was referred to as a separate event. The onset, offset and code for each event were recorded. The entire coding system, with definitions of each behavior type, is presented in Table 1. The behavioral categories ranged from Non-interactive (i.e., the adult acted without regarding the infant) to Demonstration (i.e., the adult acted on the objects exclusively for the benefit of the infant). The coding scheme was designed to sample the communicative style of the adult and to reflect the different ways in which:

(1) the adult may act to engage the infant with the objects; (2) the adult may act to disengage the infant from the objects; and (3) the adult may act neutrally with regard to the infant's manipulatory actions. The type of object manipulations exhibited by these infants was described in detail elsewhere (Vauclair & Bard, 1983).

**Table 1****Definitions of Adult Events**

Code	Category	Definitions
13	Non-interactive	Adult manipulates an object with no attempt to engage the infant's attention
14	Clear	Adult moves object(s) in order to clear a space or move objects out of the way
15	Point	Adult directs finger or knuckle to an object in order to direct infant's attention to the object
16	Offer	Adult holds object off ground within reach of infant's hands, intending the infant to take possession
17	Take Away	Adult takes hold of an object and attempts to remove it from infant's possession (both successful and unsuccessful attempts are included)
17B	Take when Infant Offers	Adult takes possession of an object when infant gives it to the adult
18	Request	Adult requests, either verbally or gesturally, to take possession of an object currently in infant's possession
19	Hide	Adult conceals an object
20	Exchange	Adult and infant sequentially or simultaneously transfer objects
21	Move Interactively	Adult moves an object in order to get the infant's attention or to place the object in closer proximity to the infant
22	Turn-taking	Adult performs an action on an object, then pauses while the infant acts on an object, after which the infant pauses and the adult acts again
23	Demonstrate	Adult physically shows the infant how to act on an object or how an object can be manipulated

Adult communicative events were viewed, in conjunction with the infant's manipulatory behaviors, in two different ways. First, in order to see if the intent of the communicative event was attended to by the infant, the infant's behaviors that occurred during the period from the onset of the adult event until 5 s after the adult event ended were examined. Infant behaviors were classified according to whether or not they reflected attention to the adult's behavior. "Attend" was recorded if the infant changed its object-oriented behavior in a way that related to the adult's action and/or attended to the action through looking, making physical contact with the same object, or if the infant imitated the adult's actions. "Not-Attend" was recorded if the infant continued or changed its activity (object- or non-object-oriented) in a way that did not relate to the adult's actions. For example, if the adult waved the stick in front of the infant and the infant looked at and then grasped the stick, "Attend" was recorded. However, given the same adult event, if the infant grasped the cup and did not look at the stick, then "Not Attend" was recorded.

Second, in order to investigate whether or not infant actions influence the onset of adult behaviors, the 3 s period preceding each adult event was examined. The videotapes were reviewed and the focus of the infant's attention prior to the adult's communicative event was noted. Infant attention was classified as either Not Engaged, Engaged Socially, Engaged with Objects (with either simple or complex manipulatory activity) or Attempt to

Disengage from objects. Simple manipulations consisted of looking, mouthing, sniffing or passively contacting objects, while complex manipulations involved active contact (e.g., grasping), putting at least two objects into simple or complex relations, instrumentalization or conventional usage (e.g., "drinking" from the cup). Attempt to Disengage was coded when the infant was avoiding, withdrawing from or actively removing himself/herself from object-oriented activity.

#### *Interobserver Agreement*

Agreement among three independent observers was assessed at the beginning, middle and end of the study. Two assessment methods were used: percentage agreement, and Cohen's Kappa (Cohen, 1960). A problem with percentage agreement is that it tends to overestimate when chance agreement is high (Hollenbeck, 1978). The Kappa statistic corrects for agreement due simply to chance, and it is applied to the entire coding system. For the seven sessions in which agreement was assessed, the average percentage agreement was 94.6 (range 90.6 – 95.6) and the average Kappa was 0.82 (range 0.77 – 0.91). All scores were over the 80% criterion for percentage agreement and the 70% criterion for the more conservative Kappa statistic.

### 3. Results

In the following sections, communicative events are classified according to inferred intent, i.e., efforts made or not made by the adult to focus the infant's attention on objects: (1) did the adult act on objects to engage the infant's attention; (2) did the adult act on objects to disengage the infant's attention from the objects; and (3) did the adult act neutrally, intending neither to engage nor to disengage the infant's attention with respect to objects. The events classified as Neutral consisted of Non-interactive and Clear, and the events

**Table 2** Frequency and duration (seconds) of adult communicative events

	Cookie/Chesley (Chimpanzees)		Matata/Kanzi (Bonobo)		Caregiver/Kanzi (Human/Bonobo)		Caretaker/Joseph (Human/ Chimpanzee)		Patti/Aleah (Humans)	
Non-interactive	10	55.3	70	1499.4	23	288.5	6	27.4	6	31.4
Clear	—	—	10	48.3	16	27.1	21	39.0	25	33.2
Point	2	4.1	—	—	—	—	1	0.7	15	27.7
Offer	—	—	1	3.1	5	24.4	10	57.8	7	24.6
Take Away	—	—	2	5.2	1	12.6	—	—	5	16.1
Take When Offered	—	—	—	—	—	—	—	—	1	1.6
Request	—	—	—	—	—	—	—	—	1	2.8
Hide	—	—	1	50.0	—	—	—	—	—	—
Exchange	—	—	—	—	—	—	—	—	—	—
Move										
Interactively	—	—	6	37.3	44	259.8	53	227.3	87	262.6
Turn-taking	—	—	—	—	—	—	—	—	1	13.7
Demonstration	—	—	—	—	4	37.9	4	7.0	10	21.9
?(Unknown)	—	—	2	10.4	4	74.6	11	25.7	7	130.8
TOTAL	12	59.4	92	1653.7	97	724.9	106	384.9	165	566.4

classified as Disengage consisted of Take Away and Hide; the remaining categories were classified as Engage.

The total frequency and duration for each adult's communicative events are presented in Table 2. The common chimpanzee mother (Cookie) rarely contacted the objects in any way. In fact, the two instances of Point are misleading, since they were attempts to direct the attention of a caretaker, and not the attention of her infant, toward objects. Cookie contacted objects for a total of less than one minute (of a possible 60 minutes). In contrast, the bonobo chimpanzee adult (Matata) contacted objects for a total of 27.5 minutes. This amount of time was more than twice that observed in any other adult subject. Nonetheless, the adult apes were similar in that over 80% of their object contacts and over 90% of the time they spent in contact with objects did not involve engagement with the infant (i.e., Non-interactive and Clear). Matata occasionally interacted with both the objects and the infant bonobo, but she spent as much time disengaging the infant from the objects (e.g., Take Away) as she did attempting to engage his attention (e.g., Offer, Move Interactively).

Overall, the human caregiver to the bonobo infant acted on the objects as frequently as did Matata. However, more than half of the human's contact with objects, compared with less than 8% of Matata's actions, involved an engagement with the infant. Approximately 40% of the caregiver's communicative events were Neutral. This pattern was evident, in varying degrees, in communicative events of all the human adults. The human caretaker to Joseph, the common chimpanzee infant, exhibited more frequent and higher percentages of time in events that involved infant engagement, rather than non-engaged events (64.1 vs 25.2% of the total frequency, respectively). The human mother (Patti) demonstrated many more total events than did any of the other subjects. She had the highest percentage of events that involved interactive engagement (73.9) and the lowest percentage of neutral events (18.8). Additionally, Patti was the only subject to exhibit instances of Turn-taking, Request and Take when Offered, which reflect reciprocal actions during joint (adult-infant) engagements with objects.

Results of the second analysis, designed to determine the influence of adult communicative events on the infant's actions with objects, are presented in Table 3. The results revealed that the common chimpanzee infant rarely attended to his mother's actions by interacting, visually, orally or manually, with objects. The low number of

**Table 3** The effects of adult communicative intent on infant behavior

Subjects (adult/infant)	Adult Acts to Engage		Adult Acts Neutrally		Adult Acts to Disengage	
	Infant Attends	Infant Does Not Attend	Infant Attends	Infant Does Not Attend	Infant Attends	Infant Does Not Attend
Cookie/Chesley	—	16.7(2)	—	83.3(10)	—	—
Matata/Kanzi	4.3(4)	3.3(3)	25.0(23)	60.9(56)	2.2(2)	1.1(1)
Caregiver/Kanzi	19.6(19)	34.0(33)	2.1(2)	38.1(37)	—	1.0(1)
Caretaker/Joseph	42.4(45)	21.7(23)	6.6(7)	18.9(20)	—	—
Patti/Aleah	52.1(86)	21.8(36)	6.7(11)	12.1(20)	1.8(3)	1.2(2)

Number of entries included in each percentage is in parentheses. Percentages add to 100 when non-visible or uncodeable events and responses are included.

**Table 4** Infant behaviors prior to adult events

Communicative Intent Subjects	Infant Behavior				
	Not Engaged	Engaged Socially	Engaged with Objects		Attempt to Disengage
			Simple	Complex	
<b>Adult Acts to Engage</b>					
Cookie/Chesley	—	16·7(2)	—	—	—
Matata/Kanzi	—	3·3(3)	—	4·3(4)	—
Caregiver/Kanzi	15·5(15)	28·9(28)	2·1(2)	7·2(7)	—
Caretaker/Joseph	10·4(11)	10·4(11)	34·0(36)	8·5(9)	0·9(1)
Patti/Aleah	7·3(12)	4·2(7)	6·7(11)	55·8(92)	—
<b>Adult Acts Neutrally</b>					
Cookie/Chesley	8·3(1)	75·0(9)	—	—	—
Matata/Kanzi	19·6(18)	34·8(32)	5·5(5)	25·0(23)	—
Caregiver/Kanzi	7·2(7)	23·7(23)	—	6·2(6)	—
Caretaker/Joseph	6·6(7)	2·8(3)	8·5(9)	6·6(7)	0·9(1)
Patti/Aleah	3·0(5)	1·2(2)	3·0(5)	11·5(19)	—
<b>Adults Acts to Disengage</b>					
Cookie/Chesley	—	—	—	—	—
Matata/Kanzi	—	1·1(1)	—	2·2(2)	—
Caregiver/Kanzi	—	—	—	1·0(1)	—
Caretaker/Joseph	—	—	—	—	—
Patti/Aleah	—	—	—	3·0(5)	—

Number of entries that are included for each percentage is in parentheses. Percentages add to 100 when invisible or uncodeable events and responses are included.

communicative events exhibited by the common chimpanzee mother makes it inadvisable to interpret further from the results of this pair of subjects.

The bonobo infant (Kanzi) typically did not attend to the adult bonobo's actions. When Kanzi did attend, Matata was acting in a neutral manner. Kanzi exhibited a similar pattern of object-oriented responses to both Matata and the human caregiver, although the adults acted with different styles. The human often attempted to engage Kanzi's attention with objects; however the bonobo infant typically did not attend to the adult's actions. The common chimpanzee infant, when in the presence of a human caretaker, exhibited a pattern of object-oriented responses that was very similar to that observed in the human infant. This pattern consisted of high frequencies of appropriate (i.e., Infant Attend) responses to the adult's attempts to engage, and a high proportion of instances in which the infant did not attend when the adult acted in a neutral manner.

Results of the third analysis, designed to determine if certain infant behaviors consistently preceded the communicative actions of the adult, are presented in Table 4. Chesley, the common chimpanzee infant, was engaged socially with his mother, Cookie, prior to most of her communicative object-oriented behaviors. Primarily, these social behaviors consisted of ventro-ventral clinging. Kanzi was most frequently socially engaged prior to actions on objects by both Matata and the caregiver (38·1 and 52·6% of the total communicative events, respectively). The next most frequently observed infant behavior that preceded Matata's communicative events involved action on objects by Kanzi

(30.5%), followed by infant not engaged (19.6%). Preceding the caregiver's communicative events, Kanzi, at times, was not engaged (22.7%) and at other times, he was engaged with objects (15.5%).

Joseph, the common chimpanzee infant, was engaged with objects prior to more than half of the actions of the caretaker (59.7%). Joseph sometimes was not engaged (17.0%), and occasionally he was socially engaged (13.2%) prior to the caretaker acting neutrally or acting to engage him with objects. Patti most frequently acted on objects following Aleah's activity with objects (77.0). Patti rarely attempted to engage Aleah's attention with objects at a time when Aleah was not already engaged with objects.

In summary, Cookie, the chimpanzee mother, rarely contacted objects and, when she did, it was neither to engage nor disengage her infant from objects. Chesley primarily was engaged socially prior to his mother's events, and the infant typically did not attend to her actions with objects. The bonobo adult-infant pair exhibited a similar, but less extreme, pattern of behavior. Kanzi acted socially or with objects prior to Matata's actions with objects. The majority of Matata's object-oriented behaviors were not directed toward interactions with Kanzi, and this infant usually did not look at or contact the object upon which Matata acted. In fact, following Matata's activity with an object, Kanzi typically continued to do whatever he was doing prior to his mother's actions. The activity of Kanzi's human caregiver usually followed non-object play (i.e., social engagement) by the infant, and generally was directed toward engaging Kanzi with objects. Kanzi's responses to both Matata and the human caregiver were similar; he typically did not respond to an adult's object-oriented actions by engaging with objects.

Joseph was already engaged with objects prior to the majority of the object-oriented actions of the nursery caretaker. The caretaker attempted to engage Joseph further by moving objects in an interactive manner and by occasionally offering new objects and demonstrating actions to him. Joseph tended to respond to the adult's object-oriented actions most frequently by looking at and sometimes contacting the same object. The human infant, Aleah, was almost always engaged with objects prior to Patti's communicative actions with objects. Patti acted to sustain or enhance Aleah's actions by moving objects interactively and, occasionally, pointing or demonstrating. Aleah typically responded to her mother's actions by actively manipulating (e.g., grasping) the same object.

#### 4. Discussion

The present study highlights the characteristic style of interactions between mother and infant within the context of object manipulation. It confirms the findings of previous studies (Collis, 1981; Trevarthen, 1977) which showed that human adults do attend to infants' behaviors with objects and try to stimulate infants' manipulations by engaging their attention with objects (e.g., offering, pointing, demonstrating) (Belsky *et al.*, 1980). Moreover, the human infant typically responds to its mother's stimulations by manipulating the objects on which she is focusing. Similar maternal efforts and infant reactions have not been found in apes. When both mother and infant apes explore and manipulate even the same type of objects, their actions appear to be independent (McGrew, 1977). In fact, we observed the bonobo infant initiate exploration of a new object or manipulate an old object in an unusual way, and the mother interfered with the infant's actions and took the object from her infant to manipulate it for herself. Our data



and their interpretation are clearly limited, however, by a minimal sample size and by possible individual and sex differences within the same species (Vauclair & Bard, in press; see also Rumbaugh *et al.*, 1972). Comparative statements, therefore, must be considered speculative.

Regarding the communicative patterns of object manipulation between mother and infant, it has been observed that maternal style in humans varies considerably among individuals (Belsky *et al.*, 1980) and cultures. For example, in Western societies, human mothers may best be characterized by a high level of control over the manipulations of their young offspring, whereas among some African cultures, mothers have been described as much less intrusive and interventionistic during the manipulations of their infants (Dasen *et al.*, 1978).

The specific effect of the human mother's behaviors on her infant, compared to the effect of the human caretaker's object-oriented behaviors on the ape infants, suggests that different mechanisms act on their reciprocal interactions. Complex communicative behaviors between a human mother and her infant (e.g., precocious imitation and mutual focus on physical objects) involves "preadapted patterns of perception and behavior in the infant providing for the possibility of an interpersonal orientation from the beginning of life" (Smilie, 1982, p. 287). It is likely that among apes, such interactive patterns do exist regarding vocal, gestural and emotional exchanges, but not regarding physical objects other than food and, perhaps, nesting materials. This might explain why ape mothers apparently do not engage their infants with objects. However, the case of the chimpanzee Joseph indicates that the presence of a human (a substitute for the mother who displays a behavioral repertoire presumably similar to that which she would use with a human infant) has some effects on the chimpanzee infant's behaviors with objects. Interestingly, the presence of Joseph's responses to the caretaker's solicitations are contrasted by an absence of responses by Kanzi. Kanzi was raised by a female bonobo whose influence might outweigh that of an adult human.

It is important to emphasize that the communicative context of object manipulations was investigated here for situations in which objects were explored for themselves. We have, thus, deliberately omitted other social communications involving physical objects. It has been found, for example, that young apes use objects in a way that is similar to the use of object by human infants, i.e., to attract attention from their mothers (e.g., cases of "leaf grooming" or "running away with an object"; see Plooij, 1978). Moreover, young and juvenile chimpanzees have been observed using a variety of objects (twigs, leaves, fruits) during play sessions in the wild (van Lawick-Goodall, 1968). Clearly, instances in which a single object is used during social interactions can be distinguished from situations involving the use of two or more objects which are explored and manipulated in different ways and combinations with each other.

In conclusion, the present study has outlined a typical form of communication in humans during object manipulation and has suggested comparisons with bonobos and chimpanzees. This form of human communication lies in the early mutual exchange between mother and infant regarding a large variety of discrete, moveable objects. As expected, the human mother encouraged and sustained her infant's engagement with objects, whereas the ape mother did not give this encouragement to her infant. The sharing of mutual object manipulations has the effect of attracting the infant's attention, and later of elaborating a common, communicative code that Smilie (1982) called "referential communication". Moreover, this communication about a common world of objects and

manipulations may permit the human infant to develop complex forms of object manipulations that are not evident in same-aged ape infants (Vauclair & Bard, 1983).

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