

Evidence-based practice

The use of a simple and practical water-based enrichment in a pair of lion-tailed macaques

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Abstract

Environmental enrichment is frequently used to improve the captive environment, aiming to enhance the quality of captive animal care. Water-based enrichment can increase exploratory behaviour and tool use, promoting object manipulation, particularly in macaque species. Several water-based enrichments were evaluated by observing the frequency of interaction with each enrichment type by two lion-tailed macaques *Macaca silenus*. Four types of water enrichment were provided: food only, non-food only (stones and shells), mix of food and non-food and water only. Data were analysed using randomisation tests, with a difference found in the frequency of interaction between the different enrichment types, particularly between food-only and mixed although this difference was not statistically significant. This enrichment showed that the provision of non-food items along with food items can increase interaction with an enrichment. This type of enrichment is also simple and easy to modify, making it ideal for many zoos.

Background

Environmental enrichment is frequently used to improve the captive environment, aiming to enhance the quality of captive animal care. Water as a form of enrichment has great potential, particularly for macaque species, several of which have been observed to frequently swim and forage in water (Robins and Waitt 2011). Water enrichment can increase exploratory behaviour and tool use, with the added benefit of being cost-effective and readily available (Robins and Waitt 2011). The provision of water as enrichment has been found to promote object manipulation (Parks and Novak 1993). Huffman and Quiatt (1986) observed Japanese macaques *Macaca fuscata* gathering and carrying stones, as well as rolling and rubbing the stones in their hands, which was also seen in lion-tailed macaques *M. silenus* in Fota Wildlife Park (personal observation February 2015) where this study took place. Water-based enrichment was chosen for the macaques in Fota Wildlife Park as they had been observed fishing regularly in the

water surrounding the island enclosure, particularly for crabs, occasionally wading out to greater depths and even swimming completely across the water barrier to the visitor paths (Casey 2007; personal observation 2014). The aim of this research was to examine the frequency of interaction with different types of water enrichment in a pair of lion-tailed macaques.

Action

This research took place in Fota Wildlife Park, Carrigtwohill, Co. Cork, Ireland. There were two lion-tailed macaques in this study, a 23-year-old adult male (local ID 4057) and a 15-year-old adult female (local ID 3346). Previously these two macaques had been part of a large, successfully breeding group in Fota. The male macaque had been the dominant male in the group for eight years, and had sired 14 offspring in that time. As part of the long-term management plan both macaques had been removed from the group (Newman et al. 2020) and housed together until decisions could be made about their long-term

Table 1. Overview of both water enrichment trials at Fota Wildlife Park in 2018.

Trial 1. (420 m ² island enclosure)			Trial 2. (Tropical House pen)		
Day	Date	Enrichment type	Day	Date	Enrichment Type
1	12 Mar 2018	Non-food	10	30 May 2018	Water only
2	15 Mar 2018	Water only	11	01 Jun 2018	Non-food
3	19 Mar 2018	Food	12	02 Jun 2018	Food
4	23 Mar 2018	Mixed	13	04 Jun 2018	Non-food
5	26 Mar 2018	Non-food	14	06 Jun 2018	Mixed
6	28 Mar 2018	Mixed	15	08 Jun 2018	Food
7	29 Mar 2018	Water only	16	20 Jun 2018	Mixed
8	04 Apr 2018	Food	17	21 Jun 2018	Water only
9	06 Apr 2018	Mixed	18	23 Jun 2018	Food
			19	25 Jun 2018	Mixed

relocation. The pair were non-breeding at the time of the study.

The first trial of this study took place from 12 March to 6 April 2018 when the two macaques were housed together on a 420 m² island enclosure. The enrichment trial took place in one of the indoor houses (Figure 1A, Table 1). The study was then repeated from 30 May to 25 June 2018 after the two macaques

were relocated to a smaller enclosure (approximately 16 m²) located in the Tropical House at Fota. This enclosure is composed of indoor (Figure 1B) and outdoor pens and is not accessible to visitors. Data were collected using instantaneous scan sampling. Over a 30-minute period, at 30-second intervals, it was recorded if either the male and/or female macaque was interacting with

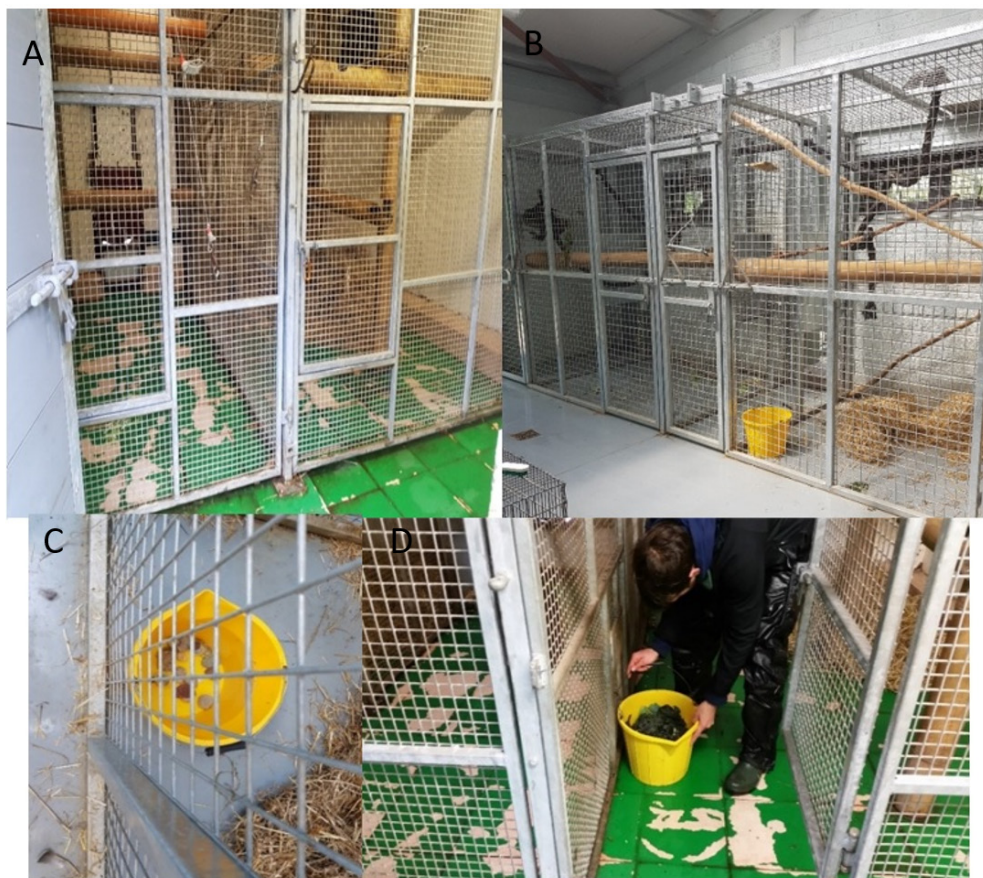


Figure 1. The water enrichment study on the male and female lion-tailed macaques. A: Indoor pens in the indoor enclosure during the first enrichment trial. B: Indoor pens at the off-exhibit site during the second enrichment trial. C: Enrichment with non-food only items (shells, stones). D: Enrichment with food-only items (leafy greens on top). Photographs © R Newman

the enrichment (defined by the macaque physically interacting with the items, the water or the bucket itself). One enrichment type was given per day and the time of day sampled was randomly chosen, and began at either 1030, 1230 or 1430, with slight variations depending on staff availability.

Enrichment was given using a reversal design, alternating between water-only and intervention (food-only, non-food-only, mix of both food and non-food) (Alligood et al. 2017). Enrichment type was chosen at random; each type was placed in a bucket (approximately 40 cm high) and filled approximately two-thirds full with water (this was not exact and was visually estimated). The bucket was then secured to the inside pen using a carabiner (Figure 1D). Food items included approximately 10 g nuts and seeds, 100 g leafy greens and 100 g starchy vegetables. The non-food items were coloured rocks and shells (Figure 1C). A total of 19 days were sampled with a total of 1140 scans collected.

Randomisation tests were performed to compare the level of interaction observed between the food-only enrichment and the other enrichment types; water and food-only enrichment, food-only and non-food enrichment, and food-only and mixed enrichment. Post-hoc analysis was performed using Tukey honest significant difference (HSD) tests. Wilcoxon signed rank tests were used to determine the individual differences in interaction with enrichment between the two trials. Variability is described using standard error (\pm SE)

Consequences

One thousand re-randomised pseudosamples were generated by randomising the interaction frequencies across each enrichment. The percentage frequency of interaction with each enrichment type can be seen in Table 2. Although both macaques interacted

more with the food (31.33 ± 2.9) and mixed (30.83 ± 2.6) enrichment in comparison to non-food (5 ± 1.4) and water-only (1.25 ± 0.7), the randomisation tests found no significant difference between any of the enrichment types ($P < 0.05$).

A significant difference was found in the male macaque's interaction with all of the enrichments between the two trials, with more interaction in Trial 1 (13.7 ± 1.4 ; $P < 0.001$, $W = 70800$) compared to Trial 2 (7.5 ± 0.9) (Table 2). The female macaque was observed to interact more with the enrichment during Trial 2 (9.33 ± 0.01) than Trial 1 (8.33 ± 0.01) (Table 2) but no statistically significant difference was found. The total frequency of interaction with each enrichment observed in both macaques for each observation session can be seen in Figures 2 and 3.

Although no statistically significant differences were found between the different types of enrichment, the two macaques in this study did interact more with the mixed and food-only enrichments provided, in comparison with the water-only and the non-food only enrichments. Interaction with the enrichment and object manipulation continued after the recording periods, as rangers noted the shells and stones scattered throughout the enclosure (staff, personal communication June 2018). The female macaque in particular was observed to interact more with the enrichments containing non-food items during and after recording periods (personal observation June 2018). This is a possible limitation of the study, and it could be improved by extending the sampling period or using recording equipment to monitor the macaques' interaction with enrichment over a longer period of time. It was also observed that the female macaque generally interacted more with the enrichments when the (more dominant) male interacted less (during Trial 2, although this was not statistically significant). Providing more than one bucket or container, especially when there are multiple individuals, may

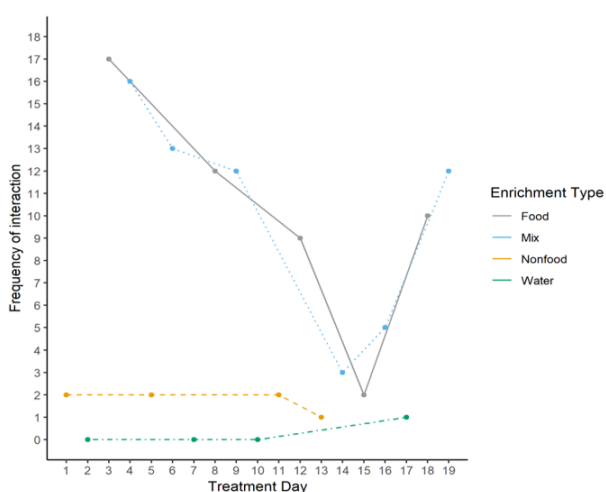


Figure 2. The frequency of the male macaque's interaction with each enrichment type (food, mixed, non-food and water only) for each 30-minute observation session over the entire study at Fota Wildlife Park

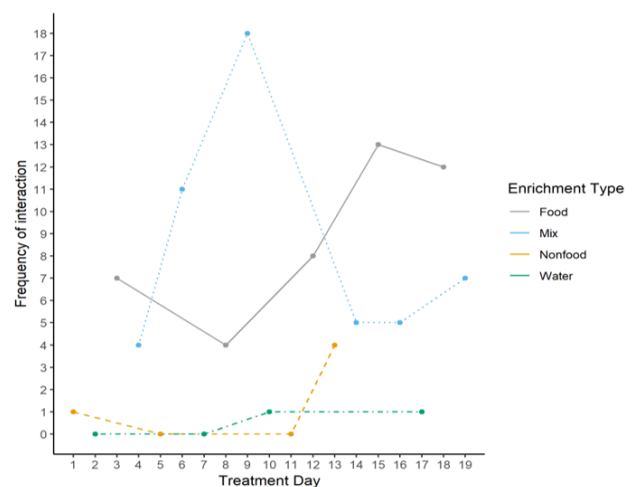


Figure 3. The frequency of the female macaque's interaction with each enrichment type (food, mixed, non-food and water only) for each observation session over the entire study at Fota Wildlife Park

Table 2. The percentage frequency of interaction (\pm SE) of individuals with each enrichment type, in each trial.

Enrichment type	Average percentage frequency of interaction (\pm SE)				
	Total	Male macaque (4057) only		Female macaque (3346) only	
		Trial 1	Trial 2	Trial 1	Trial 2
Food	31.33 \pm 2.9	24.16 \pm 3.9	11.66 \pm 2.3	9.16 \pm 2.6	18.33 \pm 2.8
Mixed	30.83 \pm 2.6	22.77 \pm 3.1	11.11 \pm 2.3	18.33 \pm 2.8	9.44 \pm 2.1
Non-food	5 \pm 1.4	3.33 \pm 1.6	2.5 \pm 1.4	0.83 \pm 0.8	3.33 \pm 1.6
Water only	1.25 \pm 0.7	0%	0.83 \pm 0.8	0%	1.66 \pm 1.1
Total		13.70 \pm 1.4	7.50 \pm 0.9	8.33 \pm 0.01	9.33 \pm 0.01

reduce the monopolisation of enrichment by dominant individuals and limit aggression (although no aggression was noted in this study).

The male macaque was found to interact more with the enrichments in the first trial than the second trial. In the second trial, the two macaques were in a different temporary enclosure, with less space and foraging opportunities (in comparison to the previous enclosure). The male's interaction with the enrichment may have decreased by the second trial as the enrichment was less novel, or because the ties securing the bucket 'failed' more during the first trial, allowing the male to tip the bucket partially or occasionally completely. When he was unable to tip the bucket, he generally showed less interest in the items within (personal observation June 2018). This could be important in future applications of this type of enrichment; i.e. individuals may prefer the ability to manipulate the bucket or container. It is unclear whether the depth of the water affected interaction in the current study as it remained relatively consistent throughout, so providing this enrichment with varying levels of water could be of interest in any future applications of this type of enrichment.

This water-based enrichment study indicates that the provision of non-food items along with food items (mixed enrichment) may increase interaction with enrichment. However, further research is needed, possibly expanding on the data collection methods as suggested in addition to increasing the sample size. Costa et al. (2018) stated that enrichment tends not to be utilised regularly in many zoos due to economic or logistical constraints, so there is a real need for enrichment to be cost- and time-effective. These same constraints are generally the reason why when enrichment is implemented it is not evaluated at all or is evaluated incorrectly, especially in smaller zoos with no research staff (Bishop et al. 2013; Podturkin and Papaeva 2020; Shepherdson 1998). Therefore having simple and flexible methods of assessment is also vital. This type of water enrichment is appealing as the equipment needed is generally easily available, it is quick to set up and can be modified very easily, making it potentially suitable for a wide range of primate species.

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