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Short Report  
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Maternal Responses to a 1-Year-Old Male Offspring with Severe Injury in a Free-Ranging Group of Japanese Macaques

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INTRODUCTION

Primates living in the wild are sometimes severely injured. Investigation of the bones of several primate species suggests that not only adult but also juvenile individuals can recover from fractures (Bulstrode *et al.*, 1986). Although they did not present any evidence, Bulstrode *et al.* (1986) speculated that, in some primate species, juvenile individuals with severe injuries survive as a result of assistance from their parents.

Non-human primate mothers may care for their injured infants, and such maternal behaviors are sometimes even directed toward dead infants (Berkson, 1970; Nakamichi *et al.*, 1996). Sugiyama *et al.* (2009) showed that while Japanese macaque (*Macaca fuscata*) mothers sometimes carried their dead infants, most mothers did not carry dead infants that were older than 1 month of age. Berkson (1970) described rhesus macaque (*Macaca mulatta*) mothers carrying 1-month-old infants that had been experimentally blinded. It is probable that maternal behaviors toward injured or dead offspring occur only in the early period of infancy. Chapman & Chapman (1987) reported a case in which a female spider monkey (*Ateles geoffroyi*) cared for her injured juvenile offspring. However, very few

studies have reported maternal behaviors toward juvenile offspring that have severe injuries, and no studies have indicated the contexts in which primate mothers direct maternal behaviors toward their injured juvenile offspring.

Unlike dead offspring, injured juvenile offspring can demand maternal attention through distress calls. Distress calls by offspring elicit maternal behaviors (Maestripieri & Call, 1996). Therefore, maternal affiliative behaviors might be directed toward injured juvenile offspring much more frequently when the offspring emit distress calls than when they do not.

In the Katsuyama free-ranging group of Japanese macaques, one male yearling suffered severe injuries to his feet, causing him to drag his legs while moving. Prior to the occurrence of these injuries, one of the authors (U.M.) routinely observed not only the mother of the injured juvenile but also two other females with yearlings. Therefore, we can offer valuable information about maternal behaviors toward this juvenile offspring before and after he received injuries and compare the behaviors of the mother with the injured offspring to those of mothers with non-injured offspring. Here, we investigated the following three questions. (1) Did the frequency of the affiliative

behaviors between the mother and her offspring change after the offspring was injured? (2) Did the frequency of the offspring's distress calls change after receiving injuries? (3) Did the mother respond to the needs of her injured offspring?

METHODS

We observed a free-ranging group of Japanese macaques at Katsuyama, Okayama Prefecture, Japan. The Katsuyama group has been artificially provisioned since 1958. The genealogical relationships through maternal lines and the ages of all individuals born after 1958 were known at the time of the study (Itoigawa *et al.*, 1992). In September 2011, the group contained 146 individuals, including 57 adult females (≥ 5 years of age). All group members were identified by facial and body features. More information about the study group is reported elsewhere (Itoigawa *et al.*, 1992).

We found that Bs'10 (formal name, M10 Barisa' 71'84'98'; born on April 10, 2010) received a severe injury to his left leg on November 25, 2010 and dragged the leg. He had some scratches on his body, but no other external wounds were observed. On December 5, Bs'10 was observed dragging both of his legs. Again, no noticeable extreme wounds were visible on the surface of his body. We observed him on December 28, 2011, but he has not been seen since that time.

The injured yearling was found while observing 14 adult females as focal animals for another research project. Bs (parous and 13 years of age), who was the mother of the injured yearling (Bs'10), was one of these 14 focal females. Two other females (Pk and Ez: both females were primiparous and 7 years of age) who each had a 1-year-old offspring (Pk'10: male, born on April 9, and Ez'10: female born between June 5 and 8) were also focal females, and they were therefore selected as

controls for the present study. These three adult females did not have other offspring. U.M. observed them by using 30-min focal animal sampling and recorded their behaviors with a digital video camera. Each of the three following categories of behavior was recorded for each minute of digital footage: maternal grooming of offspring, mother-offspring physical contact, and mother-offspring proximity (< 2 m). We also recorded all distress calls (gecker or scream) uttered by offspring when mothers and offspring were in proximity to one another. Observations were not focused on a particular time of the day, and the recorded behaviors did not seem to be strongly affected by the time of the day. We analyzed the data collected for the 2 months prior to the injury of Bs'10 (period 1) and those collected for 1 month after the injury occurred (period 2). Bs, Pk, and Ez were observed for a total of 60, 90, and 90 min, respectively, in period 1 and 119, 63, and 114 min, respectively, in period 2. Statistical analyses were performed using R. 2.14.0.

RESULTS

Grooming, contact, and proximity between mothers and their offspring

Figure 1 shows the proportion of data points categorized as maternal grooming, contact, non-contact proximity, and non-proximity before and after Bs'10 was injured. The proportion of these behaviors to the total number of recorded behaviors differed significantly between periods 1 and 2 for each mother-offspring pair (Fisher's exact test, $p < 0.01$, for all pairs). Residual analysis indicated that the proportion of total observations categorized as maternal grooming and contact increased significantly and that of non-proximity decreased significantly for the Bs-Bs'10 pair. In contrast, the proportion of total observations categorized as

Fig. 1 Proportion of observations classified as non-proximity, proximity, contact, and grooming for three mother-offspring pairs of Japanese macaques before one of the offspring (Bs'10) was severely injured (period 1) and after the injury occurred (period 2).

grooming and non-proximity decreased significantly for the Pk-Pk'10 pair. For the Ez-Ez'10 pair, the proportion of observations categorized as grooming significantly decreased, while those categorized as contact significantly increased. These findings suggest that Bs groomed and was in contact with Bs'10 more often after Bs'10 received injuries than before Bs'10 was injured, while Pk and Ez decreased the amount of time spent grooming their offspring as their offspring aged.

Distress calls of offspring

Bs'10 was not observed to emit any distress calls in period 1, but 10 distress calls were recorded in period 2. The number of calls in periods 1 and 2 were 8 and 1, respectively, for Pk'10, and 4 and 4, respectively, for Ez'10. We examined whether offspring emitted distress calls during each proximity event. A proximity event was defined as the period between the start and end of mother-offspring proximity. In period 1, Bs'10 had 4

proximity events but did not emit any distress calls. In contrast, in period 2, he emitted distress calls in 6 of 8 proximity events. This increase in the ratio of proximity events with distress calls to the total number of proximity events was weakly significant (Fisher's exact test, $p = 0.06$). However, this ratio was not significantly different between periods for the other two pairs. That is, an increase in distress calls was found only for the Bs-Bs'10 pair.

We compared the number of distress calls made by offspring while in contact with their mothers to the number of distress calls made by offspring when in proximity to, but not in contact with, their mothers. We found that Bs'10 emitted more distress calls when Bs'10 was not in contact with Bs than when he was in contact with her (9 vs. 1: binomial test, $p < 0.05$). In the other two pairs, the values did not differ significantly between the two situations (Pk'10: 5 vs. 4, Ez'10: 4 vs. 4).

Maternal responses to distress calls by offspring

In order to investigate whether Bs responded to distress calls uttered by her injured offspring, we counted the number of distress calls that were followed by maternal grooming within 20 s for each of the three mother-offspring pairs. The proportion of distress calls made by Bs'10 after which Bs groomed Bs'10 was significantly higher (7 of 10 distress calls) than the proportion of distress calls that were followed by grooming in the other two mother-offspring pairs (1 of 9 distress calls for Pk and 1 of 8 distress calls for Ez; Fisher's exact test, $p < 0.01$). These findings indicate that, in response to Bs'10's distress calls, Bs groomed him more frequently than the other two mothers groomed their offspring.

DISCUSSION

Non-human primate species, even apes, rarely interact with severely injured group members (Byrne & Stokes, 2003). Mothers and their offspring, who are strongly bonded to each other, are the exception, as mothers sometimes take care of their injured infants (Berkson, 1970). However, there is little information about maternal behaviors toward offspring injured during the juvenile period. Our study showed that a Japanese macaque mother performed affiliative behaviors more often with her male juvenile offspring after he was injured than she did before he received the injuries.

Our study also showed that the injured juvenile male emitted more distress calls when he was not in contact with his mother after he received injuries than he did prior to injury. These findings suggest that he might have sought and required contact and grooming from his mother. In addition, his mother responded appropriately to his calls more often than the other two mothers responded to the calls of their uninjured juvenile offspring. In rhesus

macaques, the frequency of gecker peaks at the fourth month of age and then decreases (Patal & Owren, 2007). No distress calls were recorded for Bs'10 prior to his injuries. Such an unusual increase in distress calls following injury prompted responses by Bs.

It is a common observation that 1-year-old juvenile macaques do not depend a great deal on their mothers for nutrition and locomotion (Nakamichi & Yamada, 2010). In this study, we did not observe any attempts by the juvenile male to suck his mother's nipple or cling to his mother's body before or after receiving injuries. Nevertheless, he appeared to seek out contact with, and grooming from, his mother. A similar observation was reported in the Awaji Island group, albeit not quantitatively, by Nakamichi (2001). Directly after a 4.5-year-old peripheral male Japanese macaque lost his left foot, he frequently stayed near his mother and was frequently groomed by her. These findings indicate that injured juvenile males might come to seek out contact and grooming from their mothers.

Sugiyama *et al.* (2009) showed that the carrying of dead offspring by female Japanese macaques was rarely observed for offspring that were older than 1 month of age. In the present study, however, a Japanese macaque mother interacted with her injured yearling offspring more often than she did before he was injured. This change seemed to be at least partly due to his distress calls. Therefore, the presence of a requirement, as indicated by distress calls, probably results in the observed differences between maternal behaviors toward dead offspring and those toward injured offspring.

Conclusions should be drawn with caution from the present study because our study included only one mother with her injured offspring. Moreover, the observation period was not long. However, our finding that the Japanese macaque mother directed affiliative behaviors toward her injured juvenile

offspring that were dependent on his distress calls are an important contribution to the overall understanding of mothering behaviors toward juvenile macaques, which are usually somewhat independent of their mothers.

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(要約)

ニホンザル集団における怪我をした1歳齢のオスの子への 母親の反応

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勝山ニホンザル集団において、怪我をした1歳半のオスの子へ母親が行った行動を調べた。その子が怪我をする前後や、怪我をしていない同年齢の子を持つ2頭の母親との間で、その行動を比較した。1歳半のオスの子は後肢に怪我をしたため、後肢を引きずって移動するようになった。その母親は、以前に比べて、怪我をした子へ多く身体接触や毛づくろいをしていた。また、その子が怪我をする以前の観察中には、distress callは記録されなかったが、怪我をした後には、母親と接触していない時に、distress callを頻繁に発していた。怪我をした子の母親は、子のdistress callの後、他の2頭の母親よりも高い割合で、子に毛づくろいをしていた。これらの結果は、母親に強く依存してはいない1歳を過ぎた子が怪我をしたときに、子のdistress callに応じて、母親が子へ毛づくろいを多く行うようになったことを示唆している。

Keywords: distress call, grooming, injury, Japanese macaques, maternal behavior

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