



Utility of social network analysis for primate behavioral management and well-being

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Abstract

New management strategies for detecting social instabilities and promoting social cohesion are needed to reduce aggression-based morbidity and mortality among captive groups of rhesus macaques. This study was conducted to determine the utility of social network analysis for deciphering patterns of aggression and wounding in rhesus macaques. Over 37,000 observations of affiliative, submissive and aggressive activities were collected over a 3-year period on ~1300 rhesus macaques housed in 13.2 ha enclosures. Data also were analyzed on management factors such as age/sex composition and matriline configuration that might promote or reduce aggression in rhesus macaques. Results suggest that social network measures such as subordination degree (social power), displacement fragmentation and groom reciprocity within social groups were not only significantly associated with rates of contact aggression and wounding but with the occurrence of severe aggressive outbreaks, known as cage wars. In addition, groups with a lower proportion of adult females and a more uniform distribution in the number of individuals across matriline exhibited higher social power and lower fragmentation. These data indicate that by manipulating group composition and matriline configuration of social groups to promote social cohesion and stability, behavioral managers may be able to reduce the level of aggression and aggression-based morbidity and mortality. These data also show that social network measures are valuable predictors of deleterious aggression and even cage wars indicating that such measures could be used to longitudinally track changes in social dynamics to detect significant instabilities, allowing managers to prevent severe outbreaks before they occur in populations of rhesus macaques and perhaps other non-human primate species.

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1. Introduction

In the breeding programs of many primate centers and other facilities in the US, rhesus macaques (*Macaca mulatta*) are housed in multimale–multifemale social groups in large outdoor corrals, which simulates the natural social and environmental features characteristic of the species, enhancing their reproductive performance as well as their psychological well-being. Despite the importance of this naturalistic social housing, one of the most difficult problems in socially housed rhesus macaques is their propensity for spontaneous bouts of deleterious aggression (Thierry et al., 2004). Although aggression serves crucial functions in preserving social structure and order in rhesus groups (Bernstein and Ehardt, 1985; Flack and de Waal, 2004), in a captive setting aggression can become prolonged, escalated and intensified to the degree that it results in serious physical trauma and reduced psychological well-being.

In the wild, rhesus groups are characterized by female philopatry and male dispersal; females remain in their natal groups and form dominance hierarchies according to their matrilineal kinship (known as matriline) while males emigrate from their natal groups at the beginning of the breeding season shortly before puberty, and may transfer groups throughout their lives in search of mating opportunities (Melnick et al., 1984). Female rhesus macaques very rarely leave their natal groups (Fooden, 2000).

Among females, rank remains relatively stable over a lifetime and is passed on to female offspring. Each female rises in rank above her older sister, and therefore when old, high-ranking females disappear or die, they are usually replaced by their youngest daughters, known as the youngest ascendancy rule. Dominance status and rank among males is not stable over a lifetime, compared to female rhesus macaques. Immature males inherit the rank of their mothers, but as they mature, their status changes based upon a combination of social and aggressive skills (Lindburg, 1971; Berard, 1999). Aggression is frequently used by both sexes to establish and reinforce social position, and aggressive behavior seen in macaques includes slapping, pushing, pulling fur, tail yanking, and biting as well as other non-contact behaviors such as displays and threats (Lindburg, 1971).

While social housing of rhesus as large multimale–multifemale breeding groups in outdoor corrals simulates the natural features of free-ranging rhesus macaques, because rhesus macaques rely so heavily on aggression to mediate their dominance relationships, there is enormous potential for aggression to escalate out of control when social groups become unstable (Bernstein and Ehardt, 1985), leading to severe wounding especially in the confines of a captive environment of densely housed groups. The dominance style of both captive and free-ranging rhesus macaques has been described as the most despotic of all macaque species by numerous experts on macaque behavior (de Waal and Luttrell, 1985). Both field and captive research have shown that this despotic dominance style is characterized by unidirectional aggression directed at subordinate individuals, frequent severe aggression, strong emphasis on kinship, and infrequent post-conflict affiliation (Flack and de Waal, 2004). Conflict asymmetry in dominance relationships is high and aggression plays a particularly important role in maintaining dominance relationships (Bernstein and Ehardt, 1985). Lower level non-injurious aggression such as chasing and threatening serves to maintain social structure, order and stability within as well as between matriline (Bernstein and Ehardt, 1985), but more severe aggression can result when dominance relationships between individuals become ambiguous or during conflicts over important resources (e.g., high quality food, reproductive opportunities). In captivity, such ambiguity can occur as a result of changes in management such as the removal of key individuals

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