The Hygienic Function of Social Grooming for a Provisioned Japanese Macaques (*Macaca fuscata*) : Focusing on Changing of Grooming Success Rate

ニホンザル（*Macaca fuscata*）餌付け群におけるグルーミングの衛生的機能：グルーミング成功率の変化に注目して

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Abstract

Social grooming is thought to serve both hygienic and social functions among Japanese macaques (*Macaca fuscata*). I performed a field study on a provisioned troop of Japanese macaques in Arashiyama, Kyoto, in order to understand the significance of the hygienic function of grooming. I divided grooming into two distinct actions, "searching" and "removing," and recorded the occurrence of each. I defined the ratio of occurrence of removing to that of searching as the grooming success rate. I found that the success rate in a given day tends to decrease, albeit not significantly; however, the success rate during each bout of grooming decreases significantly. There was a tendency for the success rate to come down when a grooming bout ended spontaneously. The results suggest that Japanese macaques try to remove parasites effectively. Therefore, I was able to verify the practicality of the hygienic function of grooming.
Key words: Japanese macaque, Social grooming, Hygienic function, Success rate

要旨

ニホンザル（*Macaca fuscata*）の社会的グルーミングには、衛生的機能と社会的機能があるとされている。本研究では衛生的機能の実態調査として京都府嵐山の餌付けニホンザル群を対象としてフィールドワークを行った。

グルーミングを、毛をかき分ける「探索行動」と外部寄生虫であるシラミの卵を取り除く「除去行動」に大分し、二つの行動をそれぞれ記録した。分析では「探索行動」に対する「除去行動」の比を「成功率」とした。調査の前半では個体追跡法を用いて 1 日の中での成功率の変化、後半では時刻と共に行動を記録して 1 グルーミングバウトの中での成功率の変化を分析した。結果、1 日の中での成功率の変化に関しては減少傾向が見られたがあまり明確なものではなかった。一方、1 バウトごとに分析すると自発的な終了の仕方の場合とくに減少している傾向が見られ、外的要因によって終了した場合と明らかな差があった。

これらの結果からニホンザルが効率的に寄生虫を取り除こうとする様子が明らかになり、衛生的機能の実態が確認できた。
重要語句：ニホンザル、グルーミング、衛生的機能、成功率

Introduction

It is now commonly accepted that social grooming (hereafter, grooming) among primates serves two types of functions, namely hygienic and social. The hygienic function of grooming is to remove harmful parasites from their bodies. Parasites sometimes cause anemia and dermatitis, among other problems. However, we have not been able to find many papers that report the death of primates due to parasites. This may be because primates spend much of their energy protecting themselves against parasites (1). The social function of grooming, on the other hand, serves to establish and maintain social bonds with grooming partners (2). Grooming behavior could provide clues as to how human beings have evolved an advanced cognitive capacity for complex interactions (3).

Most published studies have focused on social functions of grooming. For example, there has been an analysis of the relation between grooming and behavior both pre- and post-grooming (4). Grooming is often seen as an indication of affinity between two individuals. However, grooming also serves a hygienic function. Therefore, I decided to focus solely on the hygienic function and try to determine its importance.

Most studies to date have focused on only the duration or frequency of grooming (5). Therefore, I divided grooming into two separate actions: "removing" and "searching." I defined "removing" as the removal of louse eggs by the groomer from the groomee's hair and carrying them to its mouth. Sometimes, the groomer will use its mouth to remove louse eggs directly. I also regarded this as removing. As for

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"searching," I defined this as the groomer pushing the groomee's hair aside using the hand that is not used for removing. I defined the ratio of the number of removing action to that of searching as the success rate. Next, I analyzed how the success rate changed within each day and during a grooming bout. My aim was to use this analysis to clarify the hygiene function of grooming.

Materials & Methods

Data collection

I performed a field study to observe the grooming behavior of a provisioned troop of Japanese macaques (*Macaca fuscata*) in Arashiyama Monkey Park, "Iwatayama", Kyoto for 4 days (May 16, May 30, June 6, and June 15 in 2015).

On the first 2 days of the study (May 16 and May 30), I used the focal animal sampling method (6). The focal animal was the second highest-ranking female called *Hiruko* (Mino-63-69-74-83). The data were recorded between 10 am and 2 pm on both days. I counted the number of instances of both searching and removing by the groomer and recorded the duration of each instance per bout of grooming in which *Hiruko* was involved.

On the latter 2 days (June 6 and June 15), I used sequence sampling (6) for data collection. I searched for grooming pairs while walking about in the monkey park. After I found a grooming pair, I recorded grooming behavior regardless of whether *Hiruko* was included in the pair. I observed eleven bouts of grooming. When grooming began, I recorded the duration of each searching and removing action by the groomer using the stopwatch application of an electronic terminal. During several grooming bouts, I also recorded when the groomer changed the removing spot from which groomer was removing lice or when the groomee changed posture. When the direction of grooming between two individuals was changed, I regarded it as a separate grooming bout.

The total observation time was 14.5 h and I could observe grooming for 4 h 26 min of that duration.

Data analysis

For the data from the first two days, I calculated the success rate of each bout and analyzed how it changes in a day. For the data from the latter two days, I calculated the success rate for each minute and determined how it changed within a single bout. I defined the success rate as the ratio of the number of removing actions to that of searching. I used the Pearson product-moment correlation function to evaluate the data.

Results

On the first two days, I observed 20 bouts of grooming. During 17 of those bouts, *Hiruko* was groomed by other macaques and during the remaining 3 bouts, *Hiruko* groomed others. This means that she was groomed 85% and she groomed others 15%. She groomed her daughter, the highest ranking female, twice.

Figs. 1 and 2 show the success rate of each grooming bout on the first and second days, respectively. The coefficients of correlation between the success rate and the bout numbers were -0.17 for the first day and -0.31 for the second day, which were negative but not significant.

In the latter half of the study, I observed 9 grooming bouts. I focused on each bout and determined the success rate for every minute. The correlation coefficients between the success rate and time for the duration of a bout varied from indicating strong significance (Fig. 3) to no significance (Fig. 4). However, when the bouts were grouped according to how they ended, either spontaneously or due to an external cause, interesting results emerged. Among the bouts that ended spontaneously ($N = 5$), all five bouts showed a significant negative correlation coefficient (Fig. 5). The average correlation coefficient was -0.45. Conversely, the average correlation coefficient between the bouts that ended due to external causes ($N = 4$) was 0.15 (Fig. 5).

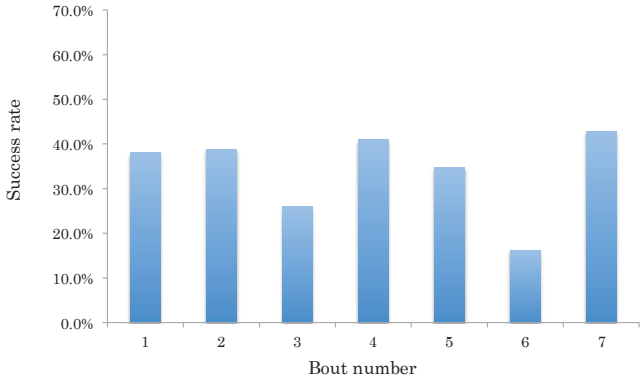

Fig.1. Success rate of each grooming bout on the first day (16 May). The coefficient of correlation between success rate and bout numbers is -0.18.

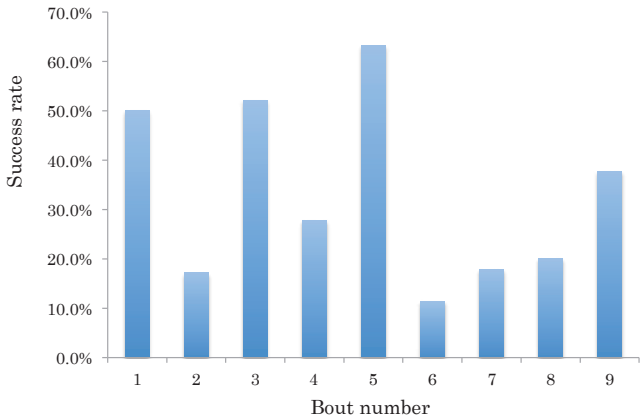

Fig.2. Success rate of each grooming bout on the second day (30 May). The coefficient of correlation between success rate and bout numbers is -0.31.

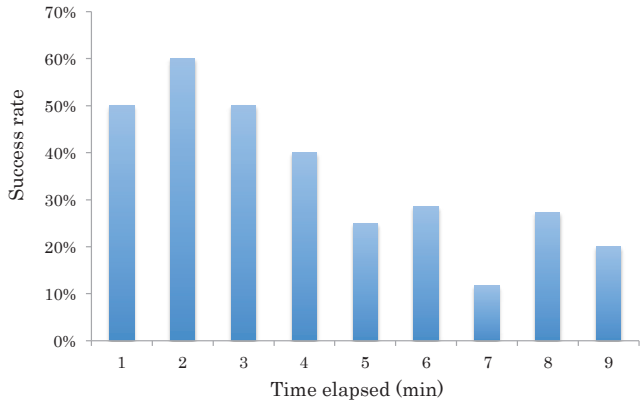

Fig.3. Change in success rate over time for a grooming bout which showed significant negative correlation between success rate and time for the duration of the bout. The correlation coefficient is -0.87.

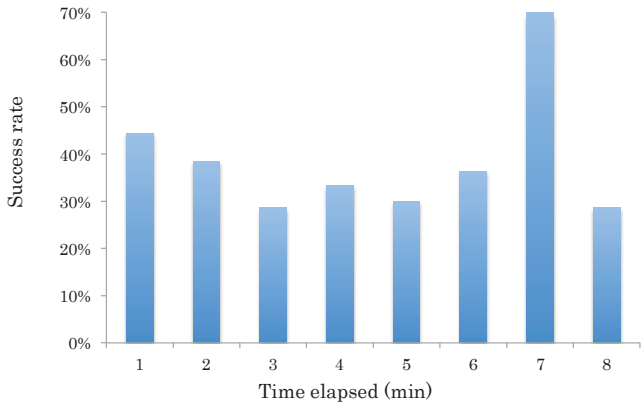

Fig.4. Change in success rate over time for a grooming bout which showed no significant correlation between success rate and time for the duration of the bout. The correlation coefficient is 0.15.

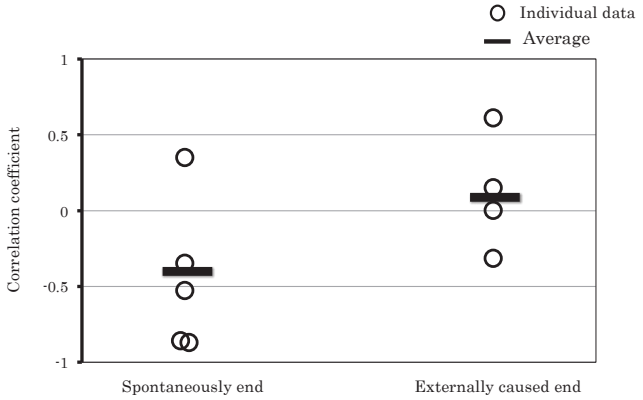

Fig.5. The distribution of correlation coefficients for grooming bouts that ended spontaneously compared to those that ended due to an external cause.

Discussion

The coefficients of correlation between success rate and bout numbers in a single day showed negative values but they were neither large enough nor were they statistically significant. However, I believe that this result does not necessarily mean that grooming has no hygienic function. For example, we have to bear in mind that some groomers are more skilled than others, and also that louse eggs may be more difficult to find on some parts of the body than others, especially on *Hiruko*, who has a bald patch on her back. This is despite a previous report that the ratio of removing to searching actions is the same for each body part (2).

For the latter half of this study, in order to exclude these factors, I focused on each grooming bout and recorded the duration (in seconds) of each instance of searching and removing activity. By doing so, two patterns of correlation emerged. From the difference between the two patterns, I can say that if the success rate goes down to a certain level, the macaques quit grooming. Considering bouts that ended due to external causes, I believe that if the groomers had not been interrupted by other macaques, their success rate would also have gone down. In other words, they tend to continue grooming until the success rate goes down.

In conclusion, I have verified the hygienic function of grooming among Japanese macaques. The macaques that I observed even seemed to specifically go for the hygienic function when grooming because they did not stop grooming spontaneously unless the success rate went down.

For future studies, louse ecology studies will help us learn more about grooming since grooming involves not only interactions between macaques but also between macaques and lice. The interactions may be influenced when lice lay eggs (e.g., during the day or at night). To research the success rate of non-troop males that have less opportunities to be groomed is also interesting to me. Furthermore, I would like to compare the difference in hygienic conditions between provisioned troops and wild, unprovisioned troops in light of their grooming success rates.

Acknowledgements

I would like to express my deep gratitude to Prof. Naofumi Nakagawa, Dr. Eiji Inoue, and Mr. Tatsuro Kawazoe of the Laboratory of Human Evolution Studies, Kyoto University for their supervision of my research project, without which this study would not have been possible. I am also deeply appreciative of the cooperation I received from the staffs at Arashiyama Monkey Park “Iwatayama”. Thanks are also due to ELCAS office members.

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