BEHAVIOURAL EFFECTS OF CAGE ENRICHMENT IN SINGLE-CAGED ADULT CATS

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Abstract *Animal Welfare 1997, 6:* 53-66

The behaviour of 10 adult individually-caged male cats was measured either in their normal cage or with additional objects, a log and a ball. Each cat was observed during five days in each condition. Results show an important novelty effect at the beginning of observations, especially for rubbing and paddling behaviour. Introduction of objects in the cages resulted in a decrease in inactivity and self-play activities, and an increase in sniffing objects and play behaviours with objects. This was particularly important with the ball. Whereas these modifications decreased over days with the log, a high level of activity was maintained with the ball. The importance of the movement and of the function of the object is discussed. An improved way of rearing isolated cats is suggested.

Keywords: *animal welfare, behaviour, cats, enrichment, objects*

Introduction

Amendments of the US Animal Welfare Act in 1985 regarding exercise for dogs and an environment adequate to promote the psychological well-being of non-human primates, have been a strong stimulus for research aimed at improving the welfare of captive animals. Although some studies (Batchelor 1991; Huls *et al* 1991; Scharmann 1991; Scott 1992; Stauffacher 1992; Hirsjärvi 1993) have been performed in rodents and lagomorphs – which represent almost 90 per cent of laboratory animals – most of this work was concerned with the promotion of the psychological well-being of primates (Chamove 1989a; Clark 1990; Bayne 1991; Sokol 1993). Because the term 'psychological well-being' is not definable in a generally acceptable way, researchers turn to terms like 'environmental enrichment' and 'behavioural pathology' (Whitney 1992). Since caged animals are not able to express their normal range of behaviour, two complementary goals of enrichment studies are both to increase the so-called normal behaviour (play, foraging, exploration etc) and to reduce undesirable behavioural patterns (stereotyped movements, aberrant behaviours, excessive inactivity) (Chamove 1989a). As a general rule, it is assumed that objects placed in cages enhance the well-being of laboratory animals by decreasing inactivity and abnormal behaviours, and by increasing the range of spontaneous behaviours in primates (Bayne 1991; Watson 1992; Reinhardt 1993) and dogs (Hubrecht *et al* 1992; Helppi *et al* 1993; Hubrecht 1993). Moreover, it improves rats' and mice's performances in different kinds of

exploratory, emotional or cognitive tests (Chamove 1989b; Hirsjärvi *et al* 1990; Scharmann 1993; Van de Weerd *et al* 1993).

No studies seem to have been conducted on enrichment in adult laboratory cats. Most work has been carried out on social enrichment and only with kittens or juveniles. The main results show abnormal development of social interactions and play as a consequence of early social isolation (Guyot *et al* 1980; Bateson & Young 1981; Mendl 1988). The importance of infantile stimulation for activity, learning and later tolerance for handling was also demonstrated (Wilson *et al* 1965). Laboratory cats are often kept in groups and more attention has recently been given to their social behaviour and group dynamics with regard to the organization of free-ranging Felidae (Hurni & Rossbach 1987; Van den Bos & De Cock Buning 1993), and their behaviour with familiar or unfamiliar persons, in order to suggest suitable laboratory holding facilities (Karsh & Turner 1988; Mertens & Turner 1988; Podberscek *et al* 1991). But in some experimental designs (for example, in studies on feline viruses), cats must be kept in confinement and social isolation for a long time.

The purpose of the present investigation was to observe if introduction of objects in the cages of isolated adult cats facilitated the expression of a larger part of their normal range of behaviour and reduced their amount of inactivity and possible abnormal behaviour. In order to distinguish temporary enhancement due to novelty from durable effects, observations were made during five days after introduction of objects. Two kinds of objects, permitting expression of different behavioural items were compared.

Methods

Animals, housing and care

The subjects were 10 six-month-old specific pathogen free (SPF) male cats (Ico: Fec Eur (tif) IFFA CREDO, France). They were kept in an SPF environment at 21 ± 2°C in individual cages (56x63x67cm) made of stainless steel with a wire mesh roof and front door. The cages contained a litter box, a plastic resting shelf (63x17cm), and food and water dishes fastened to the front door. The cages were sited on two roller racks (3x3 and 2x2 cages) located in the same room, so that the cats were allowed to see each other. Every morning (0700–0800h), the litter boxes were emptied, the animals were fed with a sterilized laboratory diet and the cages were cleaned. Water was available ad libitum. At the beginning of the study, the animals had been kept in their home-cage for six weeks.

Observation schedule

The treatments and observation schedule is summarized in Table 1. The 10 cats were observed in their home-cage five days per week during three weeks. Each observation day each cat was observed during a 15 minute period. The order in which the 10 cats were observed was random, giving a total of 3h 45min of observation per individual. The observations were made between 0900 and 1700h. Each cat was observed either with no object in the cage, or with a longitudinally sawed wooden log (12cm in diameter and 40cm in length) hooked against the wall by a steel shaft opposite to the resting shelf, or with a tennis ball suspended 12cm above the floor in the middle of the cage.

Table 1 Treatments and observation schedule.

Before observation	First week (days 1 to 5)	Interval	Second week (days 8 to 12)	Interval	Third week (days 15 to 19)
A0 no object	A1 no object	no object	A2 + log	+ log	A3 log + ball
B0 no object	B1 + log	no object	B2 no object	+ log	B3 log + ball

1. First week (days 1 to 5)
Five cats (Group A1) were observed in their home-cage with no object. Five other cats (Group B1) were observed with a wooden log in the cage. The log was introduced at the beginning of the observation period and remained in the cage all week long until the end of the last observation period on day five.

2. Second week (days 8 to 12)
The five cats of group A1 received a wooden log (Group A2). Conversely, the five cats of group B1 were observed in their home-cage without the log (Group B2). At the end of the fifth observation period, on day 12, each cat received a log in his cage until the end of the third week.

3. Third week (days 15 to 19)
Group A3B3 was composed of the 10 subjects. Each cat was given a tennis ball at the beginning of the first observation period (day 15). Balls and logs remained in the cages until the end of the last observation period on day 19.

Recording technique
All observations were made by the same person. This person handled the cats when they were used in virological experimentation. She was very familiar with them, talked to each cat and caressed them daily. The observer entered the room ten minutes before the first observation and sat in front of the two racks in order to standardize the starting point of the observation and to minimize any variation due to the presence of the observer (greeting behaviours, excitement, mewing etc). Frequencies and duration of behaviours were recorded using a 'datamyte' electronic event recorder. The data were then offloaded and analysed using the STATXACT® package (CYTEL software corporation) for non-parametric comparisons and the SPAD.N package (CISIA) for multivariate analysis. According to the literature related to the behaviour of carnivores, some patterns were studied in duration and others in frequencies.

Behavioural patterns
1. General activities

Inactive (duration):	lying still with eyes closed or almost closed (Bateson & Young 1981).
Still (duration):	sitting or lying, awake and watchful, with open eyes.
Moving (duration):	standing or moving on the floor of the cage, going on to or leaving the shelf.

Self-grooming (duration):	cleaning, licking or nibbling itself.
Rubbing (frequency):	flank, neck or cheek rubbing against the cage (front door or walls), or against the shelves.
Paddling (frequency):	forepaw paddling with claws often exposed, on the floor or against the walls of the cage. (In kittens this behaviour is associated with sucking and performed on the mother's belly.)
Self-play (duration):	chasing own tail, sometimes rolling on the side or on the back (Mendl 1988).
Object-play (duration):	manipulate with paws anything in the cage: wire mesh, handles, litter's grains or water and faeces.

Note: Object-play includes three behaviour patterns which were plotted because in caged animals they often appear together in complex sequences and they are not easy to distinguish.

Paw/pat/bite:	pawing, patting and biting movements directed at objects without grasping or holding them (Barret & Bateson 1978).
Wrestle:	holding or grabbing object (with two or four paws), sometimes kicking at it with the hindlegs, the cat sometimes laying on the back or standing on his hindpaws (Bateson & Young 1981; and personal observations).
Hold/bite object:	holding the object in the forepaws with hindquarter slightly raised or standing on the hindlegs; holding the object with four paws, lying on the back and sniffing, biting, chewing at it (Mendl 1988; and personal observations).

2. Activities directed to objects

Log-playing (duration):	playing with the log.
Ball-playing (duration):	playing with the ball.
Log-sniffing (frequency):	sniffing the log.
Ball-sniffing (frequency):	sniffing the ball.
Log-rubbing (frequency):	flank, neck or cheek rubbing against the log.
Log-paddling (frequency):	paddling or scratching with the forepaws on the log, the claws often being exposed.

Statistical analysis

Evolution of the performances of the same groups during the five days (related measures) was tested by the non-parametric Friedman analysis of variance (Siegel 1956). Comparisons between groups (independent samples) were performed by the Mann-Whitney *U* test (Siegel 1956). Comparisons between different treatments for the same animals were performed with the exact Wilcoxon matched pairs signed rank test (Metha & Patel 1992).

In order to compare the change of the different treatment groups along the experiment considering the whole set of variables, a multivariate description was performed by a principal component analysis. Multivariate descriptions of change in biological data were previously suggested and realized (Benzecri *et al* 1992). The scores of the eight general behaviour patterns were used as columns and all 150 observations as rows (10 cats x 5 days x 3 situations). The correlation matrix was used.

Results

Effects of the presence of the observer

These effects were evaluated in a study of the changes in the scores across the five days without any added object in the cage. These days were the first test day for one half of the cats (A1 group), but were during the second week for the other half (B2 group). Results are given in Table 2. In both groups duration of moving, self-grooming or playing did not show any particular change. Conversely, in A1 group only rubbing and paddling were strikingly higher the first day and then declined quickly, this being significant. Even if not significant, change in duration of inactivity and 'still' are to be noted: duration of inactivity showed an increase along the week and conversely the time spent 'still' showed a decrease along the week. This was true in both groups.

Table 2 **Median values of the five cats of both A1 and B2 groups for each day of observations in the absence of any additional object. Values are either durations (d) in minutes per 100 minutes or frequencies (f). One-tailed *P* values of testing for significant change over days are indicated.**

		Inactive (d)	Still (d)	Moving (d)	Self-grooming (d)	Rubbing (f)	Paddling (f)	Self-play (d)	Obj-play (d)
A1	day 1	2.75	6.82	0.58	0.32	11	11	0	0
	day 2	5.6	3.71	2.56	0.14	5	4	0.06	0
	day 3	11.3	3.09	0.27	0	0	1	0.16	0
	day 4	9.5	2.01	0.56	0.39	1	0	0.14	0
	day 5	8.69	0.48	0.12	0.03	0	0	0	0
	P	ns	ns	ns	ns	< 0.05	< 0.05	ns	ns
B2	day 8	5.02	7.49	0.46	0.07	0	0	0	0
	day 9	4.85	5.94	0	0.2	0	0	0	0
	day 10	4.02	6.1	1.27	0.95	1	0	0.03	0.03
	day 11	9.46	3.8	0.58	0.09	0	0	0	0
	day 12	14.04	0.28	0	0.13	0	0	0	0
	P	ns	ns	ns	ns	ns	ns	ns	ns

Effects of log and ball on total activity scores

Because no differences appeared between the two groups when observed without an object, the results for the 10 cats were pooled. The same occurred with the B1 and A2 groups observed with the log. As a result, comparisons between the three situations were performed on the 10 cats (Table 3).

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Table 3 **Median values of the 10 cats, obtained in each experimental situation. Values are either durations *(d)* in minutes per 100 minutes or frequencies *(f)*. The superscripts indicate statistically significant differences with (two-tailed) *P* values of $^{a}P < 0.002$, $^{b}P = 0.004$, $^{c}P = 0.02$, $^{d}P = 0.04$.**

Behaviours	Situations		
	No object	Log	Log and ball
Inactivity (d)	38.73 [a]	18.0	7.42 [a]
Still (d)	19.0	31.4	22.6
Moving (d)	4.3	4.4	4.5
Self-groom (d)	2.6	3.9	3.1
Rubbing (f)	8.0	4.0	7.5
Paddling (f)	1.0	1.5	1.0
Self-play (d)	1.43 [d]	2.295 [b]	0.225 [bd]
Object-play (d)	1.2	0.5	1.3
Log-rubbing (f)	-	3.5	4.0
Log-paddling (f)	-	1.0	1.5
Log-playing (d)	-	5.035 [c]	1.16 [c]
Log-sniffing (f)	-	13.5 [a]	4.5 [a]
Ball-playing (d)	-	-	20.1
Ball-sniffing (f)	-	-	15.0

Inactivity was lower when the log or ball were present. With the ball, inactivity was five times lower than in the no-object situation, and this was a highly significant difference. Self-play duration was very low when the ball was present, but was not affected by the introduction of the log. Scores in the ball situation exhibited significant differences with the two other situations. In the same way log-playing and log-sniffing exhibited a significant decrease when the ball was introduced. In contrast, frequencies of log-rubbing and log-paddling were very alike whether or not the ball was present.

Moreover it can be noted that the duration of ball-playing is longer than the duration of log-playing, even when compared with log-playing in the situation with only the log.

Changes in general activity

A synthetic description of the changes observed in each group during the experiment was performed by taking the eight behaviour patterns into account in a principal component analysis. This allows the comparison of the 'trajectories' of each treatment group. The results

are shown in Figures 1 and 2. Although the two first factors accounted respectively for 31 per cent and 16.3 per cent of the total variance only, the third and fourth factors are not represented here. Dispersion along the third and fourth factors were indeed only due to oppositions between two or three observations.

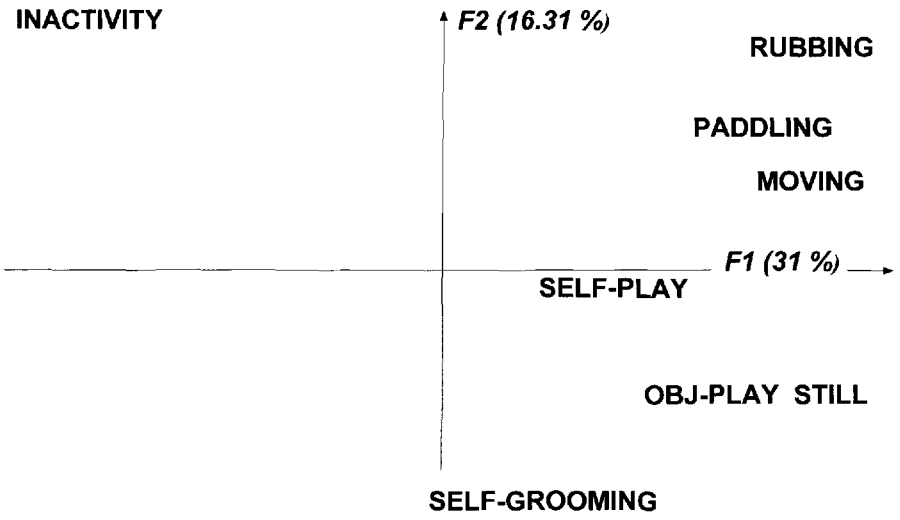

Figure 1 **Principal component analysis of the changes of general activity in the three situations. Correlations of the eight behavioural variables with the F1 and F2 factors: a behavioural pattern in negative coordinates on F1 (like 'INACTIVITY') is negatively correlated with this factor. This means that observations with negative coordinates on F1 (like ◆5 on Figure 2) have relatively very high scores of inactivity. Percentage of variance explained by each factor is indicated.**

Figure 1 shows the correlations of the behaviour patterns with the first two factors. The first factor showed an opposition between inactivity (negatively correlated with F1) and activity patterns. Three subgroups of activity patterns were distinguishable: one with duration of moving, and frequencies of rubbing and paddling; another one with object-play, 'still' and self-play duration; duration of self-grooming was apart, opposed to inactivity on the second factor but with no correlation with other activity patterns.

For clarity of the graph, only gravity centres of subgroups of observations are represented in Figure 2, and only for days one and five, this allows the description of the general evolution of behaviour in each group. The first day of observation of the no-object group (A1-day1) was characterized by very high scores of rubbing and paddling, as seen earlier. The A1 group evolves then in the direction of negative coordinates on F1, because of increasing inactivity. The B2 group (no-object, second week) showed a higher tendency for inactivity from the start, and then reached even more negative coordinates on F1. Both log groups (B1 and A2) started with positive coordinates on F1, that is to say with a good

activity level, and did not show an important change along F1. The last day of the B1 and A2 group was characterized by higher scores of self-grooming as shown by the change along F2. Evolution of the ball groups (A3 and B3) is very striking and opposed to the others. Animals started with negative coordinates and evolved in the direction of more activity and a decline in inactivity over the days. Moreover, both groups showed very similar dynamics over the week.

Gravity centres of both the log and the ball groups were very close on the graph whereas the no-object group was in more 'inactive' coordinates.

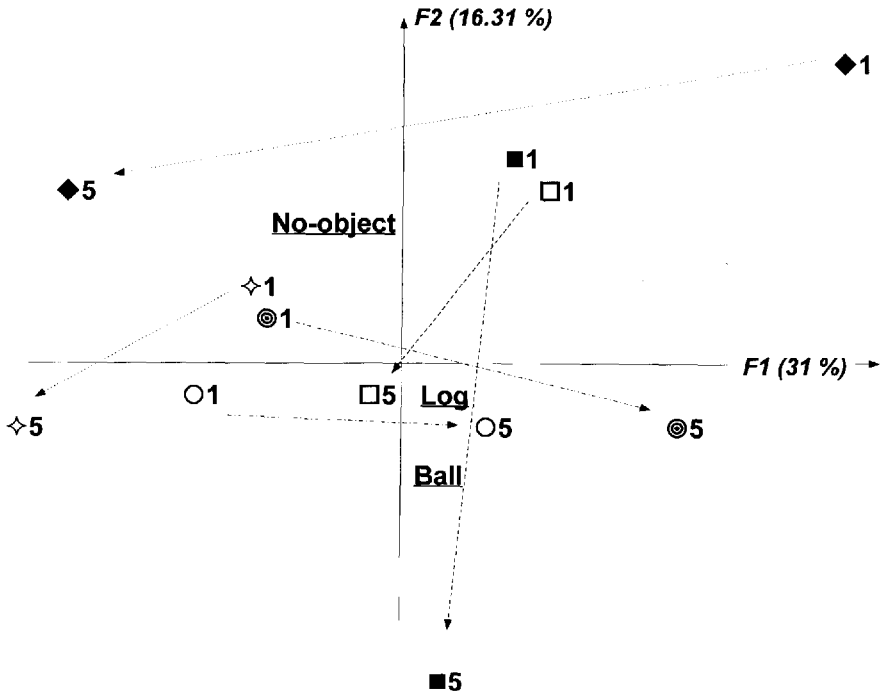

Figure 2 **Principal component analysis of the general activity patterns in the three situations. Gravity centres (ie median points of the five measures) of experimental groups for day one and day five are represented. The symbol indicates the group (see Table 1) and the last number indicates the day of observation in each week:**

1. **groups with no object:** ◆ **A1 (no object, first week)**
   ✧ **B2 (no object, second week)**
2. **groups with the log:** ■ **A2 (with log, second week)**
   □ **B1 (with log, first week)**
3. **groups with ball + log:** ◎ **A3 (with ball + log, third week)**
   ○ **B3 (with ball + log, third week)**

Gravity centres of each situation are underlined. The coordinates of the points are derived from their values on the axes in Figure 1. For example, movement along the F1 axis from positive to negative is related to a decrease in ACTIVITY.

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Evolution of the use of added objects

Figures 3 and 4 show the per cent of time spent playing with or sniffing the log and ball each day. In both cases an important novelty effect was seen on the first observation day, either for playing or for sniffing. From the second day an important decrease was noted, concerning both behavioural patterns. Nevertheless whereas sniffing objects decreased to zero, playing with objects did not, especially with the ball.

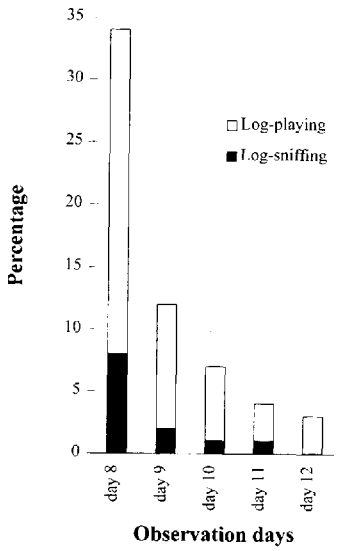

Figure 3 **Per cent of time spent sniffing the log or playing with it when only the log is added.**

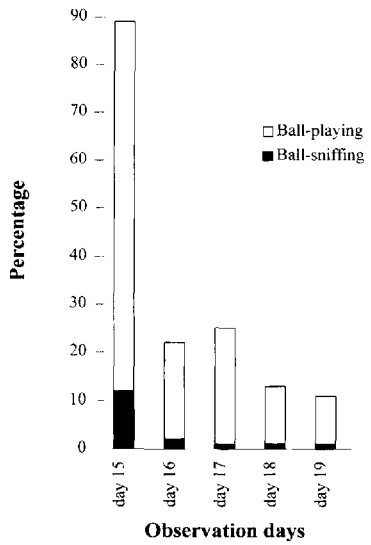

Figure 4 **Per cent of time spent sniffing the ball or playing with it.**

Discussion

Novelty effects on the cats' general activity (mainly the inactivity and 'still' categories) were seen on the first days of weeks one and two. Two behaviours were especially strongly affected by the presence of an observer during the first week: rubbing and paddling.

In their study on colony cats' reactions to humans, Podberscek *et al* (1991) noted more attention to behaviours like 'rub against person', 'claws person', 'lies near person', etc on the first day than on the second and third days for both familiar and unfamiliar persons. In domestic cats, head or flank rubbing against persons are generally considered as greeting or friendly behaviours. Repertoire of friendly approach also includes murmuring, purring and rolling patterns (Leyhausen 1979). Moelk (1979) argued that in human terms, it can be said that the cat has these four ways of saying 'hello'. In our confined animals, direct greeting was not possible toward the familiar observer. Cats rubbed head, check and flank against the front door of their cage. This could be interpreted as an indirect friendly behaviour.

Evolution of paddling frequencies during the first week of our study could be regarded in the same manner. Indeed, the vocal and touch behaviours (purring and paddling) accompanying sucking are the origin of all future friendly behaviour in the cat (Moelk 1979); paddling being very frequent in adult domestic cats when climbing on the knees of a familiar person. Novelty effects decreased quickly from day two and were less clear in the second week since animals were then accustomed to the presence of the observer.

Introduction of objects into the cages resulted in substantial modifications of behaviour. These changes were maximum on the first day of introduction of the log or ball and concerned mainly inactivity, sniffing object and playing. Inactivity was lower when the objects were put into the animals' cages, this being highly significant for the ball. Effects of toys and other objects on an animal's activity level have been observed in many species. Hubrecht (1993) showed that time spent inactive by dogs fell notably when toys like Gumabone chew (Nylabone Waterlooville, UK), rolled Rawhide (Centaur House, Castle Carey, Somerset, UK) or plastic piping were suspended in the animals' pen. The same effect was observed in rabbits (Huls *et al* 1991), in mice and rats (Hirsjärvi 1993; Scharmann 1993) and in non-human primates (see Bayne 1991 or Reinhardt 1992 for reviews). It is generally accepted that a blank cage environment results in inactivity, which is detrimental to psychological well-being; behaviour elicited by interaction with objects must be assumed to imply a decrease of boredom.

However, in our study, a loss of interest in objects over time was observed. On the fifth day after the introductions, cats spent only 3 per cent of their time using the log; and 10 per cent using the ball. Such decline in interest is not observed in all species. In their study with rabbits, Huls *et al* (1991) noted that there was no significant decline in interaction with any of the objects (ie wooden sticks or rings, brass ball) placed in the cage during the five-day observation period. The same conclusions were made with rodents using straw deposited on the top of the cage or paper towel and wooden sticks placed into the cage. Studies of dogs and primates with various toys showed the same results as in the present study. Yet, interest in objects can be maintained at a good level (for example a mean of 24 per cent of total time after two months in dogs, Hubrecht 1993) if they are often replaced or if they could be removed from the cage by the animals.

It is interesting that the function, of various objects chosen, in enriching an animal's environment appears to vary with experimenters and with species. In rodents and lagomorphs, objects were selected that stimulate a great variety of behaviours such as climbing, nesting, building, gnawing etc, and not particularly manipulative behaviours. On the other hand, for carnivores and primates, objects have been chosen that encourage natural manipulative behaviour or 'play'. This could explain the observation that some species continuously use objects over time, although others use them sporadically. In the present study, behaviours performed by cats on the two objects were different. The log elicited mainly rubbing and paddling behaviours whereas the ball (a mobile object) especially stimulated play. Paddling on the log is often performed with exposed claws. Scratching is thus a possible use of the log. Considering that standard cages are generally made of steel, preventing scratching, the presence of a piece of wood could be important for the expression of the basic comfort behaviours, such as self-grooming, stretching etc. Moreover, it would be interesting to know if confined cats are more interested in movable objects which could have different meanings according to their positions in the cage.

Nevertheless, a suspended ball seems to be an appropriate enrichment for confined cats as shown by the multivariate description of general activity change: the ball group did not show a decrease in activity, as did the log and the no-object groups. It is also interesting to note that introduction of the ball provoked a decline in self-play activity and a loss of interest in the log. Eliciting play behaviour in isolated animals is considered to enhance well-being, play being a sensitive indicator of an animal's general state of physical and mental health (Martin & Caro 1985). Carlstead *et al* (1993) showed that in stressed cats, active exploratory and play behaviours were suppressed. It was also argued that around the end of weaning, social play starts to decline and object play increases sharply in cats (Barret & Bateson 1978). Object enrichment seems therefore to be an appropriate form of enrichment for cats isolated from conspecifics as adults.

Suggestions regarding housing conditions for laboratory animals should be made against the background of the species-specific behavioural repertoire. Studies on free-ranging cats indicated a flexible social life from strictly solitary to close contact with conspecifics. In the latter situation animals maintain a certain distance, and the group-living of domestic cats, or Felidae in general, may be qualified as 'living apart together' (Bradshaw 1992). Under confinement, cats in a group may develop a dominance hierarchy often based on a strongly linear rank order which can eventually have detrimental effects on low ranking cats (Van den Bos & De Cock Buning 1993). Hart (1980) recommended the provision of shelves in colony cages so that the animals could have a chance to be alone. Podberscek *et al* (1991) showed that cats in groups spent most of their time alone. Concerning play behaviour, he concluded that playing was rarely observed among adult cats and when they played this was mostly alone. Therefore in adult cats, social isolation may not be considered a totally unfortunate housing situation, because the animals may not necessarily be deprived of social contact if they have daily human contacts, view of other cats and play opportunity. Our individually-confined cats did not develop any abnormal behaviour (ie anorexia, bulimia, excessive or inadequate self-grooming etc), moving stereotypies, autoaggression or distress vocalizations, at least not when observers were present.

Animal welfare implications

We suggest that individually-housed cats should be provided with various objects and their cages fitted with shelves and hiding places (as suggested by Carlstead *et al* 1993, for example), so that animals can perform a wide range of their spontaneous behaviours. Additional studies are still required, comparing efficacy of different objects, and particularly objects that could be moved by the animals.

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