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ScienceDirect
Applied Animal Behaviour Science 114 (2008) 182–195
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

The effect of feeding enrichment toys on the behaviour of kennelled dogs (*Canis familiaris*)

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Accepted 7 January 2008
Available online 20 February 2008

Abstract

In general, an animal's inability to perform specific behaviours (for example, due to a lack of suitable stimuli or physical restraint) is often viewed as a cause of reduced welfare of animals kept in captivity. There is increasing evidence that the opportunity to display more species-specific appetitive behaviours is beneficial to captive animals. The present pilot study aimed to investigate the effects of feeding enrichment toys on the behaviour of domestic dogs (*Canis familiaris*) housed under laboratory conditions.

The behaviour of eight laboratory dogs (Toy group) was observed in their home cage during three trials (pre-toy, toy interaction and post-toy). During the toy interaction trial, the animals received the 'Kong extreme™'; a rubber dog toy stuffed with dog treats. The behavioural observations of the Toy group were compared to those of a sham-treated control group without a feeding enrichment toy, which consisted of nine laboratory dogs that were simultaneously observed.

This study demonstrated that the presence of these food enrichment toys stimulates appetitive behaviours and increases the level of activity (exercise), measured in terms of time budgets and the total number of behavioural transitions. Moreover, it also appears to result into lower barking frequencies.

The provision of a relatively simple feeding enrichment toy appears to be a useful tool to stimulate appetitive and more variable behavioural patterns, at least in the short-term, thereby promoting the welfare of (laboratory) dogs housed in kennels. The method of feeding enrichment used in this study may also be useful for dogs in other facilities which lack sufficient stimuli, such as animal shelters. Future studies should include a larger sample, more control groups and additional observation methods to detect, for example, low-frequency behaviours. Furthermore, they should also focus on individual food preferences (long-term) habituation effects and the provision of feeding enrichments under social housing conditions.

Keywords: Dogs; Enrichment; Housing; Welfare

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0168-1591/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.applanim.2008.01.001

1. Introduction

The domestic dog (*Canis familiaris*) has become increasingly popular in Western societies. While the majority of dogs are kept as family pets (e.g. Askew, 1996), these animals are also used in laboratories for research purposes. In the Netherlands, for example, there are 2119 officially registered laboratory dogs (Food and Consumer Product Safety Authority, Anon., 2005). In most Western countries, national legislation has established the minimum standards for animal housing and husbandry in laboratory settings (e.g. Animal Experimentation Act, Anon., 1977).

According to the minimum standards, laboratory housing systems are often environments that lack sufficient stimuli. Given this and the limited space they offer, it is not possible for animals to display a minimum of their species-specific behavioural repertoire, including behaviours that may be categorised as *ethological needs*. Dogs kept in low-stimulus housing conditions may, for example, develop excessive fear or aggression, increased auto-grooming and vocalisations, increased passiveness, the manipulation of enclosure barriers, repetitive locomotive behaviour (stereotypies) and coprophagy (e.g. Hetts et al., 1992; Hubrecht et al., 1992; Beerda et al., 1999). Most of these behavioural patterns are commonly acknowledged and used as indicators of chronic stress (e.g. Broom, 1991; Broom and Johnson, 1993; Beerda et al., 1999).

Denying the animal the opportunity to perform behaviours for which it is strongly motivated is not only considered stressful, but is also related to behavioural and physiological pathologies (see e.g. Dawkins, 1988, 1990; Hughes and Duncan, 1988; Mason, 1991; Mason and Mendl, 1997; Poole, 1992; Lindberg and Nicol, 1997). 'Ethological needs' is the term that is generally used to describe the need to perform specific behavioural patterns, irrespective of the nature of the environment and whether the physiological needs, which the behaviour serves, are actually fulfilled (Jensen and Toates, 1993, p. 167). Examples of ethological needs include grooming and appetitive feeding behaviours, such as hunting, rooting and so forth. The motivation to perform these essential behavioural patterns is primarily directed by an internal motivation (Friend, 1989). It is the rewarding properties of the display rather than its efficacy, which ensures that it is performed (cf. Herrnstein, 1997; Spruijt et al., 1992, 2001). If such activities are viewed as independent motivational systems, it is then conceivable that captive animals need to display such appetitive behaviours, even in the presence of food (Newberry, 1995; Hughes and Duncan, 1988).

Newberry (1995, p. 230) has defined 'environmental enrichment' as an improvement in the biological functioning of captive animals, which results from modifications to their environment. The existing literature reports that environmental enrichment may have two distinct effects: firstly, environmental enrichment induces structural changes in the brain that result in improved cognitive abilities (e.g. Rozenzweig and Bennet, 1996; van Praag et al., 2000; Wolfer et al., 2004) and, secondly, it allows an animal to satisfy more ethological needs (e.g. Markowitz, 1982; Jensen and Toates, 1993; Newberry, 1995). The latter is rewarding for the animal (e.g. Dawkins, 1990; Spruijt et al., 2001) and may counteract the effects of stress induced by behavioural deprivation (van der Harst et al., 2005). Moreover, the increased brain plasticity, and the increased behavioural variability due to the displays of species-specific behaviours, increase the adaptive capacity of the animal in the long-term (e.g. Larsson et al., 2002).

One type of effective enrichment for many animal species is 'feeding enrichment'. This can vary from scattering food in the enclosure to hiding food in interactive puzzle-feeders (e.g. Markowitz, 1982; Newberry, 1995; Young, 1997). Typically, animals fed in captivity do not have the potential to display appetitive behaviours that might otherwise be rewarding to them (e.g. Spruijt et al., 2001; Berridge, 2004). Food enrichment is known to change the behavioural repertoire of captive animals in many ways. It can, for instance, increase the display of appetitive feeding behaviour, result in less inactivity and reduce abnormal behaviours, such as stereotypies (Hayes, 1990; Forthman et al., 1992; Stepherdson et al., 1993; Ings et al., 1996; O'Connor, 2000; Swaisgood et al., 2001; Shyne, 2006).

To date, the effects of feeding enrichments in kennelled dogs have hardly been investigated. The present pilot study thus aimed to investigate whether the application of feeding enrichment has an influence on appetitive feeding behaviour, activity levels and the display of abnormal behaviour patterns in kennelled laboratory dogs. It was hypothesised that the provision of feeding enrichment would increase both the display of appetitive feeding behaviour and activity levels, and reduce stereotypies, coprophagy and excessive barking, thus allowing the animal's ethological needs being met better eventually leading to fewer behavioural pathologies.

2. Material and methods

2.1. Subjects, housing, daily care

In this pilot study, a total of 17 healthy laboratory dogs of various breeds (i.e. seven Beagles, eight Beagle-Bedlington crossbreeds, one other crossbreed, one Labrador), were divided into two groups: the experimental group 'Toy' ($n = 8$) and the control group 'Control' ($n = 9$), which were as standardised as far as possible according to gender, age and character (i.e. dogs that typically consume or ignore treats offered and social abilities with respect to humans and other dogs).

The dogs were housed individually, except for four female subjects in the control group, which were kept under social (pairwise) conditions. All subjects were housed in relatively barren enclosures that were situated along two different aisles. Visual contact with conspecifics was not possible. However, the animals were still able to smell and hear one another. The enclosures consisted of a heated indoor section (dimensions: Length × Height × Width: ±1 m × 2.5 m × 1.5 m) with a plastic dog-bed, metal water bowls, and free access to an outdoor section (dimensions Length × Width: ±3 m × 1.5 m). The enclosures were cleaned daily between 9 and 11 am.

Water was available *ad libitum* and the animals were fed at about 10:45 am each day. Feeding procedures were maintained throughout the experiment according to normal practices (feeding time and quantities). All animals were routinely handled by the animal caretaker in a standard fashion and most dogs were regularly allowed to spend some time in a large fenced outdoor enclosure (though not during or just prior to observations).

2.2. Experimental procedure

The experiment consisted of three trials (see Fig. 1) during which the subjects were videotaped in their home cages. Prior to the start of the first trial (pre-toy), there was a three-day habituation period during which all the procedures that were performed in the experiment, such as the positioning of cameras and the

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<tr><td colspan="3">trial 0 (habituation)</td><td colspan="7">trial 1 (pre-toy)</td><td colspan="7">trial 2 (toy interaction)</td><td colspan="7">trial 3 (post-toy)</td></tr>
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Fig. 1. Time schedule of trials June–July 2006. Trial 0: Monday June 19 to Wednesday June 21, habituation presence observer and camera set-up. Trial 1: Thursday June 22 to Wednesday June 28, pre-toy-trial. Trial 2: June 29 to Wednesday July 5, toy-trial (Toy group receives toy containing food twice a day, control group receives no toy). Trial 3: Thursday July 6 to Wednesday July 12, post-toy-trial.

researcher walking through the halls and around the kennels, were practiced. The habituation was deemed necessary given that unfamiliar objects (cameras) and persons (researcher) could potentially influence the dogs' behaviour.

Neither of the groups received any feeding enrichment during the pre-toy trial. The behaviour observed during this trial can be defined as a 'baseline' control. In the second trial (toy interaction), food enrichment toys (Kong extreme™, containing a mixture of viscous "Kong peanut butter flavoured filling paste"™, Frolic™ dog biscuits and some pieces of bread) were distributed to the dogs in the toy group twice a day. The Kong extreme™ was selected on the basis of the results of an earlier pilot study on 13 family dogs, which evaluated the animals' preferences, the extent to which appetitive behaviour is stimulated, hygiene and the robustness of various different feeding enrichment toys (Schipper, 2006, *unpublished data*). All the dogs in the toy group received their food toys at 8 o'clock in the morning; these were left in the enclosure until feeding time (10:45 am). In the afternoon, the toys were given to the animals just prior to the start of the camera observation (the first observations started at around midday) and were left inside the enclosure until 4 pm. The animals in the control group received a *sham-treatment*, which involved the implementation of all procedures (i.e. the researcher walked around and stood in front of the kennels), except the provision of food toys. This second trial sought to determine how access to a feeding enrichment toy affected the dog's behaviour.

Finally, in the third trial (post-toy), neither of the groups received any feeding enrichment. The behaviour observed during this trial was used to identify the possible impact of prior access to feeding enrichment toys and deprivation.

2.3. Data analysis

The subjects' behaviour was recorded on video during the trials in 20-min sessions per dog per day between 12 am and 3 pm in varying daily sequences. The videotaped sessions were subsequently analysed by one trained observer using a focal animal sampling method and the Observer 5.9 (Noldus Information Technology B.V., Wageningen, The Netherlands). The ethogram used consisted of 18 behavioural states, which were divided in two simultaneously recorded classes: 11 *locomotion* elements and 7 *activity* elements. It also included 11 behavioural elements, which were recorded as events, independent of the aforementioned classes. A short description of the recorded behavioural elements can be found in the ethogram, see Table 1.

Not only was the mean duration of the behavioural elements (time budgets) measured with respect to the *locomotion* and *activity* elements, but the incidence was also registered. As far as the behavioural events are concerned, only the incidence of the elements was recorded.

Some behavioural elements (i.e. '*total active time*' and '*behavioural transitions)*' were not directly scored, but were instead later computed from other elements (see Table 1).

The behaviours relating to the element '*toy interaction'* (e.g. lifting up, chewing, and pawing of the toy) could be performed by both groups since, in principle, these behaviours could also be performed using other objects, such as the dog's bed and food/water bowls. Furthermore, in order to adequately compare the behaviour between groups, the behavioural element '*toy interaction*' was included in the computed element '*total active time'*. '*Toy interaction'* was only analysed as a separate behavioural element for the detection of habituation effects with respect to the toy (see Section 3.2).

Only behavioural elements that accounted for at least 5% of the animal's time budgets were analysed and reported in the results section of this paper. From the class 'Activity', these include the behavioural elements '*total active time*' and '*inactive time*'; in the class 'Locomotion', they include '*moving*', '*standing*', '*sitting*' and '*lying*'. It should be noted that, in the class 'Activity', the element '*other active behaviour*' is the only exception. Although this behavioural element accounted for more than 5% of the observed time in both groups, it was not further analysed. This is because it did not apply to specified behaviours and was also included in the more general element '*total active time*'.

For the frequency (incidence) data, the main focus is on the total number of '*behavioural transitions*', which can be used as a robust parameter for the activity level (van der Harst et al., 2003). Since *stereotypies*,

Table 1
Ethogram: behavioural elements recorded during the observations

Behavioural element	Description
Locomotion	
Moving	Dog moves around the enclosure (e.g. walking, running, mobile exploration)
Standing	Dog is in a standing position, supported by three or four legs
Sitting	Dog is sitting with hind-legs in a flexed and front-legs in a stretched position
Lying	Dog is lying with the body in a lateral or ventral position
Hind legs	Dog stands in an upward position supported by hind-legs with front-legs lose or supporting against wall/object
Grooming	Animal is in a sitting/standing/lying position in order to scratch/bite/lick its own body/fur
Urinate/defecate	Animal is in a urination position with a hind-paw lifted or a squatting position and urinates/defecates
Play bow	Lowered anterior part of body (lying on front-legs) and heightened posterior part (standing on hind-legs). The play bow is associated with playful intentions
Stretching	Stretched body posture
Other locomotion	Undefined locomotion/body position
Out of sight locomotion	Animal is out of sight, locomotion cannot be defined
Activity	
Inactive time	Inactivity, no other behaviour and no directed attention, often resting
Exploration	Animal is exploring its surroundings (e.g. sniffing, licking and scratching)
Attention	Attention directed to something that drew attention, head lifted/turned towards source
Drink	Drink from water bowl
Other active behaviour	Dog is active, but the activity is not defined by any of the other behavioural states described above
Out of sight behaviour	Animal is out of sight, behaviour cannot be defined
Toy interaction[a]	Dog is interacting with toy (e.g. chewing, licking, carrying, etc.)
Total active time[b]	Computed class of exploration, attention, drink, other active and Toy interaction
Events	
Coprophagy	Feeding on own/other dogs faeces
Barking	Animal barks (short, loud noise)
Stereotypies	Completion of 1 stereotypy (1 complete turn in circling, 1 complete 'route' in pacing etc.)
Jerk	Sudden, quick movement with body/head
Shake	Shaking of the body/head
Startle	Startle response
Sneeze	Sneezing
Yawn	Yawning
Paw lift	Dog is standing/sitting with and lifts one paw while being alert
Tongue	Short, quick licking movements with tongue on lips
Other	Undefined behavioural events
Behavioural transitions[b]	Total frequency of all behavioural elements

[a] The behavioural element 'toy interaction' is only used in the toy group during trial 2.
[b] Not directly recorded during observations, but later computed with the help of other behavioural elements.

increased vocalising (*barking*) and *coprophagy* have also been reported as welfare indicators (see above), the study aimed to investigate the frequencies of these behaviours in particular. The frequency of the remaining behavioural events in Table 1 are not reported in the present paper due to their extremely low incidence.

2.4. Statistics

The data presented in the figures and tables are expressed as means ± S.E.M., with an accepted significance level of $p \leq 0.05$. Statistics were calculated using the statistical package SPSS 13.0. All data were first tested for normal distribution (1-sample Kolmogorov–Smirnov analysis). Where no normal distributions could be found, statistics were calculated using non-parametric statistics.

Correlations (Pearson) were conducted in order to identify possible relationships between the daily temperature (°C) and mean scores of behavioural elements ($n = 15$) in both groups. Possible habituation effects of the food enrichment toy (i.e. a decrease in the animal's interest over time) were investigated using an ANOVA for repeated measures (within subjects factor: day) for the 5 days of the second trial. A *t*-test for independent samples was used for the analysis of the differences between groups in each trial. Subsequently, scores with respect to the various behavioural categories were compared between trials within groups using a paired samples *t*-test. Alternatively, when data were not distributed normally, a Mann–Whitney *U*-test and a Wilcoxon matched pairs test were used respectively.

3. Results

3.1. External influences (daily temperature)

No significant correlations between temperature and any of the behavioural elements in the control group ($r \leq 0.43$, N.S.) were found. However, a trend towards a negative correlation between temperature (°C) and the number of behavioural transitions ($r = -0.47$, $p = 0.076$, $n = 15$) was identified. The ambient temperature increased from trial 1 to trial 2 and then slightly decreased from trial 2 to trial 3 (mean daily temperature trial 1 = 15.24 ± 0.05 °C, trial 2 = 22.1 ± 0.33 °C, trial 3 = 20.22 ± 0.14 °C, source: KNMI, De Bilt, The Netherlands, data not shown).

3.2. Toy interaction

When the food enrichment toys were present in the toy group (trial 2), the mean time spent interacting with the toy (e.g. appetitive behaviours) was 31.78 ± 8.26% as a percentage of the total observed time (see Table 2). Two subjects, however, spent less than 5% of the observed time interacting with the toys. There were no habituation effects of the food enrichment toys with regard to the time (%) spent interacting with the toy or any other behavioural elements introduced during the 5 days of trial 2. A trend towards a temporal effect on time (%) spent interacting with the toy (day: $F(2.92, 20.44) = 2.79$, $p = 0.07$) was identified, but this did not indicate a general decrease in time spent interacting with the toy over a 5-day period (means: day 1: 34.47 ± 12.79%; day 2: 43.51 ± 11.54%; day 3: 39.36 ± 11.96%, day 4: 16.60 ± 4.72%; day 5: 24.98 ± 7.15%). The lowest score on the time interacting with the toy occurred on day 4, which was also the day with the highest temperature (ambient temperature [°C] day 1: 17.0; day 2: 20.2; day 3: 24.0, day 4: 25.0; day 5: 24.3). Nonetheless, the correlation between temperature and toy interaction was not significant ($r = -0.7$, N.S.).

3.3. Time budgets – activity: inactive and total active time

Fig. 2a illustrates that the animals in the toy group displayed a significantly lower level of inactive time (and consequently, a higher level of total active time) than the animals in the control group during the second trial (toy interaction) ($t(15) = -3.10$, $p = 0.007$), but not during the first and third trials where the toy was not present (trial 1: $t(15) = -0.43$, N.S.; trial 3: $t(15) = -0.29$,

Table 2
Means (±S.E.M.) of the behavioural categories in the Toy group ($n = 8$) and Control group ($n = 9$)

Activity time budgets (%) time in observed interval		Trial 1	Trial 2	Trial 3
Total active time	Toy group	78.91 ± 4.95	87.14 ± 3.75	71.48 ± 6.16
	Control group	76.23 ± 3.90	64.62 ± 5.98	69.08 ± 4.55
Inactive time	Toy group	21.09 ± 4.96	12.86 ± 3.75	28.52 ± 6.17
	Control group	23.77 ± 3.90	35.40 ± 5.99	30.74 ± 4.64
Toy interaction (included in 'total active time')	Toy group		31.78 ± 8.26	

Locomotion time budgets (%) time in observed interval		Trial 1	Trial 2	Trial 3
Moving	Toy group	11.50 ± 1.61	17.51 ± 2.05	13.49 ± 1.97
	Control group	14.56 ± 2.05	10.37 ± 1.31	11.90 ± 1.76
Standing	Toy group	38.85 ± 6.87	44.53 ± 2.95	37.38 ± 6.32
	Control group	36.57 ± 4.93	26.68 ± 3.56	31.75 ± 4.00
Sitting	Toy group	9.29 ± 3.59	2.67 ± 0.95	4.25 ± 1.99
	Control group	10.14 ± 3.50	11.47 ± 2.27	8.78 ± 1.85
Lying	Toy group	25.17 ± 5.67	25.85 ± 3.34	35.37 ± 6.80
	Control group	27.39 ± 5.65	44.17 ± 5.31	41.18 ± 6.06

Frequencies (behavioural events)		Trial 1	Trial 2	Trial 3
Stereotypies	Toy group	2.05 ± 2.54	0.73 ± 1.21	0.90 ± 2.20
	Control group	5.80 ± 2.39	2.33 ± 1.14	4.07 ± 2.07
Barking	Toy group	1.53 ± 2.38	0.33 ± 2.86	4.63 ± 3.37
	Control group	4.49 ± 2.25	6.71 ± 2.69	2.40 ± 3.18
Coprophagy	Toy group	0.05 ± 0.11	0.00 ± 0.00	0.10 ± 0.10
	Control group	0.20 ± 0.10	0.00 ± 0.00	0.09 ± 0.09
Behavioural transitions	Toy group	114.73 ± 15.12	145.10 ± 18.43	98.45 ± 12.37
	Control group	141.13 ± 14.83	89.89 ± 12.99	98.82 ± 15.06

N.S.). This difference between groups with respect to time spent inactive in the second trial was caused by a trend towards an increased inactive time in the animals in the control group as compared to the baseline levels. In contrast, the time that the animals in the toy group spent inactive tended to decrease (although not significantly) between these trials (Toy trial 1 vs 2: $t(7) = 1.69$, N.S.; Control trial 1 vs 2: $t(8) = -1.18$, $p = 0.06$). The inactive time in the toy group increased significantly from trial 2 to trial 3, but tended to decrease (although not significantly) in the control group (Toy trial 2 vs 3: $t(7) = -2.77$, $p = 0.03$; Control trial 2 vs 3: $t(8) = 1.47$, N.S.). During the third trial, the time spent inactively did not differ from the baseline level for either of the groups (Toy trial 1 vs 3: $t(7) = -1.65$, N.S.; Control trial 1 vs 3: $t(8) = -1.60$, N.S.).

The statistics for 'active time' (Fig. 2b) were exactly the opposite to 'inactive time' and will consequently not be further described here.

3.4. Time budgets – locomotion: moving, standing, sitting and lying

There were no differences between experimental groups during the first and third trials with respect to the following locomotive elements: *moving*, *standing*, *sitting* and *lying* (trial 1:

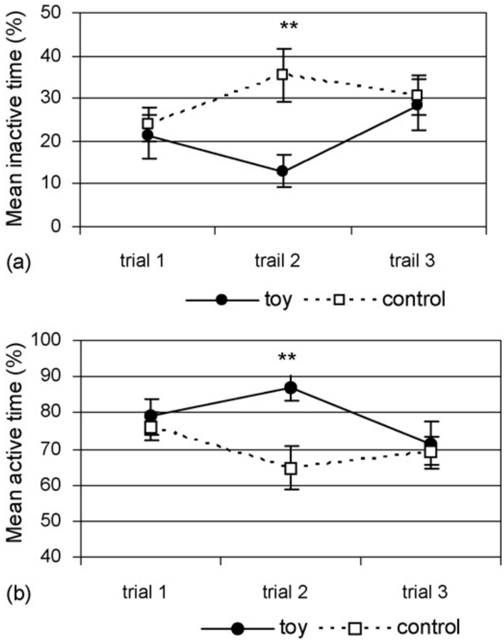

Fig. 2. Level of activity in the toy-group ($n = 8$) and control-group ($n = 9$) reflected by the mean time (%) (±S.E.M.) spent (a) active and (b) inactive in each trial (trial 1, pre-toy; trial 2, toy interaction; trial 3, post-toy). See also Table 2 for means (** $p \leq 0.01$).

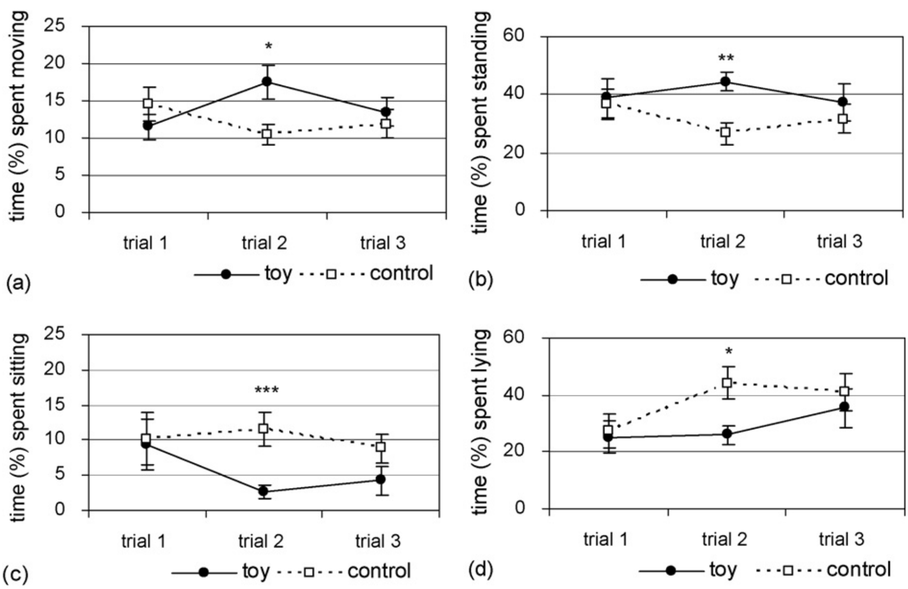

Fig. 3. Locomotion in the toy-group ($n = 8$) and control-group ($n = 9$) reflected by the mean time (%) (±S.E.M.) spent (a) *moving*, (b) *standing*, (c) *sitting* and (d) *lying* in each trial (trial 1, pre-toy; trial 2, toy interaction; trial 3, post-toy); see also Table 2 for means (* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$).

$t(15) \geq 0.27$, N.S.; trial 3: $t(15) \geq 0.56$, N.S.). There were, however, significant differences between experimental groups during the second trial, as illustrated by Fig. 3a–d. During this trial, the animals in the toy group spent more time (%) *moving* ($t(15) = 2.84$, $p = 0.013$) and *standing* ($t(15) = 3.81$, $p = 0.002$) than those in the control group, but spent less time *sitting* ($t(15) = -4.10$, $p = 0.001$) and *lying* ($t(15) = -2.92$, $p = 0.012$).

The time (%) spent *moving* significantly increased in trial 2 as compared to baseline conditions of the first trial involving the toy group (Toy trial 1 vs 2: $t(7) = -3.18$, $p = 0.02$). However, it decreased in the control group (Control trial 1 vs 2: $t(8) = 2.45$, $p = 0.04$) (see Fig. 3a). From trial 2 to trial 3, a trend towards a decrease in the time spent *moving* could be observed in the toy group (Toy trial 2 vs 3: $t(7) = 1.96$, $p = 0.091$), while moving remained unchanged in the control group (Control trial 2 vs 3: $t(8) = -0.80$, N.S.). A similar pattern could be discerned with regard to the time spent *standing*, but none of the changes between trials were significant as far as the toy group was concerned. The time spent *standing* in the control group had decreased significantly in trial 2 as compared to trial 1 (Control trial 1 vs 2: $t(8) = 2.86$, $p = 0.02$), and did not change from trial 2 to trial 3 any further (Control trial 2 vs 3: $t(8) = -1.23$, N.S.; see Fig. 3b). Neither of the groups displayed a significant change in the time spent moving or standing from trial 1 to trial 3.

The differences between groups with respect to the time spent sitting and lying during the second trial are a result of a decrease (although not a significant one) in the time spent *sitting* from trial 1 to 2 in the toy group (Toy trial 1 vs 2: $t(7) = 1.24$, N.S.), while the control group remained at the same level (Control trial 1 vs 2: $t(8) = -1.48$, N.S.). Furthermore, these differences also resulted from a significant increase in the time (%) spent *lying* in the control group (Control trial 1 vs 2: $t(8) = -4.49$, $p = 0.002$), while lying in the toy group did not change (Toy trial 1 vs 2: $t(7) = -0.12$, N.S.; see Fig. 3c and d). From trial 2 to trial 3, the time spent sitting and standing did not change in either of the groups. From trial 1 to trial 3, a trend towards a decrease in time spent sitting (Toy trial 1 vs 3: $t(7) = 2.07$, $p = 0.077$) and a significant increase in time spent lying (Toy trial 1 vs 3: $t(7) = -2.37$, $p = 0.050$) could be discerned in the toy group. The control group did not display any differences between trial 1 and 3 as regards the time spent sitting (Control trial 1 vs 3: $t(8) = -0.20$, N.S.), but a trend towards an increase could be identified regarding the time spent lying down (Control trial 1 vs 3: $t(8) = -2.28$, $p = 0.052$).

3.5. Frequency – behavioural transitions

The number of behavioural transitions was used as a parameter for the level of activity. The results were generally identical to the results for the parameter 'active time' (see Section 3.3). There were no differences between the experimental groups during trial 1 ($t(15) = -1.24$, N.S.) and trial 3 ($t(15) = -0.02$, N.S.). However, during the second trial, the animals in the toy group displayed significantly more behavioural transitions than those in the control group ($t(15) = 2.49$, $p = 0.025$). This difference was the result of a non-significant increase in behavioural transitions from trial 1 to trial 2 in the toy group (Toy trial 1 vs 2: $t(7) = -1.32$, N.S.) and a significant decrease in the control group (Control trial 1 vs 2: $t(8) = 3.89$, $p = 0.005$; see Fig. 4).

From trial 2 to trial 3, the number of behavioural transitions decreased significantly in the toy group (Toy trial 2 vs 3: $t(7) = 3.10$, $p = 0.02$) but did not change in the control group (Control trial 2 vs 3: $t(8) = -0.76$, N.S.). No differences in the number of behavioural transitions made between trial 1 and trial 3 were found in the toy group (Toy trial 1 vs 3: $t(7) = 1.37$, N.S.), but a significant decrease was identified in the control group (Control trial 1 vs 3: $t(8) = 6.30$, $p < 0.001$).

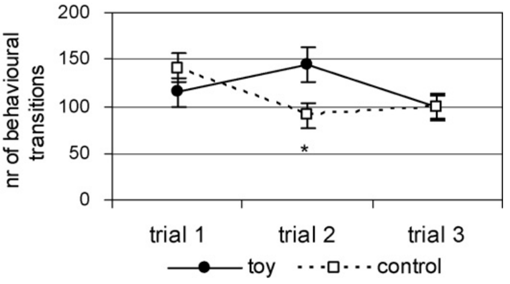

Fig. 4. Number of behavioural transitions in the toy-group ($n = 8$) and control-group ($n = 9$) in each trial (trial 1, pre-toy; trial 2, toy interaction; trial 3, post-toy); see also Table 2 for means ($*p \leq 0.05$).

3.6. Frequency – stereotypies, barking, coprophagy and remaining categories

The frequencies of stereotypies, barking and coprophagy were very low and these behaviours were not displayed by all animals.

The frequency of *stereotyped behaviours* (see Fig. 5a) appeared to be lower in the toy group than in the control group during all three trials, but none of these differences were significant ($U < 31$, N.S.). In both groups, the frequency appeared to be lower during the second than during the first trial, but this was not significant in the toy group and only a trend was present in the control group (Toy: $z = -1.83$, N.S., Control: $z = -2.02$, $p = 0.06$). From trial 2 to trial 3 the frequency of stereotyped behaviour did not change in the toy group, but did, however, appear to increase in the control group, albeit not significantly ($z > -0.73$, N.S.). During the third trial, a trend towards a decrease in the frequency of stereotypies could be discerned in both groups in comparison to baseline level (trial 1) (Toy: $z = -2.02$, $p = 0.06$, Control: $z = -2.03$, $p = 0.06$).

Barking frequency (see Fig. 5b) appeared to be higher in the control group than in the toy group during trial 1 and 2, whereas the reverse was the case in the third trial. However, none of these differences between the groups were significant ($U < 33.5$, N.S.). The barking frequency appeared to decrease in the toy group from trial 1 to 2 and then increased again from trial 2 to 3, while the control group first appeared to show an increase and then a decrease respectively. From trial 1 to 3, the barking frequency of the animals in the toy group appeared to increase, while the barking frequency of those in the control group appeared to decrease. None of the changes between trial described above were significant ($z > -1.83$, N.S.).

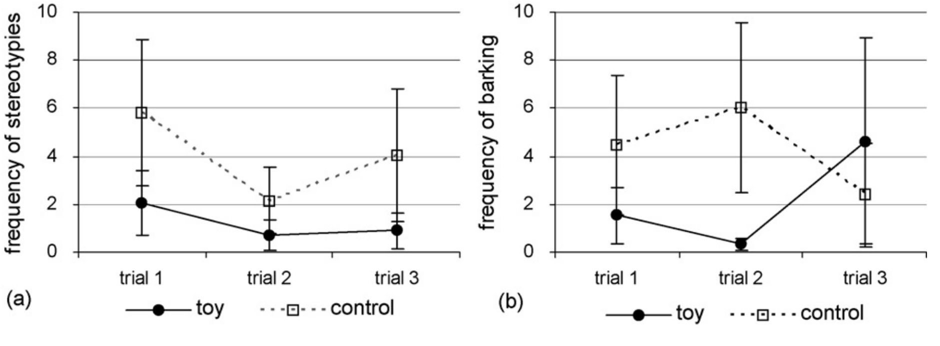

Fig. 5. Frequency of (a) *stereotypies* and (b) *barking* in the toy-group ($n = 8$) and control-group ($n = 9$) in each trial (trial 1, pre-toy; trial 2, toy interaction; trial 3, post-toy), see also Table 2 for means.

Coprophagy was only sporadically observed. Moreover, the frequency of *coprophagy* did not seem to differ between groups or within groups between trials and has a very low incidence (mean frequency per trial <1). This was also the case with respect to the remaining categories in the frequency class: jerking, shaking, startling, sneezing, yawning, paw lifting and tongue (data not shown).

4. Discussion and conclusion

The present study aimed to investigate whether the application of feeding enrichment (Kong extreme™) affects appetitive feeding behaviour, activity levels and the display of abnormal behaviour patterns in kennelled laboratory dogs.

The main results can be summarised as follows: firstly, providing food enrichment toys leads to an increase in the time spent on appetitive feeding behaviour; secondly, it also results in a higher level of activity (i.e. less inactive time, more behavioural transitions and more locomotive activity/exercise) as compared to the control animals; thirdly, the provision of food enrichment toys also appears to result in a decrease in the frequency barking as compared to baseline behaviour. These effects were not maintained after the toy was removed. Some of the issues dealt with in this study are discussed in greater detail below.

The presence of feeding enrichment toys resulted in the increased display of appetitive feeding behaviours that may allow the animal to satisfy more ethological needs, which are internally rewarding. The mean time spent interacting with the toy (appetitive feeding behaviour) was $31.78 \pm 8.26\%$ of the total observed time. These results are similar to Hubrecht (1993), who found that kennelled dogs spent nearly a quarter of their time interacting with chewable toys immediately after they were first given to the dogs. An increased proportion of time spent on appetitive feeding behaviour during feeding enrichment has also been reported in zoo-housed canids (Ings et al., 1996) and other animal species (e.g. Stepherdson et al., 1993).

In the current study, there were two animals that spent only about 5% of the total observed time interacting with the food enrichment objects. A more detailed analysis of the data revealed that, after initial exploration, the toys did not elicit further interaction in these animals; this was probably because the food reward was not palatable enough. This assumption is underlined by the observation that pieces of food, which had fallen out of the enrichment toy, were not consumed by these dogs, while these animals were still keen to consume their regular food and (other) dog-biscuits. The use of other food rewards inside the toys may, therefore, result in more interaction. A prior pilot experiment with respect to individual food preference may prevent unpalatable foods being used in the future.

The presence of feeding enrichment toys resulted in a higher level of activity. A similar increase in (physical) activity has also been found in other studies, which have investigated the effect of chewable toys on dog-behaviour (Hubrecht, 1993; Wells, 2004). Making the animal actively obtain food from feeding enrichment stimulates physical exercise and increases behavioural variability, which can have beneficial effects on the animal's physical condition; for example, it may prevent obesity (Markowitz, 1982; Clarke et al., 2005).

The reduced inactive time and the increased number of total behavioural transitions in this study were a result of direct interaction with the toy. With regard to locomotive activity, the interaction with the food toys resulted in an increase in the time spent moving around as the Kong™ rolled away or was carried around the enclosure. The time spent standing also increased as the dogs were observed licking the filling-paste out of the Kong™ from a standing position. This was, however, contradictory to Wells' (2004) results, which reported a reduction in time spent standing. This discrepancy might be explained by the characteristics of the enrichment objects provided: the toys used in present study had to be chewed and licked in order to obtain the food reward hidden inside, but the round shape and smooth material of the toy probably made it more difficult for the animals to hold the toy between their paws and chew them while lying down. The toys that were used in Wells' (2004) study (e.g. nylabone chew and ball), did not require this typical standing position for chewing, nor did they contain any food rewards.

Although not significant, in comparison to baseline observations, there was a decreased frequency in *barking* when the feeding enrichment toy was present. However, the barking frequency increased in the control group. Although a similar pattern did not apply to the frequency of stereotyped behaviour, we cannot conclude that feeding enrichment does not affect stereotyped behaviour. Indeed, the current experimental design was not ideal for the detection of stereotypies and barking. Typically, both these behaviours and coprophagy were not displayed by all animals in the experiment. Moreover, these behaviours did not occur frequently. In future experiments, a different observational method, for instance, an all-occurrence sampling, 24 h recording and a larger sample size may prove to be more suitable for studying the effect of feeding enrichments on these low-frequency behaviours.

A lower frequency in the display of abnormal behaviours during feeding enrichment has also been found in many other studies relating to different species (e.g. Swaisgood et al., 2001; Stepherdson et al., 1993). Furthermore, this lower frequency has also been found in dogs in relation to different types of environmental enrichment (Hubrecht et al., 1992; Hubrecht, 1993; Hetts et al., 1992). The reduction in barking in the current study might have been caused by the aforementioned shift in time budgets: animals invested over 30% of their time interacting with the toy, which subsequently may have led to a reduction in other behaviours. Interaction with the toy may also reduce the animal's responsiveness to their external environment (e.g. disturbances outside, barking of other dogs in the kennel), which will probably lead to a decrease in arousal-related behaviours, including barking.

The fact that the behaviour of the animals in the *control* group changed between trials indicates that factors other than the effect of the presence/absence of the feeding enrichment toy contributed to the dogs' behaviour. A very likely factor is the fluctuation in ambient temperature. From trial 1 to 2 there was an increase in external temperature, which possibly contributed to a decrease in the general activity of the control group (i.e. an increase in *inactive time* and *time spent lying* and a decrease in *number of behavioural transitions*, *time spent moving* and *standing*). Nonetheless, a tendency towards a correlation with temperature only confirmed this relationship with regard to the number of behavioural transitions. The other categories did not correlate with temperature, which might have been due to the small sample size ($n = 15$). The influence of weather conditions on the behaviour of kennelled dogs has been reported previously by Beerda et al. (1999), although the authors did not describe the impact of temperature explicitly. Since the rise in temperature and the presence of feeding enrichment appears to have had opposite effects on activity (inhibiting and stimulating respectively), we suggest that the true extent of the effect of the presence of feeding enrichment toys *could even have been greater* than was actually observed in this study.

Habituation effects are known to affect the effectiveness of enrichment strategies (e.g. Meehan and Mench, 2007, in canids: Ings et al., 1996; Wells, 2004). No such effects were detected in the present study, but the toys were only present for 5 days, which might have been too short a period to witness the effects of habituation. In the longer term, habituation problems with the Kong™ may be prevented by varying the contents of the enrichment toy, thereby altering the level of difficulty with respect to obtaining foods from the toy. Furthermore, providing different types of food enrichment toys in rotation would require additional strategies for obtaining rewards, which may further challenge the animal.

Finally, this pilot study demonstrated that laboratory dogs make significant use of food enrichment toys; in this instance, the 'Kong extreme^{TM}'. The presence of these food enrichment toys stimulates appetitive behaviour patterns, increases the animal's (physical) activity levels, and appears to lead to lower barking frequencies.

On the whole, the provision of a relatively simple feeding enrichment toy appears to be a useful tool to stimulate appetitive and more variable behavioural patterns that respond to the animals' ethological needs, at least in the short-term, thereby promoting the welfare of (laboratory) dogs housed in kennels. The method of feeding enrichment used in this study may also be functional for dogs in other facilities which lack sufficient stimuli, such as animal shelters. Future studies should include a greater sample size, more control groups and additional observational methods in order to detect low-frequency behaviours as well. Such studies should also focus on individual food preferences (long-term) habituation effects and the provision of feeding enrichments under social housing conditions.

Acknowledgement

The authors would like to thank E. Beitler for allowing us to work in the dog laboratory facilities and I.I.M. van Duiven for both the daily care of the animals and her support of this project.

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