

# Integration of a hand-reared chimpanzee (*Pan troglodytes*) infant into a social group of conspecifics

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**Abstract** Rejections of infants among non-human primates occasionally occur in the wild as well as in captive settings. Controlled adoptions of orphans and introductions of individuals into new groups are therefore sometimes necessary in captivity. Consequently, behavioral research on integration procedures and on the acceptance of infants by adoptive mothers is much needed. In this study, the introduction and subsequent adoption were examined in an 18-month-old hand-reared chimpanzee (*Pan troglodytes*). The infant was introduced into an age/sex-diversified social group of conspecifics at Furuvik Zoo, Gävle, Sweden, and continuous focal data was collected during the final stage of integration, including infant care exhibited by the group members and the infant's secure base behavior. The infant was successfully integrated into the group and engaged in positive social interactions with all group members. An adult primiparous female chimpanzee formed a bond resembling a mother–infant relationship with the infant, which continues to be maintained at publication. However, the female initially showed very limited interest in the infant. It was, in fact, two other younger female group members that exhibited most infant care. The infant's secure base behavior patterns indicate that she adapted well

to the new circumstances in the chimpanzee group as the integration progressed. This provides evidence that a final adopter does not necessarily initially show maternal interest and that there can be flexibility in maternal behavior in adult chimpanzee females. Moreover, the methods applied employing gradual familiarization with all the group members and the use of an integration enclosure, may have contributed to a successful result. These findings extend our knowledge of introduction procedures in captivity as well as provide information on foster mother–infant attachment in chimpanzees.

**Keywords** Integration · Adoption · *Pan troglodytes* · Captive management · Caregiving behavior · Secure base

## Introduction

Rejection of newborns by chimpanzee mothers does occur occasionally, and the majority takes place in captivity by first-time mothers who often have no prior experience of infant care (Bloomsmit et al. 2003). There are also cases of chimpanzee mothers exhibiting poor maternal competence (e.g., transporting the infants wrongly by dragging or pushing, over-grooming, giving an insufficient amount of body contact, and being generally unresponsive to the infant's signals) out of sometimes unclear reasons (Bard 1994). Therefore, controlled adoptions of orphans and introductions of older chimpanzees into new groups are fairly frequent in zoos and sanctuaries. Thus, empirical research on introduction procedures and on acceptance of infants by adoptive mothers is of importance.

Pinpointing the key factors for a successful introduction and integration of chimpanzee infants is complicated. Varying aspects and conditions must be accounted for and

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procedures typically vary from one case to another, depending on facility arrangements, target group structures, individual variations, ages, and dominance rank of group members (Brent et al. 1997). According to Pazol et al. (1998), a successful integration in chimpanzees occurs when the infant engages in positive social interactions with all members of the group. Meder (1990) used social play with all group members as a measure of successful integration in gorillas, and considered play with the dominant male as an indication that integration was complete. Bashaw et al. (2009) used, amongst other criteria, a decrease in the infant's interest in people; more specifically, the infant should direct less social behavior at humans as it became more comfortable with interacting with other chimpanzees. Furthermore, an introduction may involve risks as the hand-reared infant may lack appropriate social skills, and therefore elicit aggressive behavior from group members (Bashaw et al. 2009). This is a concern especially in cases where adult males are involved in the integration, and infants can get injured or even killed in the process (Meder 1990; Abello and Colell 2009, for gorillas). One way to avoid potential risks of these kinds and to facilitate group integration involves introducing the infant to experienced adult females first (Meder 1990; Jendry 1996; Pazol et al. 1998; Bashaw et al. 2009). This may lead to an adult female becoming a surrogate mother to the infant and developing and maintaining a mother–infant-like bond. Adult female chimpanzees have been known to adopt young infants in captivity (Palthe and van Hooff 1975; Pazol et al. 1998; Bashaw et al. 2009), as well as in the wild (Nishida 1983; Uehara and Nyundo 1983; Nishida et al. 2003; Wroblewski 2008). Male chimpanzees have likewise been documented to adopt orphaned infants in the wild (Boesch et al. 2010). These relationships often involve nest-sharing, carrying, retrieval, and intervening to reduce risk to the infant, and many seem to substitute fully for that of mother–offspring (Berman 1982; deWaal 1982 see Thierry and Anderson 1986, for a review of adoption in nonhuman primates).

In order for an adoption to occur, there has to be a change or shift of attachment from the primary caregiver, the mother, to another attachment figure (Dolhinow and DeMay 1982). The term *secure base* describes a human infant's characteristic behavioral pattern of exploration of its surrounding environment by making short trips away from the mother, returning back and moving away again with the mother as a secure base (Ainsworth and Bell 1970). This behavior is also present in chimpanzee infants (e.g., Okamoto-Barth et al. 2007), and it has also been reported that hand-reared chimpanzees use their human caregiver as a secure base when exploring novel environments (Miller et al. 1986). In the present case, the infant had to change its secure base from a human caregiver to a chimpanzee over the course of the integration period.

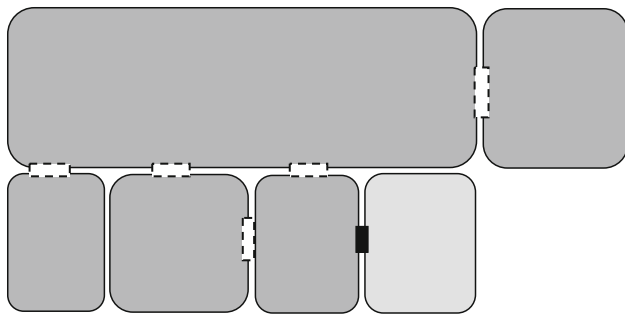
Here, we present a case of introduction and subsequent adoption of an 18-month-old hand-reared female chimpanzee (*Pan troglodytes*) infant into an age/sex-diversified social group of conspecifics at Furuvik Zoo, Gävle, Sweden. The introduction process was initiated when the infant was less than a year old and it was gradually familiarized with all the group members. Data was collected on caregiving behavior exhibited by the group members as well as on the infant's secure base behavior. The study was conducted at the final stage of introduction, when the infant was between 16 and 18 months of age and an integration enclosure was used.

## Methods

### Subjects

The infant was born in June 2008 at Kolmården Zoo in Sweden. Her mother (who had successfully reared two offspring) did not show any signs of caregiving behavior, apart from occasional carrying the newborn. For long periods of time, she neglected the infant and even lent her to young males (Ing-Marie Persson, pers comm.). After 3 days, zoo personnel could finally retrieve the infant and she was subsequently hand-reared. In the chimpanzee group at Furuvik Zoo in Sweden, an almost identical introduction of another infant had been carried out successfully approximately 4 years earlier, so this became the target group for the introduction of the present infant. The infant was moved to Furuvik Zoo and hand-reared by staff, primarily by the head of the primate department at the zoo, Ing-Marie Persson (abbr. IP). IP is able to go into the group and interact with all of its members while carrying infants, which potentially facilitates introduction procedures. All group members thus had extensive experience with the infant prior to the study from the time the infant was three weeks old. One adult female (AF2) was often handed the infant by IP and therefore had experience of carrying it around. Note, however, that in accordance with national and European zoo policies, entering a chimpanzee enclosure as a human caretaker is potentially highly dangerous and is not a recommended procedure.

At the time of the study, the chimpanzee group ( $n = 5$ ; one male, four females) consisted of one adult male (age during study period in parentheses): AM (31); two adult females: AF1 (28) and AF2 (25); one subadult female, SF (9); and one juvenile female, JF (5). Hereafter, we refer to all individuals except the infant as “the group” unless explicitly stated otherwise. The subjects were unrelated to each other and it was a non-reproducing group. The two adult females were both primiparous. However, their offspring did not survive their first year of life. AF2 was wild-caught and came to Sweden at the age of two. JF was born



**Fig. 1** Simplified map of the indoor facility. The *light grey area* illustrates the integration enclosure where the infant and a human caregiver were located during the initial 4 weeks of the integration period. The enclosure was connected to the chimpanzee group facility with an entry only the infant could fit through

at Kolmården Zoo and was introduced into the group in 2005, whereby AF2 became her foster mother.

The group was housed in an indoor facility consisting of several interconnected enclosures of different sizes, with the possibility of division between them. During the first 4 weeks of the study, an integration enclosure was used, in which both the infant and a human caregiver were located. The room was approximately 9 m<sup>2</sup> and connected to the chimpanzee enclosures by a small entry through which only the infant could fit (for a map of the integration enclosure see; Fig. 1, for photos see; Online Resource). The following 5 weeks, the infant was moved into the chimpanzee group and had no access to a human caregiver or the integration enclosure.

#### Data collection

The study was carried out during the final stage of the integration, over a period of nine consecutive weeks (Oct–Dec 2009), at Lund University Primate Research Station Furuvik and was approved by Uppsala’s Ethical Committee on Animal Experiments (Dnr. C199/9, “Observationer av vardagligt och spontant beteende hos schimpans, orangutang och gibbon”). Continuous focal sampling of the infant (Altmann 1974) was collected three times per week, 4 h per day (two consecutive hours before noon, 2 h in the afternoon), i.e., 12 h/week. Overall, a total of 108 h of data was collected and analyzed. Notes as well as contextual data were taken ad libitum.

Frequency and duration of all caregiving and play behavior exhibited by the group members specifically directed towards the infant were collected. Caregiving behavior included *dorsal* and *ventral carrying*, *grooming*, and *sitting in body contact with the infant*. Play behaviors included both rough and gentle activities such as tickling, holding, wrestling, chasing, pushing, and mock-biting the infant.

To examine the infant’s secure-base behavior, the following aspects were measured: (1) the frequency of secure

base bouts (SBB), i.e., trips of exploration from the secure base, (2) the duration (min) of a bout, and (3) the maximum distance (m) from the secure base. The distances were divided into three classes: 1–5, 6–10, and 11–15 m. The first 4 weeks the SBBs were measured from when the infant left the integration enclosure where the human caregiver was located. Subsequently, the SBBs were measured from the new chimpanzee caregiver when the infant was permanently in the group.

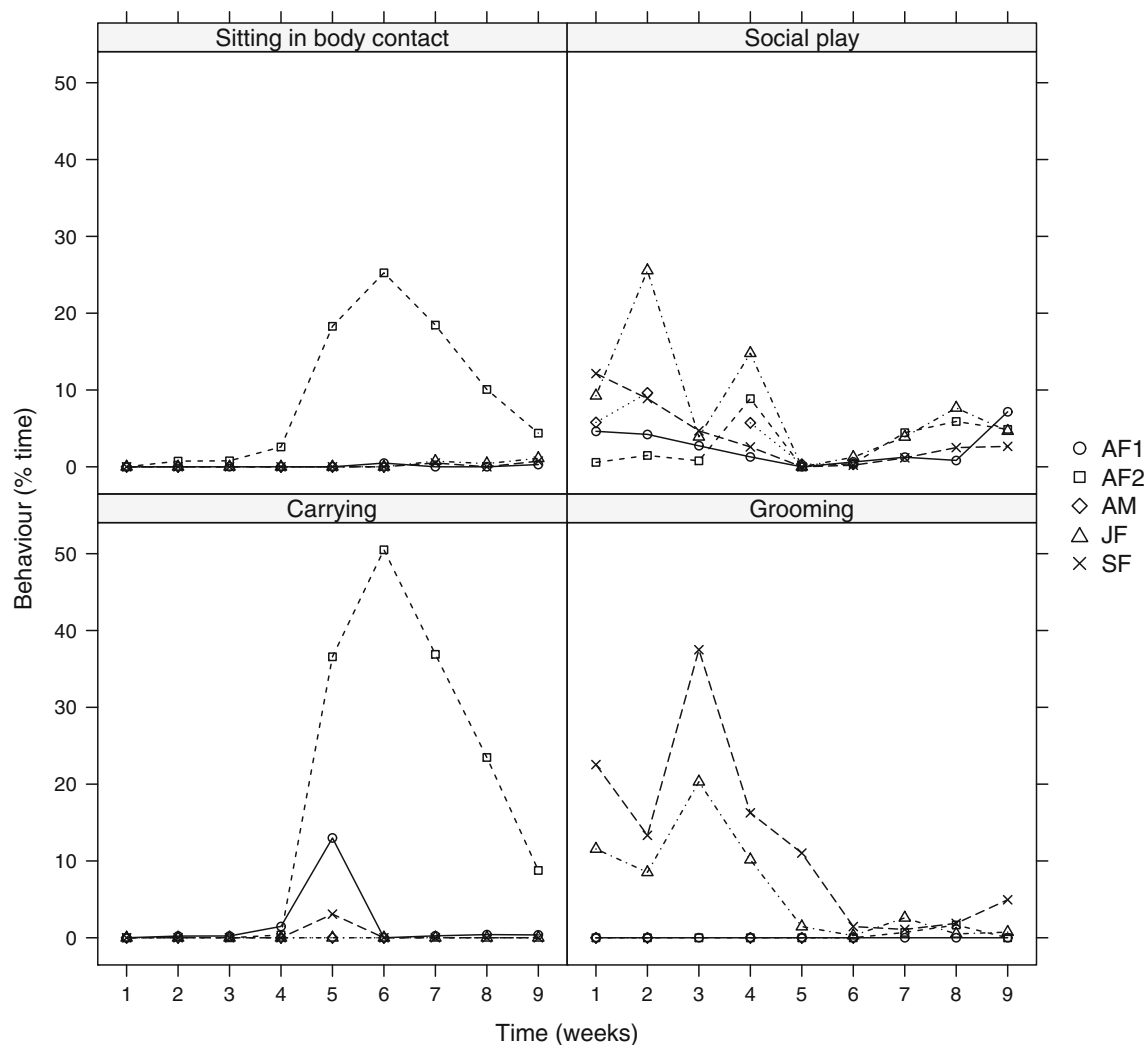
#### Results

##### Week 1–4: gradual introduction using the integration enclosure

During the first 4 weeks in which the integration enclosure was used, the infant had the opportunity to interact with all group members, including the male, the subadults, and the adult females. The patterns of interaction differed across the group members. The subadults JF and SF frequently sat in front of the infant’s entry, which separated the integration enclosure from the rest of the chimpanzee group’s enclosures, and waited for her to come out (for photographs see Online Resource). When she did, they either started playing with her or grooming her (Fig. 2). AF1, AF2, and the male, however, seemed less interested in the infant in the beginning, but occasionally interacted socially with the infant by playing with her (Fig. 2).

##### Week 5–9: observational data on caregiver shift

In week 5, the infant’s permanent transition into the chimpanzee group took place, and its contact with human caregivers ended. This decision was taken by IP and it was based on the general time-frame and overall behavior exhibited by the infant and the five group members over the integration progress (e.g., duration, frequency, and distance of SBB made by the infant, as well as interaction time with the group). At this breaking point, at which IP left the integration enclosure while the infant socialized with the group, the infant exhibited acute separation distress. She emitted high distress calls and ran about the enclosures. The group members seemed confused and stayed in the background, but occasionally approached the infant. AF2, on the other hand, periodically followed her around and initiated contact by opening her arms or reaching after her. The infant sporadically sought refuge in AF2, and clung to her back or belly, but it was not until after 45–60 min of exhibiting distress behavior that the infant clung to AF2 almost permanently, though still emitting loud distress calls. The infant exhibited anxious behavior for approximately 2 weeks after the caregiver shift, particularly when a former human caregiver was sighted or heard. It took approximately



**Fig. 2** Percentage of time a specific group member interacted with the infant over nine consecutive weeks. *AF1* adult female, *AF2* adult female, *AM* adult male, *JF* juvenile female, and *SF* subadult female. *AM* was absent during week 3, 7, 8, and 9

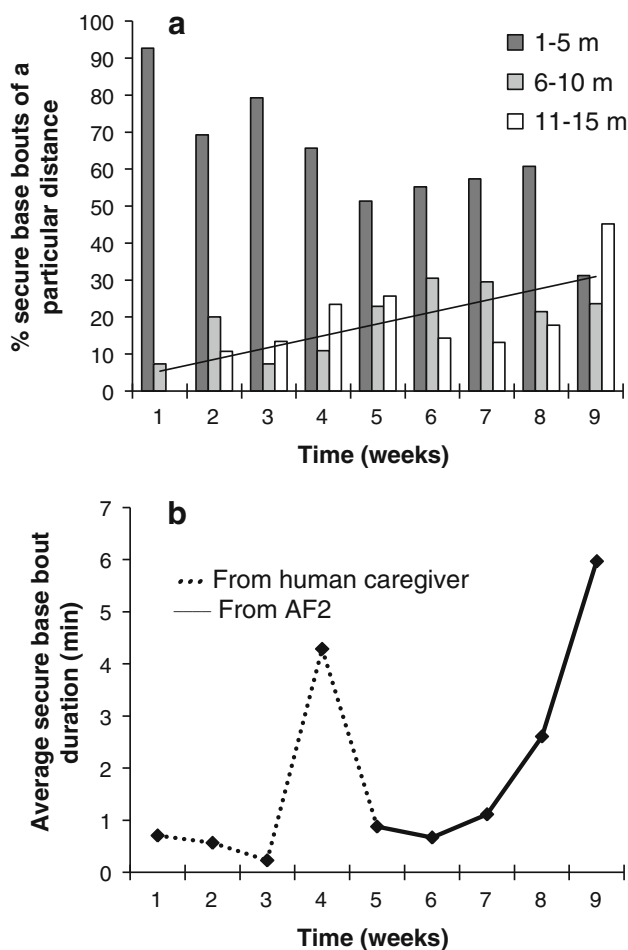
4 weeks for the infant to display behaviors that reflect a secure emotional state, such as social and solitary play, exploration, eating, and being groomed by the other group members. By week 8, the infant predominantly moved around on her own and did not cling to *AF2* much, nor did she emit distress calls, even when a previous human caregiver was present. The most frequent caregiving behavior exhibited by *AF2* was dorsal carrying. As the introduction progressed, however, *AF2*'s interactions started to increasingly include activities such as grooming and playing. It should be mentioned that *AF2* had frequent experience of carrying around and interacting with the infant prior to the study, when *IP* habitually entered the chimpanzee group with the infant and let *AF2* handle her.

#### Caregiving behavior

As noted, a sudden and clear caregiver shift from human to the adult female *AF2* occurred in week 5 when the infant's

contact with humans was terminated. From having dedicated ~3 % of time to infant care behaviors in week 4, this increased to ~55 % in week 5 for *AF2* (Fig. 2). From that point onwards, she exhibited more caregiving behaviors towards the infant than any other group member. The predominant behaviors exhibited by *AF2* were carrying the infant and sitting in body contact with her.

The difference in the frequency of caregiving behavior among the group members was significant, with *AF2* exhibiting the highest frequency ( $\chi^2 = 951.9$ ,  $df = 4$ ,  $p < 0.001$ ). Three weeks after the infant's transition into the group (week 7), the male exhibited aggressive behavior towards *AF2* and the infant. He was, as a result, separated from them during week 7, 8, and 9, and consequently shows lower frequency and percent time values. He was also in different enclosures in week 3. Therefore, only limited conclusions can be drawn from the male's data. The main behavior displayed by the male was playing with the infant (Fig. 2).



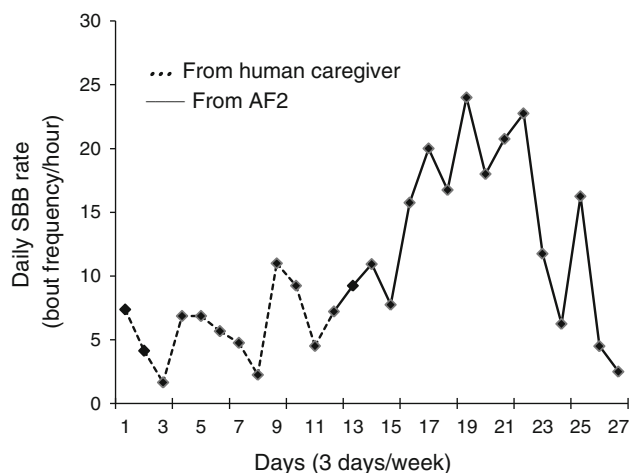
**Fig. 3** **a** Differences in secure base bout distance over the study period. The trendline shows the slope of SBBs (11–15 m). **b** The average duration of a secure base bout over 9 weeks

#### Secure base pattern

The number of SBBs with a maximum distance of 11–15 m from the infant's caregiver increased over the study period (Fig. 3a,  $k = 3.55$ ,  $R^2 = 0.48$ ). Additionally, the average duration of a SBB also increased progressively after week 5 (Fig. 3b). This measurement was calculated by dividing time the infant spent away from its secure base by the number of SBBs for that week. The daily rate of SBBs (bout frequency/hour) made by the infant also increased over the integration period and peaked by day 19 (week 7). The number then decreased over the last 2 weeks, with an exception for day 25 (Fig. 4).

#### Discussion

Pazol et al. (1998), Meder (1990), and Bashaw et al. (2009) used several criteria for evaluating the success of integrations of infant great apes into new groups. The criteria they



**Fig. 4** Daily rates of secure base bouts (frequency/hour) over the integration period. The *dashed line* shows the secure base bouts the infant made with the human caregiver as a secure base. Conversely, the *solid line* is for when the infant was permanently in the group with AF2 as secure base

used include (1) positive social interactions between the infants and all other members of the group, (2) social play with all group members, and especially with the dominant male, and (3) a decrease in the infant's interest in people, more specifically, the infant should direct less social behavior at humans as it becomes more comfortable with interacting with other chimpanzees. These requirements seem to have been met in the present case, although systematic data lacks for the last requirement. In addition, the infant formed a bond with one adult female resembling a mother–infant relationship, which continues to be maintained at publication, indicating a successful introduction. As AF2 had previous experience of foster parenting, the adoption had been anticipated. Alloparental experience facilitates the acceptance of infants in, for example, tamarins (Cleveland and Snowdon 1984) and in rhesus macaques (Holman and Goy 1980). However, the adoption was unusual in that it was not until week 5 that AF2 started to show caregiving behaviors. From hardly exhibiting any caregiving behavior in the beginning, AF2 now cared for her exclusively. As noted earlier, the predominant behaviors exhibited by AF2 were carrying the infant and resting in body contact with her, while JF and SF mostly interacted with the infant by playing or grooming her (Fig. 2). Thus, in the present case, the behaviors carrying and sitting in contact with the infant seem to be the behaviors that best predict an adoption, as opposed to grooming and playing. The percentage of time AF2 exhibited caregiving behavior gradually decreased from week 7. This was, however, likely due to the infant's increasing exploration and socialization with the rest of the group members (see secure base results, Figs. 3, 4). Yet, the infant always returned to AF2 for safety and comfort.



There are a few possible explanations as to why AF2 might have shown limited interest and care behaviors in the beginning of the introduction. One possible reason could be that JF, AF2's previous adoptee, was not fully independent of her and could have influenced her initial behavior. Chimpanzees are dependent on their mothers for up to 6 years (Goodall 1986), and JF was 5 years of age during the study. It should, however, be noted that interbirth intervals and therefore age of dependent young can vary dramatically between field and captive settings (e.g., Pusey 1983; Tutin 1994; Fragaszy and Bard 1997). Another explanation could be that AF2 did not feel comfortable with the setting and the human caregivers in the integration enclosure. AF2 is somewhat reserved and selective in the humans she interacts with (Ing-Marie Persson, pers. comm.). In addition, in the beginning of the introduction, AF2's care might have been unnecessary as JF and SF's interest in the infant was extensive at this point. However, since AF2 had already formed a relationship with the infant, including caregiving behaviors (e.g., carrying), prior to the procedure with the integration enclosure, her responses during the termination of this procedure was not surprising. The infant showed much stress when separated from her human caregivers, which AF2 responded to. As long as the infant could seek comfort at a human secure base, there was no opportunity for AF2 to give these responses. It is also clear that the infant entered a protest phase at the point of separation, but it might be the case that the care of AF2 prevented this from being a prolonged protest, and prevented the infant from entering despair (Bowlby 1969, 1973; Bard and Nadler 1983).

Male aggression can pose a potential risk in integrations of infant great apes (Meder 1990). The male in the present study, however, had not exhibited any threatening behaviors towards JF during her similar integration in 2005. Therefore, there was little reason to expect aggression in the present case. However, the male did show aggressive behavior towards the infant during points of the integration period, in forms of chasing and trying to hit AF2 with the infant on her back. Consequently, the male was placed in a different enclosure. After a couple of weeks, he was gradually allowed to spend more time together with AF2 and the infant. This highlights the unpredictability of the situation and the importance of close monitoring of the behavior of all individuals involved during an integration process.

All data recorded of the infant's secure base behavior indicates that she adapted well to the new circumstances in the chimpanzee group as the integration progressed. She explored the surroundings for longer periods of time before returning to the attachment figure (Fig. 3b), and the trips increased in distance from the secure base (Fig. 3a). If the infant would not have adapted well, we would have expected that she would for example, have spent less time

interacting with the group members, and that she would not have wanted to leave the integration enclosure during the first 4 weeks. In addition, in case of maladjustment to the reintroduction, the infant would potentially have shown signs of depression due to maternal deprivation by behaviors such as lack of playing, increasing self-directed activities, increased isolation, and indifference to an adoptive mother (Dolhinow and DeMay 1982). Our results challenge these predictions (e.g., Fig. 2).

Rejection of neonates in chimpanzees in captivity is a well-known problem. As a consequence, hand-rearing and subsequent introduction of orphans into new conspecific groups is occasionally required. Research in integration processes of this kind is therefore much needed. This particular study provides information on the use of an integration enclosure and a gradual familiarization process. These procedures might be important in easing the transition for an infant as they provide it with the opportunity to develop social skills, although future studies are needed to further pinpoint factors that contribute to successful integration. In particular, it is unknown in the present case what importance was played by the pre-exposure to the infant the chimpanzees had by IP entering the enclosures with the infant prior to the integration procedure covered in this paper. The acceptance of the infant could arguably be dependent on the acceptance of IP, the original foster mother. If this is true, integration success could be dependent on the rapport between human foster parents and the target chimpanzees. Such relationships can be established without entering the actual cages which, we must stress again, is generally not recommended. If the relationship between IP and the chimpanzees was atypical but crucial, this could potentially make the present integration technique impossible to generalize to other captive settings. This study also shows an example of a sudden caregiver shift in chimpanzees, which reflects a behavioral flexibility in maternal motivation in chimpanzees, here probably brought about by contextual circumstances. In addition, this study supports earlier evidence of formation of affiliative social bonds between infants and adult females in great apes that resemble that of mother–infant attachment (Palthe and van Hooff 1975; deWaal 1982; Pazol et al. 1998). Finally, this study also contributes with secure base behavioral data of an adopted infant, which can be compared to similar cases. Although this study is based on a single case of introduction and adoption, making findings from such procedures accessible is highly relevant for further analysis of key factors influencing the success or failure of integrations of chimpanzee infants into social groups.

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