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Social enrichment to reduce pacing in a solitary housed male lion-tailed macaque *Macaca silenus*

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Abstract

Environmental enrichment is frequently used to improve the captive environment, aiming to enhance the quality of captive animal care. Social enrichment is considered to be the most effective form of enrichment for captive primates, particularly in the reduction of abnormal behaviours. This intervention was focused on reducing pacing behaviour exhibited by a singly-housed male lion-tailed macaque *Macaca silenus* by introducing another male. Data were collected using instantaneous scan sampling before and after the introduction of the second male. Data were then analysed using randomisation tests, which revealed that the introduction of the second male significantly ($P<0.01$) reduced the frequency of pacing in the first male macaque. This study has revealed that although the formation of all-male groups, particularly in lion-tailed macaques, is difficult it can also be beneficial, providing necessary social contact especially in individuals that are already familiar with one another.

Background

Enrichment has been shown to have a positive effect on the behaviour of captive animals (Shyne 2006) and is also commonly applied to manage animals exhibiting stereotypical behaviours. Defined as repetitive behaviours induced by frustration and/or repeated attempts to cope (Mason 2006), in primates stereotypical behaviour can include pacing as well as hair-pulling and self-biting. These behaviours can arise in animals that are frustrated (unable to perform certain behaviours), living in stressful environments (near aggressive individuals or high numbers of visitors for example) or housed in sub-optimal environments (barren enclosures) (Shyne 2006). While stereotypies are not always a reliable measure (e.g. Mason and Latham 2004), they can be a sign of poorer animal welfare and it can be particularly distressing for visitors. Miller (2012) found that visitors' perception of animal care and interest in visiting zoos decreased after viewing animals exhibiting stereotypic behaviours.

Social enrichment or providing social contact with conspecifics is considered to be the most effective form of enrichment for captive primates (Lutz and Novak 2005). It promotes positive welfare; social groupings can be in the form of pair-housing and small or larger group housing and individuals can vary in terms of sex and age (Lutz and Novak 2005). For example, in a study on lab-housed rhesus macaques *Macaca mulatta*, Baker et al. (2012) found that pair-housing (males and females) led to a reduction in abnormal behaviours and an increase in active behaviours in individual macaques. Lion-tailed macaques *Macaca silenus* that are singly-housed tend to exhibit greater levels of abnormal behaviours than group-housed macaques (Mallapur et al. 2007) and male rhesus macaques exhibit

more abnormal behaviours when housed individually (Lutz et al. 2003). These abnormal behaviours can include pacing, self-biting and hair-pulling. Pair-housed individuals also tend to spend more time engaged in activity including foraging than single-housed individuals (Eaton et al. 1994; Mallapur et al. 2007; Schapiro et al. 1996). The objective of this study was to introduce another male to a singly-housed male lion-tailed macaque, with the aim of reducing pacing behaviour exhibited by the solitary male.

Action

This research took place in Fota Wildlife Park, Carrigtwohill, Co. Cork, Ireland. Due to studbook recommendations, a male macaque (Casey 4628) who previously had been part of a large group was housed by himself in a small off-exhibit enclosure located in the staff yard (Figure 1a) next to another adult male macaque (Ral 4377). This enclosure contained eight separate pens; each macaque had access to four pens each, both indoor and outdoor (Figure 1b). There was no visitor access in this area except during supervised tours and no visitor interaction with these macaques. The pens contained various items including boxes, a slide and visual barriers (partitions) between the pens. As part of the husbandry routine at Fota Wildlife Park, these macaques were given several types of enrichment feeders over the course of the study, including socks, bags and frozen foods, as well as scatter feeds on the top of the pen (Figure 1c). The long-term goal was to have these two macaques successfully housed together, allowing for them to eventually be relocated to another zoo, but they were separated due to ongoing aggression.

This study took place from 26 June to 25 August 2017. Data were collected on Casey's pacing behaviour over the course of four days, using instantaneous scan sampling every minute over an hour, between 1030 and 1130, 1330 and 1430 and 1630 and 1730, for a total of 720 scans. After this initial sampling, a juvenile male (Oisín 5070) was introduced to Casey. Data were collected again over a period of eight days using the same methods for an additional 1,440 scans.

Data were analysed using R 3.4.3 (R Core Team 2017). To compare the pacing behaviour exhibited by Casey before and after Oisín was introduced, randomisation tests were used, as outlined in Bishop et al. (2013). The standardised residuals were then calculated to determine which cells contributed to the results.

Consequences

In the analysis, 1,000 re-randomised pseudosamples were generated by randomising all of the pacing frequencies across both conditions. The difference between the mean frequency of pacing behaviour before and after the introduction of Oisín was equal to or greater than the observed value (57.87) in 3 of the 1,000 permutations (proportion=0.003). Therefore, the observed difference is statistically significant ($P<0.01$; two-tailed).

The introduction of another male dramatically reduced the frequency of pacing behaviours exhibited by the male macaque Casey in this study. Other studies have shown that pair- or group-housing can significantly reduce the frequency of abnormal or stereotypical behaviours. For example, Schapiro et al. (1996) noted that group-housed juvenile rhesus macaques exhibited significantly fewer abnormal behaviours than individually housed juveniles. Abnormal behaviour was also found to decrease in group-housed baboons that were previously singly-housed (Kessel and Brent 2001). Spring et al. (1997) report that singly-housed squirrel monkeys spent more time engaged in stereotypical behaviour than the group-housed monkeys, who generally spent more time grooming and engaged in active behaviours. While a study on pair-housing adult female macaques revealed that affiliative and active behaviour increased, it did not result in a reduction in abnormal behaviour (Eaton et al. 1994), suggesting the effects may vary by individual or group.

It is thought that providing enrichment and then removing it can create more behavioural problems than no enrichment at all (Latham and Mason 2010). As Casey (and Ral) were removed from a naturalistic enclosure with multiple conspecifics to a single-housed concrete enclosure, this may have induced stereotypical behaviours. Repetitive behaviours like pacing are also seen as coping mechanisms in stressful environments (Mason and Latham 2004). Casey was noticeably stressed (e.g. pacing became more frequent, as well as vocalisation (personal observation)) in the presence of Ral (the more dominant and aggressive male) before Oisín was introduced.

Typically, male lion-tailed macaques do not tolerate one another (Kaumanns and Singh 2012; Singh et al. 2011) and in studies on other macaque species, the pair-housing of males was less successful than for females, with males interacting less with each other (Crockett et al. 1994). However, it has previously been shown in lion-tailed macaques that introducing familiar conspecifics can reduce stress (Lindburg et al. 1997 cited in Price and Stoinski 2007). All three of the macaques in this study were familiar with one another, as they all originated from the same group (at least two of the macaques were known to be paternally related). Although the two males housed together rarely interacted with one another, there was also very little aggression noted (personal observation July 2017) and with the significant reduction in pacing behaviour exhibited by one male, the overall outcome of this introduction has been positive.

This study shows that although the formation of all-male groups, particularly in lion-tailed macaques, is difficult (e.g. Kaumanns and Singh 2012) it can also be beneficial, providing necessary social contact especially in individuals that are already familiar with one another. The importance of familiarity has been seen previously in the establishment of an all-male group of lion-tailed macaques in Woodland Park Zoo (Bound et al. 1988 cited in Watts and Meder 1996). Zoos increasingly have to deal with the issue of surplus males and the need to house them, which often leads to singly-housed males; all-males groups are perhaps a necessary solution to the problem of surplus males (Crockett 1998; Stahl et al. 2000; Watts and Meder 1996). The current study shows that familiar male lion-tailed macaques can be housed together successfully and reiterates the need to, when removing males from a group, remove them as a cluster rather than individually, as suggested by Kaumanns et al. (2013).

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References

Bishop J., Hosey G., Plowman A. (eds.). (2013) *Handbook of Zoo Research: Guidelines for Conducting Research In Zoos*. London, UK: BIAZA.

Bound V., Shewman H., Sievert J. (1988) *The successful introduction of five male lion-tailed macaques (*Macaca silenus*) at Woodland Park Zoo. AAZPA Regional Conference Proceedings.* Silver Spring, Maryland: American Association of Zoological Parks and Aquariums.

Crockett C.M., Bowers C.L., Bowden D.M., Sackett G.P. (1994) Sex differences in compatibility of pair-housed adult longtailed macaques. *American Journal of Primatology* 32(2): 73–94. doi:10.1002/ajp.1350320202

Crockett C.M. (1998) Psychological well-being of captive nonhuman primates: Lessons from laboratory studies. In: Shepherdson D.J., Mellen J.D., Hutchins M. (eds.). *Second Nature: Environmental Enrichment for Captive Animals*. Washington, DC: Smithsonian Institution Press.

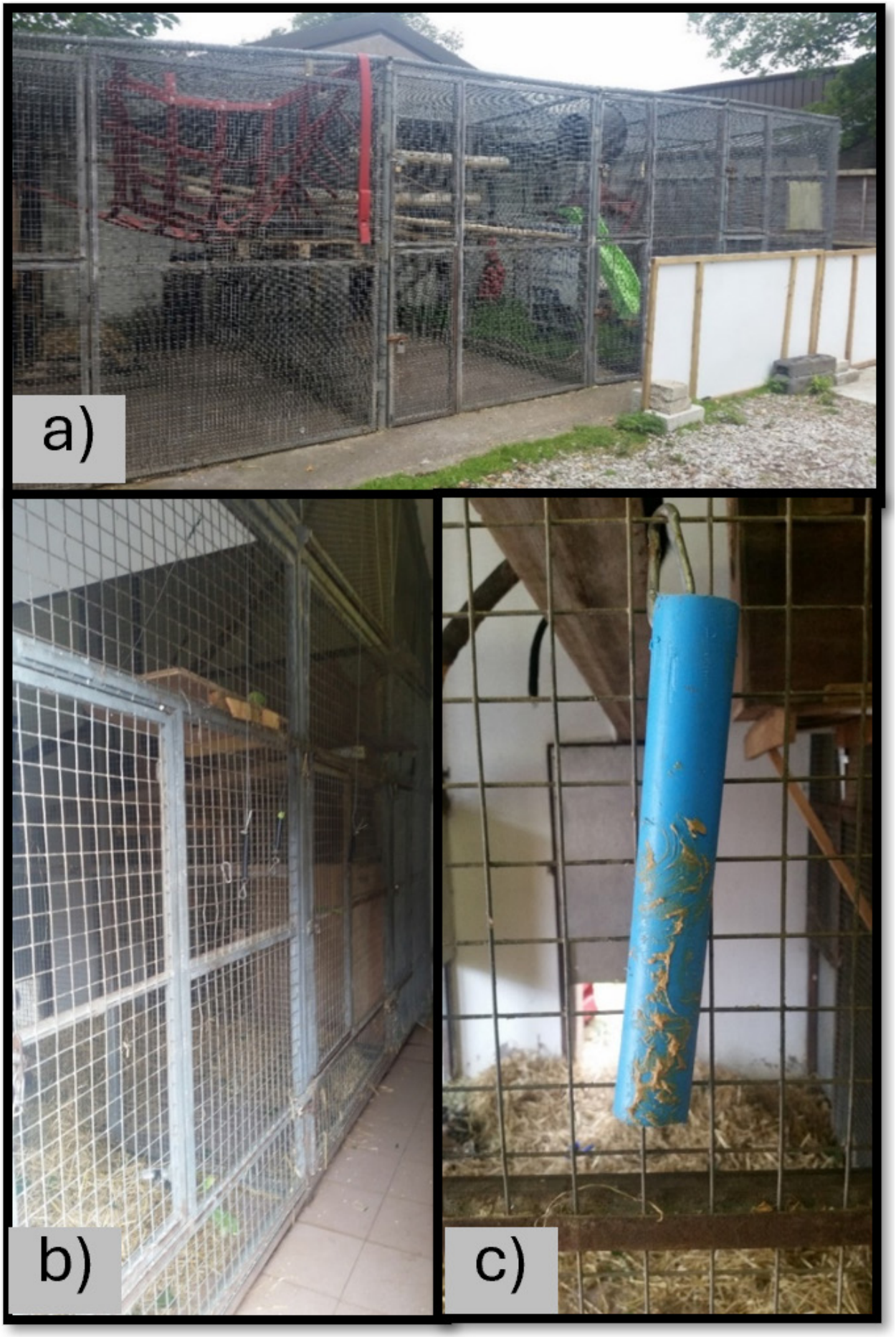

Figure 1. The off-exhibit area where the three male lion-tailed macaques were housed over the course of the social enrichment study: a) outside pens with various climbing structures, cargo net, slide, etc.; b) indoor pens; c) example of food-based enrichments regularly given to the macaques, a tube with peanut butter. Photographs© R Newman

Eaton G.G., Kelley S.T., Axthelm M.K., Iliff-Sizemore S.A., Shiigi S.M. (1994) Psychological well-being in paired adult female rhesus (*Macaca mulatta*). *American Journal of Primatology* 33(2): 89–99. doi:10.1002/ajp.1350330204

Kaumanns W., Singh M. (2012) Social relationships among lion-tailed macaque (*Macaca silenus*) males in differently structured social units. *Current Science* 102(10): 1451–1455.

Kaumanns W., Singh M., Silwa A. (2013) Captive propagation of threatened primates – the example of the lion-tailed macaque *Macaca silenus. Journal of Threatened Taxa* 5(14): 4825–4839. doi:10.11609/JoTT.o3625.4825-39

Kessel A., Brent L. (2001) The rehabilitation of captive baboons. *Journal of Medical Primatology* 30(2): 71–80. doi:10.1034/j.1600-0684.2001.300201.x

Latham N., Mason G. (2010) Frustration and perseveration in stereotypic captive animals: Is a taste of enrichment worse than none at all? *Behavioural Brain Research* 211(1): 96–104. doi:10.1016/j.bbr.2010.03.018

Lindburg D.G., Iaderosa J., Gledhill L. (1997) Steady-state propagation of captive lion-tailed macaques in North American zoos: A conservation strategy. In: Wallis J. (ed.). *Primate Conservation: The Role of Zoological Parks*. Bastrop, Texas: The American Society of Primatologists.

Lutz C., Well A., Novak M. (2003) Stereotypic and self-injurious behavior in rhesus macaques: A survey and retrospective analysis of environment and early experience. *American Journal of Primatology* 60(1): 1–15. doi:10.1002/ajp.10075

Lutz C.K., Novak M.A. (2005) Environmental enrichment for nonhuman primates: Theory and application. *ILAR Journal* 46(2): 178–191. doi:10.1093/ilar.46.2.178

Mallapur A., Waran N., Sinha A. (2007) A note on enrichment for captive lion-tailed macaques (*Macaca silenus*). *Applied Animal Behaviour Science* 108(1–2): 191–195. doi:10.1016/j.applanim.2006.11.020

Mason G.J. (2006) Stereotypic behaviour in captive animals: Fundamentals and implications for welfare and beyond. In: Mason G., Rushen J. (eds.). *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*. Wallingford, UK: CABI.

Mason G.J., Latham N.R. (2004) Can't stop, won't stop: Is stereotypy a reliable animal welfare indicator? *Animal Welfare* 13: S57–69.

Miller L.J. (2012) Visitor reaction to pacing behavior: Influence on the perception of animal care and interest in supporting zoological institutions. *Zoo Biology* 31(2): 242–248. doi:10.1002/zoo.20411

Price E.E., Stoinski T.S. (2007) Group size: Determinants in the wild and implications for the captive housing of wild mammals in zoos. *Applied Animal Behaviour Science* 103(3–4): 255–264. doi:10.1016/j.applanim.2006.05.021

R Core Team (2017) R*: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing. https://www.Rproject.org/

Schapiro S.J., Bloomsmith M.A., Suarez S.A., Porter L.M. (1996) Effects of social and inanimate enrichment on the behavior of yearling rhesus monkeys. *American Journal of Primatology* 40(3): 247–260. doi:10.1002/(SICI)1098-2345(1996)40:3%3C247::AID-AJP3%3E3.0.CO;2-Y

Shyne A. (2006) Meta-analytic review of the effects of enrichment on stereotypic behavior in zoo mammals. *Zoo Biology* 25(4): 317–337. doi:10.1002/zoo.20091

Singh M., Jeyaraj T., Prashanth U., Kaumanns W. (2011) Male-male relationships in lion-tailed macaques (*Macaca silenus*) and bonnet macaques (*Macaca radiata*). *International Journal of Primatology* 32: 167–176. doi:10.1007/s10764-010-9448-9

Spring S.E., Clifford J.O., Tomko D.L. (1997) Effect of environmental enrichment devices on behaviors of single and group-housed squirrel monkeys (*Saimiri sciureus*). *Contemporary Topics* 36(3): 72–75.

Stahl D., Herrmann F., Kaumanns W. (2000) Group formation of a captive all male group of lion-tailed macaques (*Macaca silenus*). *Primate Report* 58: 93–108.

Watts E., Meder A. (1996) Introduction and socialisation techniques for primates. In: Kleiman D.G., Allen M.E., Thompson K.V., Lumpkin S. (eds.). *Wild Mammals in Captivity: Principles and Techniques*. Chicago, Illinois: The University of Chicago Press.