Affiliative David's Scores: An Analysis of Social Change over Two Years in a Semi-Free Ranging Group of Japanese Macaques (*Macaca fuscata*)

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Introduction

Typically, dominance in primates is determined through aggressive interactions with initiation of aggression indicating higher dominance rank. David's Score analyses using aggression are frequently used to calculate dominance hierarchies in primates (de Vries et al., 2006). However, if fights are rare then it can be hard to identify male rank. Non-aggressive behaviors like grooming can also indicate rank based on directionality. For example, higher ranking males often receive more grooming more whereas lower-ranking males will give more grooming. Feeding priority can also be an indicator of rank since more dominant males can monopolize food resources (King et al., 2008). For this study, we were interested in: 1) the layout and variation in dominance based on grooming over time and 2) how this hierarchy compared to one based on access to food enrichment.

Subjects

Our study focused on a group of Japanese macaques *(Macaca fuscata)* housed in a one-acre corral at the Oregon National Primate Research Center in Beaverton, Oregon. Although this population included 17 adult male individuals throughout the study, we only included the 11 individuals present in both the 2018 and 2019 study seasons.

Data Collection and Analyses

We collected a total of 512.5 hours of behavioral data using 15-minute focal follows with 1-minute instantaneous scans. We calculated David's Scores for each male for 2018 and 2019 using grooming interactions. We then constructed a categorical hierarchy based on access to high-value food enrichment. Finally, we ran ANOVAs to test for significant variation between 1) David's Scores in 2018 and 2019 and 2) David's Score rankings and enrichment access rankings.

Equation 1: David's Score Calculation

$$DS = w + w2 - l - l2$$

w denotes sum of win values,
$w2$ is sum of weighted w values,
l is sum of loss values,
$l2$ is sum of weighted l values.

Table 1: : Dominance ranks for each subject calculated using grooming behaviors in year 2018 (gray) and 2019 (white).

ID	DS	RANK
M1	0.77	3
	0.39	3
M2	0.82	2
	0.45	2
M3	0.53	5 or 6 or 7
	0.30	5
M4	0.00	11
	0.00	11
M5	1.00	1
	1.00	1
M6	0.53	5 or 6 or 7
	0.25	7
M7	0.65	4
	0.26	6
M8	0.53	5 or 6 or 7
	0.32	4
M9	0.24	10
	0.21	8
M10	0.35	9
	0.15	9
M11	0.41	8
	0.06	10

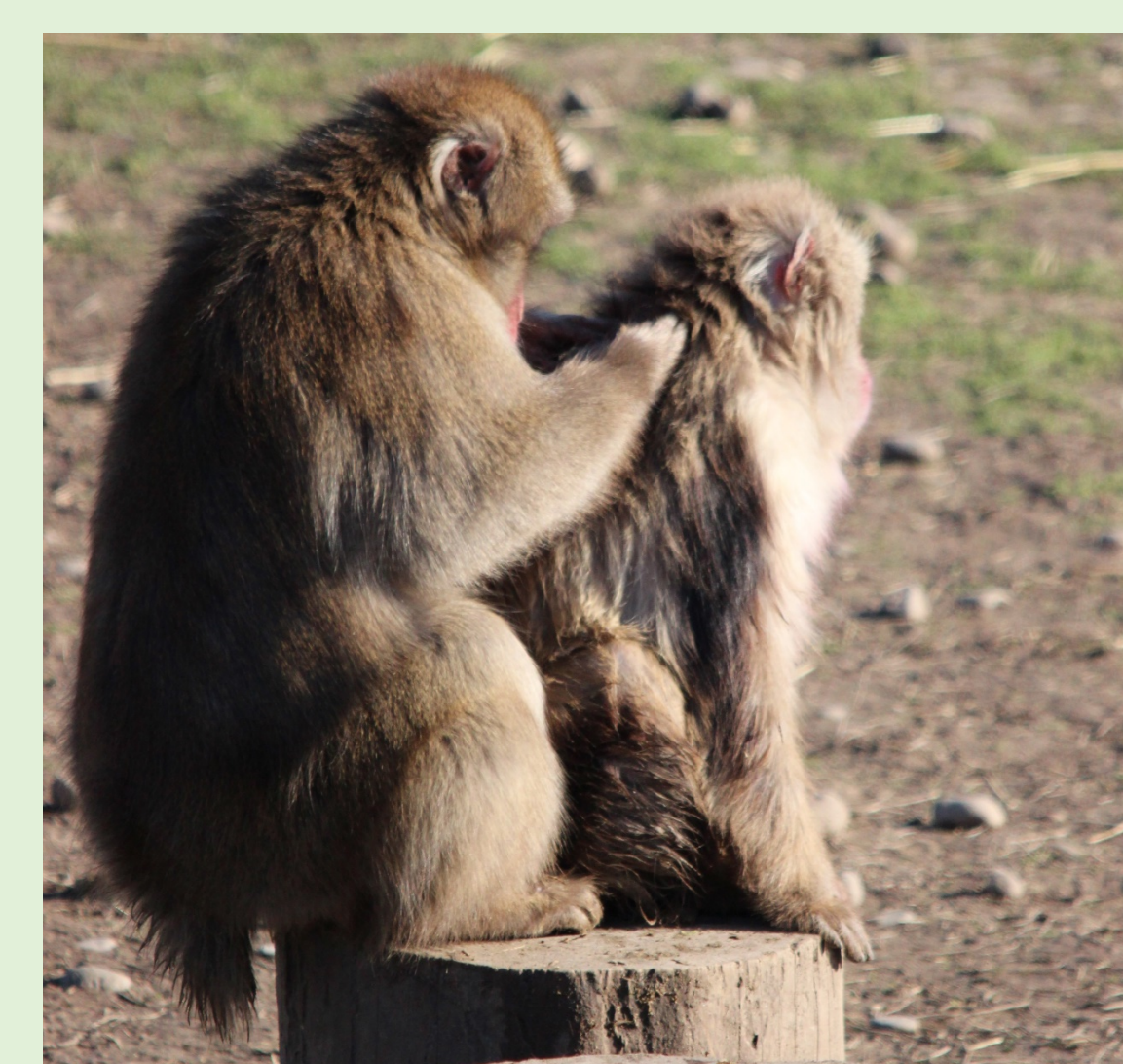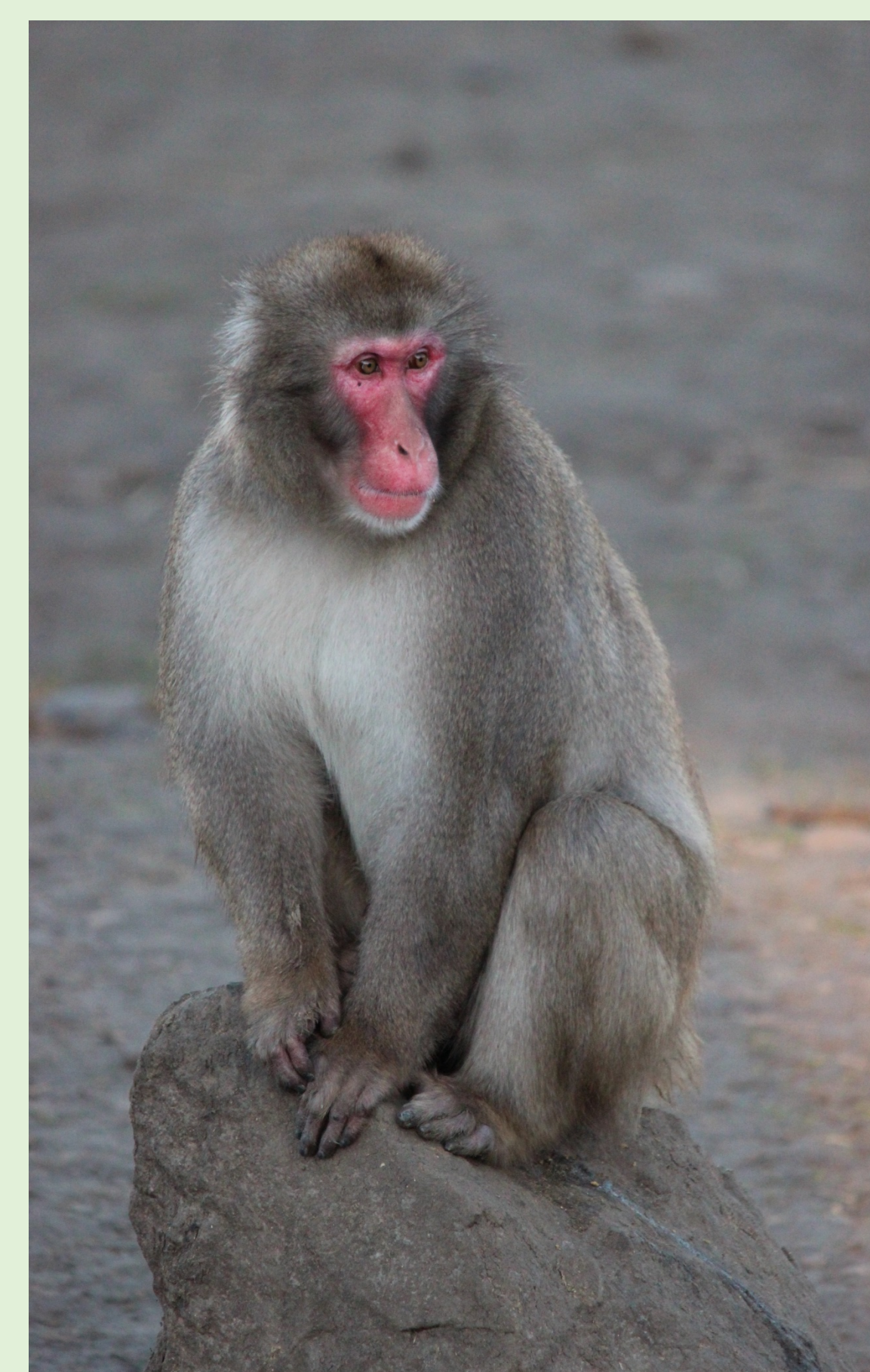**Table 2. Males organized based one priority access categories (high, middle, and low) in 2018 and 2019**

ID	2018	2019
M1	HIGH	HIGH
M2	HIGH	HIGH
M3	HIGH	MIDDLE
M4	MIDDLE	MIDDLE
M5	MIDDLE	HIGH
M6	MIDDLE	MIDDLE
M7	MIDDLE	MIDDLE
M8	LOW	LOW
M9	LOW	MIDDLE
M10	LOW	MIDDLE
M11	LOW	LOW

Results

o There was significant variation in David's scores between 2018 and 2019 (F=22.76, df=1, p=0.0001).
o High-rank male grooming effort remained constant.
o Low ranking males increased grooming efforts directed at higher-ranking males.
o There was significant variation between rank based on affiliative David's scores and rank based on enrichment access in 2019 (F=5.657, df=1, p<0.04).

Discussion & Implications

David's Score analyses are primarily used to determine linear dominance hierarchies in highly aggressive populations. Although this group of Japanese macaques had more affiliative behaviors than aggressive, but there were relatively few interactions and individuals with no observed grooming. However, assessing dominance categorically based on access to high value food enrichment provides more detail in the societal structure of the group. We observed significant variation between these assessment methods, which illustrates the need to incorporate multiple behavioral factors when evaluating dominance. David's Score as a method may also be an unreliable method of assessing dominance in highly tolerant populations such as this.

Acknowledgments

References

de Vries, H., Stevens, J. M., & Vervaecke, H. (2006). Measuring and testing the steepness of dominance hierarchies. *Animal Behaviour*, 71(3), 585–592.

King, A. J., Douglas, C. M., Huchard, E., Isaac, N. J., & Cowlishaw, G. (2008). Dominance and Affiliation Mediate Despotism in a Social Primate. *Current Biology*, 18(23), 1833–1838.