The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

Animal Welfare 2006, 15: 59-62
ISSN 0962-7286

The effectiveness of environmental enrichment on reducing stereotypic behaviour in two captive vicugna (Vicugna vicugna)

M Parker*†, D Goodwin†, E Redhead† and H Mitchell‡

† School of Psychology, University of Southampton, Highfield, Southampton SO17 1BJ, UK
‡ Marwell Preservation Trust, Colden Common, Winchester, Hampshire SO21 1JH, UK
* Contact for correspondence and requests for reprints: mop101@soton.ac.uk

Abstract

Environmental enrichment by increasing foraging behaviour and providing food item choice are widely practised and generally accepted as effective methods for reducing stereotypic behaviour in captive animals. In this study, the effectiveness of increasing foraging patch choice and food item choice on reducing motor stereotypy in two captive vicugna were examined. For the purposes of the study, first, browse was added to the vicugna's enclosure as an additional forage item and, second, the vicugna's normal feed was divided: half being provided in the indoor quarters and half in the outdoor yard. The results revealed that providing browse as an additional forage item increased the observed stereotypic behaviour; however, dividing the vicugna's feed, and therefore increasing forage patch choice, decreased stereotypy. This study was limited because of the small sample size and because the area in which the vicugna were performing stereotypic behaviour was partially visually obscured. However, this study has implications for animal welfare because it highlights the need to evaluate the suitability of foraging enrichment items, and suggests that more research into accommodating the adaptive foraging behaviour of this species in captivity may be necessary.

Keywords: *animal welfare, endangered, foraging, stereotypy,* Vicugna vicugna*, zoo animals*

Introduction

Stereotypies are repetitive, invariant behaviours that serve no apparent function (Mason 1991) and it is argued that they can be an indicator of sub-standard welfare (Wiepkema 1983). Stereotypies may be adaptive responses to adverse environmental conditions instigated by an experience of heightened and inexorable arousal (Danzer & Mittleman 1993). Evidence has also been published that links stereotypy with foraging opportunities; for example, Goodwin *et al* (2002) reported that increasing patch and forage choice reduced stereotypic behaviour in stabled horses.

Vicugna (*Vicugna vicugna*) are the smallest of the Camelidae family, originating from Peru. Until recently, vicugna were classified as an endangered species; however, over the past 30 years numbers have increased, attributable to a conservation programme, and they are currently classified as 'low risk' (Nowak 1991).

In this study, the behaviour of two captive female vicugna, reported by keepers to regularly perform stereotypic behaviour, was observed. The vicugna only had limited foraging opportunities as their enclosure was devoid of natural grazing; however, the effectiveness of providing browse as a form of enrichment is well documented (for review see Baer 1998). Consequently, cut-browse is provided in the outdoor yard as part of their routine husbandry. The purpose of this study was to examine the effect of environmental enrichment by increasing the foraging opportunities of the vicugna: during the study, foraging choice was increased from one to two food items, and patch choice was increased by placing forages outside the subjects' normal feeding area. This study also offered an opportunity to scientifically evaluate the behavioural effects of browse provision for vicugna.

It was predicted that the frequency of observed stereotypic behaviour would decrease (a) during the first treatment, which provided increased forage and patch choice, and (b) during the second treatment, when the subjects' normal feed was divided, half being provided in the outdoor yard and half in the indoor quarters, but to a lesser extent than during the first treatment because only a single food item was available.

Materials and methods

Animals and housing

The subjects of this study were two female vicugna, F1 and F2, aged nine and eight years, respectively. Both animals were born in captivity and parent reared. F1 arrived two weeks prior to the onset of preliminary observations; F2 had lived at Marwell Zoological Park, UK, since birth. Throughout the study, both subjects were housed in the same concrete-floored enclosure, which was divided into two sections: indoor quarters (5 × 5 m, length × width) and an outdoor yard (12 × 14 m, length × width). The subjects had access to both sections during the day, but were restricted to the indoor quarters at night. They were fed a

Table 1 Ethogram of behaviours for F1 and F2.

Behaviour	Description
Travelling	The subject is walking/running in an apparently functional manner, in order to reach an obvious destination
Dust bath	The subject is preparing for (ie disturbing the dust beneath its hoofs) or having a dust bath; during the dust bath, the subject rolls on its back in the dust
Faecal stamping	The subject is stamping in faeces
Out of sight	The subject is out of sight of the observer or its behaviour is unclear owing to visual constraints
Door frame chew	The subject is chewing the architrave around the door of the sleeping enclosure
Sleeping	The subject appears asleep or is resting
ST1	The subject is pacing in an apparently functionless manner, punctuated by exaggerated head-swings
Pace	The subject is pacing in an apparently functionless manner
Ruminating	The subject is ruminating
Bark chew	The subject is chewing bark from the trees or from large branches in the enclosure
Browsing	The subject is browsing from the trees in the enclosure or from the browse added by the keepers
Grooming	The subject is grooming itself or the other subject using its mouth, hoofs or an object
Floor	The subject lowers its head and is foraging off the floor of the enclosure (not including eating browse)
Eat	The subject is eating from the trough in the sleeping enclosure
Observing	The subject appears vigilant, observing the environment

custom mix of maize, oats, bran, apples and carrots daily, at 1630h, in the indoor quarters in a wall-mounted wooden trough, which was elevated by 1 m. Their indoor quarters were cleaned daily, at 1100h, and their outdoor yard was cleaned twice per week.

Behavioural observations

The vicugna were observed for a one-week pre-trial period to construct an ethogram (Table 1), to ascertain peak times of activity, to habituate the animals to the observer's presence and to assess the levels of stereotypic behaviour. During the pre-trial observations, the vicugna were provided with browse as part of their regular husbandry, which was delivered three times per week; they had daily access to the custom mix. During the study, continuous focal event sampling was carried out for 6 h per day (1000h–1300h and 1400h–1700h), five days per week, for eight weeks. However, subjects were generally only active at 1100h, 1200h, 1430h and 1530h, for periods between 5 min and 30 min. Therefore, only data gathered during these periods were used in the analysis. Continuous focal event sampling was used because of the sporadic patterns of the stereotypic behaviour.

Study design

The study used an ABACA design with each treatment lasting for five days. During the three baseline periods, treatment A, the subjects were provided with the custom mix but no browse. During treatment B, a browse condition, custom mix and browse, consisting of branches cut predominantly from oak and ash trees, were provided. Browse was added by the keepers each day, at 1100h, when the indoor quarters were cleaned to ensure that the amount of time the keepers spent in the enclosure did not increase. Following this, there was a return to treatment A (baseline 2) for five days, followed by treatment C, a split-feed condition, where the custom mix was delivered in two equal parts: half presented in the indoor quarters, and half presented in the outdoor yard; no browse was provided. Finally there was a return to treatment A (baseline 3).

Description of stereotypic behaviour

The motor stereotypic behaviour, coded ST1 (see Table 1), involved the subjects pacing around the indoor quarters and performing an exaggerated head-swing near the entrance to the outdoor yard. A similar pacing stereotypy was observed but without performing the head-swing near the entrance to the outdoor yard. Because this pacing stereotypy was topographically distinct from ST1 it was coded as 'pace' in the ethogram (Table 1).

During the pre-study observation period, very little stereotypic behaviour was observed being performed by F2. Although F2 was observed to be pacing increasingly around the indoor quarters, the ST1 stereotypy was not observed until baseline 1 (treatment A).

In order for a behaviour to be recorded as stereotypic, the animal had to complete at least two circuits of the indoor quarters. As the observer was outside the enclosure perimeter it was not possible to see the entire indoor quarters; consequently, there may be incorrect estimation of the frequency of behaviours performed. However, this constraint was constant throughout the study treatments.

Data analysis

Data was entered into SPSS 12, square root transformed and the frequency of the stereotypic behaviour performed during each treatment calculated. A two-way repeated measures analysis of variance (ANOVA) was carried out with 'identity' being the between-subjects independent variable and 'condition' being the within-subjects independent variable. Bonferroni corrected *t*-tests were carried out for each subject. The mean frequency of foraging, browsing and eating from the trough in the indoor quarters were calculated for each subject and two-way, repeated measures ANOVAs were used to analyse frequency differences during each

https://doi.org/10.1017/S096272860002995X Published online by Cambridge University Press

treatment. Because of the small sample size and the possibility of pseudoreplication, these results are not meant to be generalised. In addition, the assumptions of sphericity were violated and therefore the lowest value of epsilon was used to adjust the degrees of freedom. Despite the large number of zero values in the data, an ANOVA was considered sufficiently robust as a statistical technique; however, any α levels approaching 0.05 should be treated with caution.

Results

In this study, both subjects performed the highest frequency of stereotypic behaviour during treatment B, the browse condition, with F2 performing the highest frequency of stereotypy; this was followed by a decrease in the frequency of stereotypy during the second treatment A (baseline 2), and to the lowest level performed by F2. During treatment C, the split-feed condition, the frequency of stereotypic behaviour performed by F2 again increased (see Figure 1). The results for F1 were less clear and were explored further using inferential statistical analysis.

Analysis of stereotypy behaviour

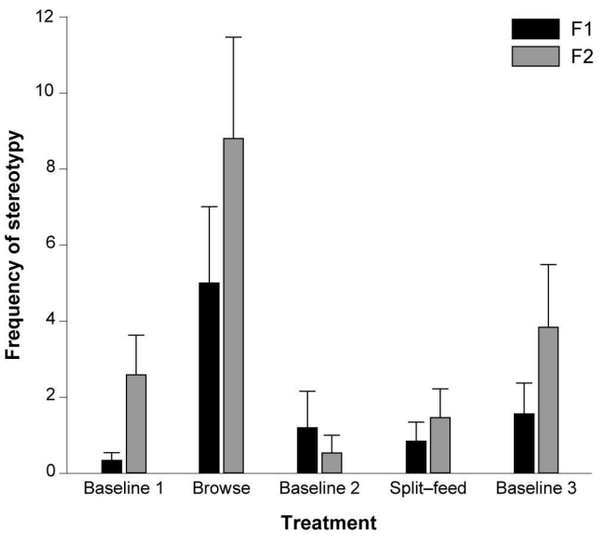
A two-way, repeated measures ANOVA revealed a significant effect for 'condition' ($F_{1,22} = 6.68$, $P = 0.017$); however, there was no significant relationship between subject and condition ($F_{1,22} = 0.59$; ns) nor between subjects ($F_{1,22} = 2.33$; ns). The *t*-tests revealed a significant relationship between the browse condition and baseline 1 for F1 ($t = 2.34$, df = 11, $P < 0.05$), with a higher frequency of stereotypy performed during the browse condition. A higher frequency of stereotypic behaviour performed by F1 was observed during the browse condition compared with baseline 2, which approached significance ($t = 2.02$, df = 11, $P = 0.06$). Furthermore, the frequency of stereotypic behaviour performed by F1 during the browse condition was higher than during the split-feed condition and this approached significance ($t = 1.83$, df = 11, $P = 0.09$); however, all the data for F1 have high α values and should be treated with caution.

The *t*-tests revealed several significant inter-treatment differences for F2: the frequency of stereotypic behaviour observed during the browse condition was significantly higher than during baseline 1 ($t = 2.63$, df = 11, $P < 0.05$), during baseline 2 ($t = 3.35$, df = 11, $P < 0.01$) and during the split-feed condition ($t = 2.42$, df = 11, $P < 0.05$). The frequency of stereotypy was also significantly higher during the baseline 3 than during the split-feed condition ($t = 2.17$, df = 11, $P = 0.05$). The frequency of stereotypy during baseline 2 was lower than during baseline 3 and also approached significance ($t = -2.09$, df = 11, $P = 0.06$). No other significant inter-condition differences were found for F2.

Analysis of foraging behaviour

Two-way, repeated measures ANOVAs were calculated to examine differences in the frequency of foraging in the outdoor yard (not including browse), eating from the trough in the indoor quarters and browsing. No significant effects for foraging were found for either animal.

Figure 1



The mean frequency (+ standard error) of pacing with head-swing (ST1) performed during each treatment by F1 and F2.

Discussion

The results of this study reveal that there was a change in the proportion of time that the two vicugna spent performing stereotypic behaviour during the browse and split-feed conditions. This study also revealed that dividing the vicugna's feed between the indoor quarters and the outdoor yard resulted in a decrease in the frequency of stereotypic behaviour. Therefore, this met the initial prediction that increasing foraging patch choice would decrease the frequency of stereotypic behaviour (Goodwin *et al* 2002). However, contrary to previous research in stabled domestic horses (Goodwin *et al* 2002), introducing browse resulted in an increase in the observed stereotypic behaviour performed by both F1 and F2. Furthermore, during baseline 2 (ie the treatment immediately following the browse condition) the frequency of stereotypic behaviour performed by both F1 and F2 decreased. The baseline periods provide evidence for condition effects, because the frequency of stereotypic behaviours observed during the third baseline period, immediately following the split-feed condition, again increased to a higher level. Foraging behaviour was not found to be significantly different in any of the treatments.

One explanation for the increase in stereotypic behaviour observed during the browse condition, and the decrease during the subsequent baseline treatment is that the two vicugna were competing for resources. Competition for resources has been suggested by some authors to increase stereotypy (eg Moncorps *et al* 1997); however, if this had been the case, the vicugna would have been expected to exhibit an increase in aggressive behaviours, according to the general resource competition theory (Brown 1981). No change in affiliative or confrontational behaviour was

https://doi.org/10.1017/S096272860002995X Published online by Cambridge University Press

observed during the browse condition, or in any other treatment, suggesting that the observed increase in stereotypic behaviour was primarily due to other factors.

An alternative explanation for the increase in stereotypic behaviour observed during the browse condition can be drawn from the work of Appleby (1997), who proposed that the welfare of an animal may ultimately be compromised if they are presented with a highly motivating 'normal' stimuli *ad libitum*. Browse is a highly palatable and energy dense substrate, which, when consumed in large quantities, may result in a disruption in the behavioural equilibrium of under-stimulated captive species. Appleby (1997) argued that enrichment substrates should be assessed for their suitability and behavioural relevance. The results of this study suggest that the use of browse as enrichment for vicugna may not satisfy this assessment.

A possible reason for the decrease in stereotypic behaviour by F1 during the split-feed condition, followed by an increase during the subsequent baseline treatment, may be attributable to the introduction of multiple foraging patches, as has been observed in horses (Goodwin *et al* 2002). However, in Goodwin *et al*'s (2002) study, the horses were given a choice of forages in addition to a choice of patches. It would be interesting to examine, in future studies, the effect of providing a variety of forages in different locations on the stereotypic behaviour performed by vicugna.

Finally, no increase was observed in the frequency of foraging behaviour during the two condition treatments, and no decrease was observed during the three baseline treatments. This suggests that facilitating highly motivated patch foraging behaviour (selecting and moving) reduced the performance of stereotypic behaviour and, conversely, that preventing foraging behaviour increased the performance of stereotypic behaviour.

Animal welfare implications

This study has suggested that browse may not be a suitable enrichment item for vicugna, as it is a highly palatable, energy dense forage item that may disrupt the environmental and behavioural equilibrium of captive vicugna. This should be explored using a larger sample size to assess the implications for the wider captive vicugna population. This study has also highlighted the need for further study into the effects of providing multiple forages.

Acknowledgements

The authors wish to thank the staff and keepers at Marwell Zoological Park, Hampshire, for all of their help and advice during the study, and to two anonymous referees for their comments on the first draft of this paper. This research was funded by a British Psychological Society 'Committee for the Welfare of Animals in Psychology' vacation scholarship award, 2003.

References

Appleby MC 1997 Life in a variable world: behaviour, welfare and environmental design. *Applied Animal Behaviour Science 54*: 1-19

Baer JF 1998 A veterinary perspective of potential risk factors in environmental enrichment. In: Shepherdson DJ, Mellen JD and Hutchins M (eds) *Second Nature: Environmental Enrichment for Captive Animals* pp 277-301. Smithsonian Institution Press: Washington DC, USA

Brown JH 1981 Two decades of homage to Santa Rosalia: towards a general theory of biodiversity. *American Zoologist 21*: 877-888

Danzer R and Mittleman G 1993 Functional consequences of behavioural stereotypy. In: Lawrence AB and Rushen J (eds) *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare* pp 41-64. CAB International: Wallingford, UK

Goodwin D, Davidson HPB and Harris P 2002 Foraging enrichment for stabled horses: effects on behaviour and selection. *Equine Veterinary Journal 34*: 686-691

Mason GJ 1991 Stereotypies: a critical review. *Animal Behaviour 41*: 1015-1037

Moncorps S, Bousses P, Reale D and Chapuis J-L 1997 Diurnal time budget of the mouflon (*Ovis musimon*) on the Kerguelen archipelago: influence of food resources, age, and sex. *Canadian Journal of Zoology 75*: 1828-1834

Nowak RM 1991 *Walker's Mammals of the World,* 5th Edition. Johns Hopkins University Press: Baltimore, USA

Wiepkema PR 1983 On the significance of ethological criteria for the assessment of animal welfare. In: Schmidt D (ed) *Indicators Relevant to Farm Animal Welfare* pp 71-79. Martinus Nijhoff: The Hague, The Netherlands

https://doi.org/10.1017/S096272860002995X Published online by Cambridge University Press