Original Article

A Study of the Mother-Infant Relationships of Chimpanzees
(*Pan troglodytes*) during the First Four Years of Infancy
in Tama Zoological Park

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ABSTRACT

Four chimpanzee mother-infant pairs belonging to Tama Zoological Park were observed in order to see how this relationship develops. The main study run from August 1986 to December 1989. Each mother-infant pair was observed for 30 minutes once a week. All behavior patterns were recorded and analyzed.

The data showed that the process of the chimpanzee infant's development of attachment resembled closely that of humans from the pre-attachment-phase to a goal-corrected- partnership (Bowlby's model 1969). Moreover, three or four-year-old chimpanzee infants seemed to have some conflict with their mother, because ambivalent behavior occurred at that time. Infants whimpered for their mother without cause for fear and soon after the mother held them, they left her and whimpered again. Such ambivalent behavior patterns towards the mother are often observed in human infants.

Many studies about mother-infant interaction have been done since Bowlby advanced his attachment theory in the 1960's. He indicated some behavior patterns to show the development of mother-infant relationships (Bowlby, 1969, 1973, 1980). For example, infant's fear, approaching the mother, clinging to the mother, exploring behavior etc. Ainsworth (1963, 1967) identified such attachment behavior as relevant to the assessment of whether or not an infant has

become attached. She showed the following behavior patterns: crying and / or following when the mother leaves the room, greeting responses, active contact behavior, the use of the mother as a secure base from which to explore, and clinging. The possible behavioral combinations led to the development of a 'strange situation' (Ainsworth & Witting, 1969). The strange situation procedure affords an opportunity to assess the balance of exploration and attachment behavior under a cumulative stress condition. This procedure can be used as one of the measurements to show the development of the mother-infant bond.

We are very grateful to keepers in Tame Zoological Park for their valuable advice and friendship.

Bowlby (1977) said the attachment behavior is seen in most mammals and remains through out life in some species. Though there are detailed differences between species, the basic tendency is the same i.e. the immature one approaching the mature one that it likes best. In fact, a lot of research, for example, by Hinde and Spencer-Booth (1971), Harlow and Mears et al. (1979) has been carried out in laboratories on macaques. They showed that there is important and indispensable behavior when the attachment develops in both macaques and humans (Montagu, 1971). These ethological and experimental approaches succeeded in making clear what the important facts are when the mother-infant bond is developing.

But infant macaques grow much faster than humans. There seem to be some difficulties in comparing humans with macaques directly by using macaques mother-infant relationship as a human model. Especially after becoming three years old human infants decrease the activity of attachment behavior. This process of change in the degree of attachment seems to be different in the case of macaques' development. It is said that in humans the character of attachment behavior at early stages of development may relate to personality or ego formation (Van IJzendoorn et al., 1987). It is well known that macaques infants deprived of their mother show some abnormal behavior after growing up (Harlow & Harlow, 1965; Harlow et al., 1966; Spencer-Booth & Hinde, 1966, 1971). But the problem of how the early relation ship of mother-reared infants affects their later life has not yet been discussed, because macaques have few varieties of mother-infant relation-

ships as well as a short growing period. Moreover adult macaques' cognitive ability is not very high (Box, 1984; Parker, 1977), so the mother-infant relationships seems to be simple.

On the other hand, chimpanzees (*Pan troglodytes*), the species nearest to humans, have a much more complex cognitive ability (Cheney & Seyfarth, 1990) and a long growing period. Therefore, how the mother-infant bond develops and how mother-infant relationships change after attachment begins can be made clearer by observing chimpanzees as representing an evolutionary stage between macaques and humans.

In regard to chimpanzee mother-infant relationships there are three kinds of studies on chimpanzees: observation data on wild chimpanzees (Plooij, 1984; Goodall, 1986; Hiraiwa-Hasegawa, 1990); studies comparing the behavior of wild and captive chimpanzees (Nicolson, 1977); observation records of captive chimpanzees, taking a side view of social interaction in the zoo (de Waal, 1982). These studies suggest that the changing mother-infant relationship is very complex. But quantitative data are lacking and there is no study using the attachment theory. Accordingly it is useful to study chimpanzees from the point of view of attachment behavior as shown in human beings and also to use the distance between mother and infant as a basic measure. This study will help us to understand the complex mind of chimpanzees and to add new facts about the development of mother-infant relationships.

OBSERVATION METHODS

For the past three and a half years, we

have been observing the behavior of captive chimpanzee mothers and infants in Tama Zoological Park. All chimpanzees leave their cells for the outside enclosure (300m²) at 9:30 A.M.. At night, most chimpanzees sleep in individual cells and only mothers and infants spend the night together. In the daytime all chimpanzees belonging to the group live together outside.

During the entire observation period, the group comprised one adult male, nine adult females, one juvenile male, and two juvenile females. Besides, one juvenile male that was sent to another zoo and two infants that died are included in the observation subjects (Table 1).

The observation period was about three and a half years, from Aug. 1986 to Dec. 1989. Direct observation was carried out once a

Table 1 Observed subjects
Observation period

Aug. 1986 —————> Dec. 1989

Subjects

	0	1	2	3	4	age
♂	2	1	1	0	0	4
♀	2	4	3	2	2	13

Name	Born	Died
Jacky	1, Dec. 1985	4, Nov. 1988
Lucky	5, Jan. 1989	
Elly	14, Apr. 1986	2, Mar. 1989
Melon	7, Dec. 1985	
Koko	13, May. 1985	

week from Aug. 1986 to Sep. 1986 and from July 1987 to Dec. 1989. Each mother-infant pair was observed for thirty min.. The behavior and positions of all subjects were noted as referring to Ainsworth (1963, 1967, 1973) and Hinde & Spencer-Booth (1971). The behavior of the other chimpanzees in

reaction to the mother-infant relationships was also noted. Total observation time was 501.5 hours.

RESULTS

1. Distance

As described below, there are four stages according to age (Fig.1). The distance categories were used in Plooi (1984) that was referenced Hinde & Spencer-Booth's observation system (1967). 1. "Ventral"

Fig. 1 Frequency distributions of observed patterns.

means that the infant is ventral to his mother if most of its weight is supported by that individual and encompassed the arms and things of the mother. 2. "Contact" means that most of the infant's weight is supported by the ground or vegetation, but the infant's body is touching the mother's body. 3. "Arm reach" means staying within arm reach of the mother if it is out of contact of the mother. 4.

"Out of reach" means the infant playing beyond the mother's reach. Zero-year-old infants spent most of the time being held by the mother or in contact with her. With one-year-olds the holding time decreased, and the out of reach time increased. After two years, infants spent two-thirds of their time out of reach. Four year old infants spent three-fourths of their time away from the mother.

2. Decreasing infant fear

The changing distance between mother and infant was shown in another way when the infant screamed with grimace because of afraid. The behavior patterns were 1. running to the mother and clinging to her, 2. going near the mother. In Fig. 2 the frequency of this behavior was noted according to age. At zero age such reactions were few because the young always stayed close to the mother. Fear behavior patterns showed a high frequency in one-year-olds. In three-year-olds this behavior soon decreased. As the infants grew, they could cope with their fear by themselves.

Mothers' reactions were observed in the same situations. The behavior patterns were: running to the infants and hugging them, walking near them to watch them and just looking at them. The frequency of these patterns is also shown in Fig. 2. Running to the infants and hugging them had the highest frequency at every age. In one-year-olds approaching to watch them also occurred with high frequency. Starting with three-year-olds, every behavior pattern decreased in frequency. This means that the mothers became less concerned about their infants' fear.

Fig. 2 Changes in behavior patterns when infants feel fear.

3. Characteristics of one-year-olds

The frequency of Mother grabs the infant's arm or leg to stop it leaving her and Mother pushes the infant away from her behaviors are shown (Fig. 3). Both patterns appeared when the infants were one year old. When infant activity increased, the mother tried to control them. When she failed to stop them from leaving, they did not always stay near her. When the infants continued playing

Fig. 3 Mother's control of infant.

in spite of the mother's restraint, some mothers played with the infants to keep them near, but even when infants wanted the mother to play with them, some didn't do so. The infants seemed secure as long as they could see their mother. When they couldn't find her after playing, they started whimpering. As soon as they saw her again, they began to play again.

4. Characteristics of two-year-olds

Two-year-old chimpanzees felt secure by looking at their mother when something happened. At the same time the behavior toward the mother became more complex. Of course they felt most secure when being held by the mother. But the hugging time was short. For example, when a violent youngster came near, the infant clung to the mother for a few seconds and soon went off. That was the greatest difference in behavior between two and one-year-olds. When two-year-olds cried and the mother came near, they continued crying until she came nearer, and then ran to cling to her.

5. Characteristics of three-year-olds

The frequency of the mother taking no notice when the infant cried and the infant's ambivalent behavior are shown (Fig. 4). Ambivalent behavior means, for example,

Fig. 4 The characteristic behavior after 3 years.

infants whimpering for their mother though there was no cause for fear. Soon after the mother held them, they left her and whimpered again. The increasing frequency with which the mother ignored its crying, showed her ambivalent behavior.

6. Characteristics of four-year-olds

Ambivalent behavior increased in four-year-olds. For example, after an infant cried because of fighting with a playmate, it continued crying even when the mother approached and was unwilling to be held, so

at last the mother hugged it by force.

7. The changing infant behavior towards the mother

Such changes in infant behavior toward the mother are shown in Fig. 5. When two zero-year-old infants cried, their mother soon hugged them and the infants' fear dissolved. One-year-old infants ran to the mother and clung to her to feel easy. Two-year-old infants kept crying until the mother came nearer. It looked as if two-year-old infants waited for the mother to come close to them. Three-year-old infants sometimes stopped crying at seeing the mother coming near. But sometimes they whimpered for their mother

though there was no cause for fear, and as soon as they were held by the mother, they ran away and whimpered again. This ambivalent behavior appeared most clearly in the case of the four-year-olds. Four-year-old infants showed such ambivalent behavior even after they cried for fear.

DISCUSSION

The change of distance between the mother and the infant seems to show the basic change of mother-infant relationships. The increase in their distance as the infants grow is the same as in the case of macaques. But four-year-old infants who were weaned spent 20 % of the observation period near the

Fig. 5 Changes in infant behavior toward mother.

mother. Although four-year-old infants in captivity were independent of mother nutritively (Tasaka & Yoshihara, 1982), they seemed to depend on their mother psychologically. In wild, Goodall wrote growth retardation (or psychosocial dwarfism) of orphans in Gombe (1986). For example, eight and a half-year-old orphan showed extremely behavior changes and signs of ill health after his mother's death. He survived only three weeks after loss of his mother though he fully weaned. Postmortem examination of his body showed that he had gastroenteritis and peritonitis. Goodall said, "It seems likely that the psychological and physiological disturbances associated with loss made him more vulnerable to disease." It is clear that the chimpanzee mother-infant relationship has some psychological factor.

1. Mother-infant relationships of zero ~ two year-olds

The first stage of attachment development in humans is shown by the infant's behavioral repertoire which includes behavior promoting proximity and / or contact with the mother. Then at about eight months the infant becomes able to distinguish the caretaker clearly from other people and begins to use its mother as a secure base to explore. The attachment-exploration balance is so characteristic of the infant-mother relationship that it has been suggested that a variety of situations is the best criteria for the presence of an attachment (Ainsworth, 1973; Waters et al, 1980). The infants who are securely attached to the mother can cope with strange situations with less fear. So to measure the development of mother-infant relationship, it is important to know how infants relate to

the mother when afraid.

The greatest difference between chimpanzees and human infants is that chimpanzee infants spend most of the time in contact with the mother for about one year after birth. During this period the chimpanzee infants' attachment behavior seems not to have been activated yet. But even zero-year-old infants tried to get away from mother although using mother as a secure base. Once infants felt afraid, they ran to the mother and clung to her. "Clinging" reduced their fear. Infants showed their fear with a "Ki" voice or a whimper, and immediately they ran to mother and clung to her for reassurance. They seemed to feel easy by clinging to the mother or being hugged by her. According to Bowlby (1979), "Whenever attachment behavior is strongly activated, clinging to the mother or being hugged by her is needed for the reduction of fear." In this point chimpanzees are similar to humans.

One-year-old infants seemed secure as long as they could see their mother. Mothers tried to control them according to the various situations. When infants were afraid, the mother hugged or went near to reduce the infant's fear. Basically this maternal behavior toward infants did not change when the infants were two years old. But sometimes she looked at the infant and did nothing. Two-year-old infants also ran to the mother and clung to her. The greatest difference in behavior between two-year-olds and one-year-olds is as follows. Crying two-year-old infants waited for the mother to come nearer, wanting to cling to (or be hugged by) her. In this case as soon as they were held by the mother, it looked as if fear left their faces. It seemed that "Separation

Table 2 Bowlby's model (1969) and chimpanzee infants' behaviors
Bowlby's model (1969) chimpanzees

1. Pre-attachment phase (0-2 or 3weeks) smiling, crying, rooting, sucking, grasping, following with the eyes	}	1. V. or Contact. (0-year-olds) always staying close to the mother
2. Attachment in the making (0-year-olds) attachment behavior to a familiar figure beginning to occur much more frequently (6 months~)		
3. Clearcut attachment (0-year-olds) active proximity seeking behavior attempting to approximate a particular 'set-goal'		2. Contact or Out Reach (1-year-olds) running to the mother and clinging to her when feeling fear
4. 'goal-corrected' partnership (1-year-olds) beginning to be able to infer something of mother's behavior		3. Arm reach or Out of Reach (2-year-olds) feeling secure by looking at mother waiting mother with crying
		4. Ambivalent behavior (3~4-year-olds)

→ Fear situation → reunion" were experienced smoothly and attachment formation was observed clearly.

These relationships were applied to Bowlby's model (1969) (Table 2), according to which, attachment develops beginning with an initial pre-attachment phase occupying the period from birth through the first few weeks of life. Infants' behavior usually result in attracting the adult by smiling and crying, and promotes more active contact by rooting, sucking, grasping, and following with the eyes. Chimpanzee infants also showed "crying", "rooting", "sucking", and "grasping" just after birth (1984). "Smiling" and "following with eyes" were observed in hand-reared-chimpanzees (Yoshida et al. In preparing). Most of the behavior shown by human infants just after birth, is also seen in chimpanzee infants.

A second phase in human development is "attachment in the making". At the end of this phase the infants are described as clearly attached to a specific figure. Attachment behavior such as smiling to a familiar figure

begins to occur much more frequently. Soon after the infant enters the phase of "clear cut attachment", active proximity-seeking behavior begins to augment the discriminative signaling characteristic of the previous phase. Chimpanzee attachment behavior seem not to be activated until the infants distance themselves from mother. As long as the infants are always held by the mother active attachment behavior may be unnecessary. Once the infants begin to go away from the mother, attachment behavior is activated when they feel fear, and begin to use mother as a secure base frequently. The sequence of development in chimpanzee attachment behavior seems to be the same as that of human beings.

The fourth phase of a "goal-corrected" partnership, beginning no earlier than a human infant's second year of life, is the ability to see things from the mother's point of view, that is, the infant begins to infer something from her behavior. It can also initiate attempts to influence her behavior in much more sophisticated ways. Chimpanzee

infants also seemed to reach this phase at two-years-old, for they waited for their mother, crying and look to see if she was coming nearer as they cried.

The process of chimpanzee infants' development of attachment resembles closely that of humans from "pre-attachment phase" to a "goal-corrected partnership".

2. Mother-infant relationships of three~four year-olds

Three-year-old infants can treat their fear by themselves even when they cried. Of course when all the members of the group were afraid, because of, for example, an adult male's violent display, the infants were hugged by the mothers. But ordinarily, infants could handle their fear by themselves. Mothers became less concerned about infants' fear, too. Three-year-old infants seemed to know how to behave when something fearful happened.

On the other hand, the infants' ambivalent behavior appeared at that time. Infants whimpered for their mother without cause and soon after the mother held them, they left her and whimpered again. Mother's behavior-change may relate to this because it happened at the time when the mother started taking less notice when the infant cried.

How can this ambivalent behavior be interpreted? "The temper tantrum" observed in wild and captive chimpanzees seems to be the answer. Goodall (1986) wrote "It is observed most frequently in youngsters who are going through the peak of weaning, after they have begged, whimpered, and cajoled their mothers for an opportunity to suckle, but to no avail." But

this "tantrum" differs from "ambivalent behavior" in the following two points. First, the tantrum stopped as soon as the mother hugged her infant. Goodall says "The tantrum seems to make her (= mother's) tense and even nervous. She hastens to embrace the screaming child-who, of course, begins instantly to suckle.". De Waal (1982) says, too "It is surprising (and suspicious) how abruptly children snap out of their tantrums if their mothers give in.". In ambivalent behavior, rather than stop when the mother embraced them, the infants kept on crying (whimpering) while pushing away from her. Secondly, in this zoo three-year-old infants have already been weaned and most of the mothers are pregnant with the next baby (Tasaka & Yoshihara, 1982). But mothers always allow infants to contact their nipples. They rarely reject the infant's requirement. Even a ten-year-old youngster sucked mother's nipple when he experienced great fear (Private letter from Ape House in Tama zoo 1990). For these two reasons, ambivalent behavior cannot be considered as an emotional reaction caused by frustration because of weaning.

There is a possibility that this behavior is characteristic of only some individuals. Though this possibility cannot be denied until more data is collected, it may not be mere the result of individuality because two mother-infant pairs showed the same behavior.

Such ambivalent behavior towards the mother is often observed in human infants. The conflict with mother is said to appear as a growing step in child development related to ego-control. Rousenbluth (1984) introduced a two-year-old girl who answered "No!" when her mother suggested taking a walk, but who then put on her coat as if to go.

but who then put on her coat as if to go. This sort of reaction is thought to be the beginning of ambivalent behavior. A conflict begins to arise in the infants' mind and three-year-old infants feel ambivalent emotions, "love and hate" toward their mother, a process indispensable to the development of an infant's ego. The question of whether chimpanzee ambivalent behavior equals that of human infants cannot be solved yet, for it relates to the problem of whether chimpanzees have an "ego" like humans. This problem relates to the question about the "chimpanzee mind". In everyday life, most humans, and many non-human animals as well, seem to operate on the premises that (a) the more that other creature looks like us, the more likely it can do anything that we can do; (b) however, there is no substitute for direct experience, because appearances can be deceptive and living beings are full of surprises (Heltne, 1989). And now we learn more about the similarities and differences between chimps and our own, for example, emotions, strong family relations, helpfulness, tool use, fabrication, forethought, insight, language, the overwhelming ability to modify our environment, and the importance of individual history as being among our distinguishing characteristics. Fouts (1989) even said "(These result indicate that) much like humans, chimps talk to themselves in sign language." If chimps can do so, it will not be so a fantastic idea to suggest the development of chimpanzee mind is complexity like humans. This point will be researched in the future with the collection of more data.

It seems certain that three or four-year-old chimpanzee infants do have some conflict with their mother.

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