CAT HOUSING IN RESCUE SHELTERS: A WELFARE COMPARISON BETWEEN COMMUNAL AND DISCRETE-UNIT HOUSING

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Abstract *Animal Welfare 2003, **12**: 173-189*

Cats living long-term (over one month) in shelters were assessed for behavioural indicators of stress, using a stress scoring method in combination with behavioural observation. It is hypothesised that because of the inappropriate social grouping of unrelated adult cats and group instability, communal housing creates more stress than discrete-unit housing. Seventy-two cats were observed: 36 were housed communally with unfamiliar conspecifics, and 36 were housed in discrete units, either alone or with other previously familiar conspecifics. The mean stress score was greater in communal housing than in discrete-unit housing. Stress scores range from 1 to 7, with 1 indicating no stress experienced, and 7 indicating extreme stress. Individual scores showed that cats in discrete units, in comparison to those in communal housing, gained a significantly higher percentage of observations in the score 2 category, indicating that no stress was being experienced. Cats in communal housing gained a significantly higher percentage in the score 4 category (stressed). Score 5 was found exclusively in communal housing, but only in 2% of instances. Extreme stress was not found in cats housed under either condition. Cats in the different types of housing differed in their frequencies of hiding, play, sleeping/resting in close contact with one another, and agonistic behaviour. There was no difference between housing types in frequency of eating, drinking, grooming, and toilet use. In this study, cats housed communally experienced moderately higher levels of stress than cats housed in discrete units. Further research is recommended to determine the effect on stress levels of longer shelter residence time and of changes in group size and/or density.

Keywords: *animal welfare, cat, communal vs discrete unit housing, group instability, rescue shelter, stress*

Introduction

A number of organisations operate rescue shelters for the domestic cat (*Felis catus*). The housing conditions within these shelters vary considerably. Some establishments house cats communally with unfamiliar conspecifics, whereas others house them in discrete units, either singly or with one or two previously familiar individuals. Animals brought into shelters remain there until they are homed. Kittens and young adult cats are usually adopted by new owners within a short period of time, but older less-attractive cats may remain in shelter care

for many weeks, months or even years. It is the welfare of these long-term shelter residents that is likely to be most affected by the conditions in which they are housed.

Broom (1986) defined the welfare of an animal as "its state as regards its attempts to cope with its environment", which refers to how much the animal has to do in order to cope with its environment and the extent to which its coping attempts are succeeding. McCune (1992) suggested that implicit in this definition is the concept of homeostasis and a state of internal stability. When an animal encounters environmental factors that disrupt homeostasis, it uses physiological and behavioural regulatory mechanisms to restore stability and thereby adapt to the disruptive factor. If the animal's biological response is inadequate to maintain mental and bodily stability it cannot adapt, is unsuccessful in controlling its internal environment and fails to cope, leading ultimately to reduced fitness (Broom & Johnson 1993). The animal can then be said to be experiencing stress. Any reaction on the part of the individual to the effect of stress is a stress response.

In order to assess whether a welfare problem exists for cats in shelters, it is necessary to observe the conditions in which cats live by choice if unrestrained. Although animals may not always choose a path that ultimately improves their welfare, discovering animals' preferences is a major technique used in assessing welfare (Broom 1988).

Many studies have been carried out on the social organisation, population structure, density and spacing patterns of free-roaming domestic and feral cats (*Felis catus*) and European Wildcats (*Felis silvestris*) (eg Laundre 1977; Fagen 1978; Macdonald & Apps 1978; Corbett 1979; Liberg 1980; Oppenheimer 1980; Wolski 1982; Kerby 1987). Cats are facultatively social and will form groups, consisting mainly of related females and their young, around a clumped resource such as a place of refuge or food provided by farmers (Laundre 1977; Fagen 1978; Kerby 1987; Langham 1992; Langham & Porter 1991; cf Corbett 1979 for when food is scant). These groups are visited by territorial solitary males who avoid each other whenever possible (Liberg 1980). If males do meet, they at best tolerate each other and often display agonistic ritualised behaviour (Dards 1983). Kerby (1987) argued that large colonies of farm cats are an amalgam of family units, amicable among themselves but competing with other families for resources. Kerby suggested that the long-term affiliation between a female and successive generations of her direct descendants is fundamental to the social organisation of all groups of cats.

Fagen (1978) suggested that the upper limit on domestic cat group size in naturalistic environments is around ten individuals. Colonies of up to 25 adults have been observed but, in these larger social units, affiliative social interactions are focussed within female lineages (Macdonald *et al* 2000). The evolution of the familial, matrilineal social structure of free-ranging animals can best be considered in terms of costs and benefits to individual group members (Mendl & Newberry 1997). Group living in cats occurs in response to the availability of unpredictable but clumped resources and enhances group members' chances of locating and defending food. Individuals also gain protection from predators by cooperative defence. Macdonald and Apps (1978) suggested that sleeping huddled together has a thermoregulatory function. Related females maximise their inclusive fitness by cooperatively caring for their own and each other's kittens. Kerby (1987) observed communal nursing and allomaternal behaviour, with females adopting orphans within their group, although allopatry was restricted to lineage.

Male cats retain their solitary territorial status as a way of maximising their own inclusive fitness by inseminating as many females as possible. They compete for available females and do not form the bonds developed by male pride lions, as they do not need to hunt

cooperatively (Liberg 1980). When resources are scarce or widely distributed, female cats also become solitary as they defend what little food they can find for themselves and their kittens (Corbett 1979). The cost of competition then outweighs any benefits of group living. Fitzgerald and Karl (1986), however, found wide overlap in female home ranges in a low-density cat population where food was patchily distributed. The ranges of females in a high-density population living in an area of patchy, although rich, food resources were also found to overlap (Apps 1986). Turner and Mertens (1986), in a study of Swiss farm cats, measured the degree of inter-group and intra-group range overlap. Inter-group overlap was found to be 4%, and intra-group overlap was 55%. These groups were subsisting on a stable, clumped food resource. Other results indicate that there is no female transfer between groups (Liberg 1980; Natoli 1985; Natoli & DeVito 1991), suggesting that, although published evidence of active defence of home range is lacking, some method exists to repel females from outside the group (Liberg *et al* 2000).

It is proposed here that the evolved social structure of free-ranging cats indicates that natural selection has favoured individuals, either male or female, which confront and display agonistic behaviour towards 'outsiders' who are non-relatives and therefore competitors. Housing large numbers of unrelated adult cats together in groups that frequently experience the addition of newcomers is, therefore, inappropriate and might be expected to adversely affect welfare.

Groups of cats housed communally in shelters comprise unrelated males and females, with individuals constantly being introduced on arrival at the shelter and being removed when homes become available. The number of animals housed together in an enclosure varies with enclosure size but usually ranges between three and fifty individuals (D Ottway, personal observation).

When two unfamiliar cats meet, each is likely to respond with wariness and hostility toward the other. Each individual is then motivated to behave in a manner that will 'turn off' the hostile response, thereby restoring internal stability (Petherick & Rushen 1997). In a free-ranging population, animals would use either agonistic ritualised behaviours such as arching of the back and piloerection (Bradshaw 1992) or, less frequently, direct aggression to resolve conflict and restore their internal stability. Mutual avoidance would then follow. In the confines of a shelter enclosure, however, permanent avoidance is impossible, so conflict is continual and repeated. The constant influx of outsiders in the form of new arrivals to the shelter worsens the situation so that animals housed in these conditions may be unable to cope and may experience prolonged stress in the form of fear, anxiety and offensive or defensive aggressive states. Loss of fitness may result as the stress responses, both physiological and behavioural, impair the animals' ability to perform functions necessary for survival and reproduction (Broom & Johnson 1993). Stress is unlikely to be experienced by cats housed singly or with familiar conspecifics (usually siblings or direct offspring) because unresolved confrontation will not occur. The conditions that make group living beneficial in free-ranging situations are not present in shelters (D Ottway, personal observation). There are no predators. Food, although clumped, is predictable in availability and location. Bedding is plentiful and warm. Cats can undoubtedly gain benefits from relationships with family members (Kerby 1987) but, in the absence of close relatives and factors that predispose them to form social groups, they are likely to prefer solitude.

Previous studies have shown that levels of stress decline in the first month after a cat's arrival at a communal shelter (Smith *et al* 1990). Stress levels have also been shown to decline over the first two weeks spent at a boarding cattery, whether the animals were housed

singly or communally (Kessler & Turner 1997). However, no clear conclusion has been reached regarding the levels of stress experienced by cats residing long-term under different housing conditions.

Kessler and Turner (1999a) concluded that cats previously socialised toward people and conspecifics suffered lower stress levels when housed in groups than non-socialised cats. All cats housed communally in shelters for long periods of time experience constant changes in group structure and size and, although socialised cats cope better with this, the cumulative effect of low levels of stress over a long period of time may still result in poor welfare.

Previous experience of catteries has been found to affect stress levels. McCune (1994) found a more rapid decline in stress in cats that had previously spent time in catteries and shelter-type accommodation than in cats that were new to the experience. In Kessler and Turner's (1997) study, most of the cats involved had, on occasions prior to the study, been housed under the same conditions in the cattery. This factor probably contributed toward the cats' rapid adjustment to the cattery, although a comparison of cats with and without previous cattery experience was not possible in this study.

Age is also a factor that may influence the stress levels of cats in shelters and boarding catteries, although Kessler and Turner's (1997) findings are contrary to those of McCune (1992). Kessler and Turner (1997) found that the age of the cats did not influence the adjustment process, but in McCune's (1992) study, the stress levels of older cats declined more rapidly. However, the average age of the cats, the space availability per cat and the scoring method were all factors which differed between these two studies.

Kessler and Turner (1999b) investigated stress and adaptation in cats housed at different densities in an animal shelter. Group density was found to correlate highly with stress levels. The cats in the study were, however, observed in relatively stable control groups with minimal addition or departure of individual animals from the group. While density is undoubtedly an important factor influencing the levels of stress experienced, in reality stable groups are unlikely to exist in rescue shelters, although it may be possible to establish stability in animal sanctuaries where animals, once admitted, spend the rest of their lives. The aim of this study was to test the hypothesis that, in long-term shelter care, cats housed communally with unfamiliar conspecifics experience higher levels of stress than do cats housed in discrete units because of inappropriate and unstable social grouping. This hypothesis generates the prediction that stress responses (reactions to the effect of stress) will be higher in intensity and will be observed more often among cats housed communally than among cats housed in discrete units. Other indirect indicators of stress would also be predicted. Cats housed communally would be expected to spend more time hidden. The incidence of behaviours such as play would be predicted to be higher in discrete housing, while the incidence of behaviours such as agonistic behaviour would be predicted to be higher in communal housing.

Some animals may react to stress by becoming apathetic and unresponsive. They show reduced activity, apparent unawareness and lack of interest in the surrounding world (Broom & Johnson 1993). This 'learned helplessness' response, when animals appear placid and passive, is often an indicator that the animals are highly stressed (Bradshaw 1992) and is thought to be the result of the production of naturally occurring analgesics in the brain. This self-narcotisation probably dulls the impact of a stressful situation but must be considered an extreme attempt to cope (Broom & Johnson 1993).

Methods

Subjects

Two matched samples were used, each comprising 36 subjects. This sample size was decided after a pilot study, using the formula (Martin & Bateson 1993):

$$n = (\sigma^2 Z^2_{\alpha/2}) / D^2$$

where n = sample size needed to give a sample mean that is within specified limits of the true population mean; D = maximum acceptable difference between sample mean and true population mean (0.5 stress score); σ = estimate of population standard deviation (0.96); α = level of statistical significance to be attached to the estimate (0.05); and $Z_{\alpha/2}$ = critical value of the cumulative normal variable Z at the $\alpha/2$ level of significance (1.96). The formula indicated that each sample should comprise 14 subjects (n). The sample size used was larger than this to account for the possible homing of subjects during the study. One sample comprised cats housed communally at the Wood Green Animal Shelter, Heydon, UK. The other sample comprised cats housed singly or together with familiar conspecifics (siblings, offspring or previous housemates) in discrete units at The Blue Cross, Cambridge, UK. Both groups were composed of randomly chosen, neutered male and female cats over the age of one year, all of which were long-term residents (ie had resided in shelter care for at least one month).

The samples were matched with regard to age group (1.0–5.5 years, 6.0–10.5 years and 11–15 years), sex, and previous background history (stray living wild, or from a domestic home environment). All subjects were of mixed ancestry, as certain pedigree breeds exhibit extreme behavioural traits (Bradshaw 1992) that might have operated as uncontrolled confounding variables, producing misleading results.

Upon admittance to the shelters, cats were routinely fitted with coloured collars and identity tags bearing a name and number. Individuals were visually identified, after a period of familiarisation, by a combination of coat pattern and colour and collar colour.

Housing

The 36 subjects from Wood Green Animal Shelter were housed with other conspecifics in three separate communal enclosures with areas of 139.5 m^2 (run 1), 189.0 m^2 (run 2; see Figure 1) and 279.0 m^2 (run 3). At the beginning of the study, the numbers of cats housed in these enclosures were 33, 47 and 65, respectively, allowing approximately 4.0 m^2 per cat. The turnover of cats in each run is shown in Table 1. Apart from the difference in group sizes, all subjects housed communally in the study were housed under identical conditions and were cared for by shelter staff using the same feeding and husbandry routine.

The enclosures had open areas, covered areas and large huts in which both raised and floor-level bedding areas were provided. There were also several small huts in each enclosure where the only access for the cat was via a cat flap. These small huts effectively offered a retreat where cats could rest, away from most of their conspecifics and from any activity in the enclosure. They did not offer complete isolation, however, as each hut could admit more than one animal. The roofs of the huts offered raised areas where the cats could sit. There was also a wooden bench in each enclosure. Each enclosure had at least two large gravel areas used as communal toilets. The cats were fed from large bowls twice daily, the main meal being in the late afternoon with a smaller meal supplied in the morning.

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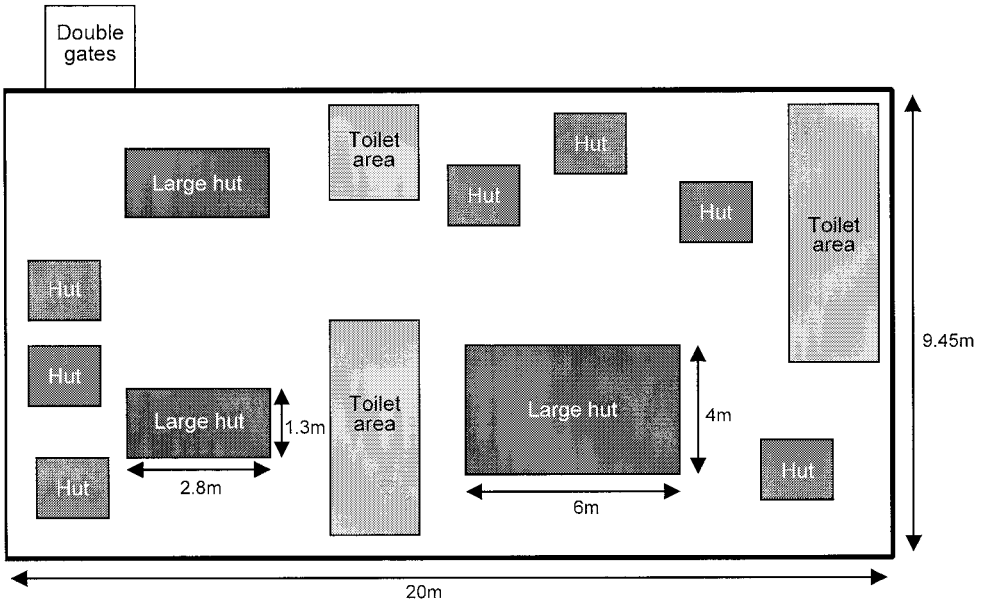

Figure 1 **Floor plan of 189.0 m^2 communal housing enclosure (Run 2) at Wood Green Animal Shelter (Heydon, UK).**

Table 1 **Turnover of cats in communal housing during the study.**

Run	Area of floor space (m^2)	Number of cats at start of study	Number of cats admitted during study	Number of cats leaving (homed) during study
1	139.5	33	11	9
2	189.0	47	14	13
3	279.0	65	15	16

Housing at The Blue Cross consisted of discrete units (Figure 2) arranged in two parallel rows. Each unit measured 4.5 m^2, and housed one single cat or two to three previously familiar individuals. A unit with double occupancy thus offered each cat 2.25 m^2, while three occupants were each allowed 1.5 m^2. The occupants of 24 discrete units were included in this study. Fifteen of the subjects were housed alone, twelve were housed in pairs and nine in groups of three.

Each unit was roofed and enclosed on three sides, the fourth side overlooking a grassed area and the front of the opposite row of units through metal bars. A raised sleeping box was attached to the back wall, accessible by catflap or side door. The bottom half of these boxes had opaque walls so that the cats could hide from view. The top half had a glass frontage and a shelf upon which to sit or lie down. Each unit contained its own litter tray and wooden stool and had two shelves, one attached to a side wall and the other attached to the front bars. The cats were fed twice daily from individual bowls, in the morning and in the late afternoon.

Data collection

At Wood Green Animal Shelter prospective owners could enter the enclosures and walk freely among the cats, handling them if they so wished. This did not occur at The Blue Cross, where cats could be viewed only from outside the housing unit. To eliminate the effect of this

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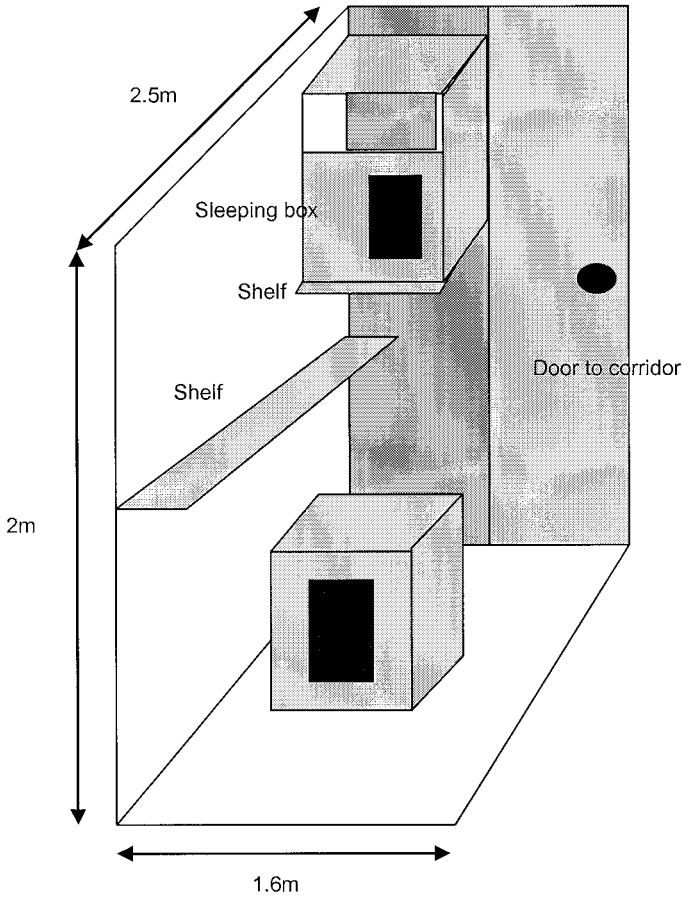

Figure 2 **Three-dimensional plan of a discrete housing unit at The Blue Cross (Cambridge, UK).**

potentially confounding factor, data were collected only on weekdays when both shelters received few or no visitors and the cats were undisturbed. Both shelters receive more visitors at weekends, however, and this may have a lasting effect on the behaviour of the resident cats. For two weeks before the study commenced, the observer (D Ottway) undertook to help with general care of the cats alongside regular staff. This habituated the cats to the observer's presence.

To record stress levels, the Cat Stress Score (Kessler & Turner 1997) was used. The stress score gives a measure of stress levels, using classification of body movements, postures and activities, and is based on the ethogram developed by the UK Cat Behaviour Working Group (1995). The use of the Cat Stress Score greatly reduces the possibility of misinterpretation of passive, apathetic responses to stress, by taking into account subtle physical indicators which might otherwise be missed. The stress score was recorded using instantaneous scan sampling (Martin & Bateson 1993) at 30 min intervals throughout the day from 0830h to 1530h. If individuals were out of sight, they were recorded as hidden. After each instantaneous scan, one–zero sampling was used; this method records whether or not a behaviour has occurred during the preceding sample interval, irrespective of the frequency or duration of the

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behaviour during that sample interval (Martin & Bateson 1993). During a 10 min sample interval the following specific behaviours were recorded: eat, drink, toilet use, self groom, play (social or object), sleep/rest in contact with conspecific, stereotypic pace, agonistic encounter.

The temperature was noted at every scan. Data collected on two mornings when the temperature fell below 15°C were not used in the analysis, as the Cat Stress Score cannot apply in these conditions (Kessler & Turner 1997). This is because at low temperatures cats will adopt certain body postures for thermoregulatory reasons.

The study took place over a six-week period. Data were collected for 15 consecutive weekdays from Wood Green Animal Shelter during the period 15 June 1998 to 3 July 1998, and for 15 consecutive weekdays from The Blue Cross during the period 6 June 1998 to 24 July 1998.

Data analysis

SPSS 6.0 for Windows was used for data analysis (SPSS 1993). The data were expressed as the percentage of instances in which each score or individual behaviour occurred. The total stress score for each subject was then converted to the mean, weighted to the proportion of times that each score was observed.

It was not possible to determine the behaviour or the score of a hidden individual without causing disturbance and elevating the score. If a subject was hidden at the time of a scan, the score value was recorded as missing and that scan was not included when calculating percentages for analysis.

Hiding and the other behaviours recorded are not mutually exclusive. Although it is possible to say with some certainty that hidden cats were not eating or drinking (no food or water was provided in the huts), pacing or playing (there was too little room in the huts), or involved in agonistic encounters (cats could leave huts if threatened), there was no way of knowing if a hidden cat was grooming, sleeping in close contact with a conspecific, or using the hut as a toilet. According to shelter staff, huts were occasionally found to be soiled with urine and faeces. Scans where cats were recorded as hidden were thus excluded when calculating percentages for analysis of grooming, sleeping in contact with a conspecific, and toilet use.

Before undertaking analysis of data from both housing conditions, the non-parametric Mann-Whitney *U*-test (Siegel & Castellan 1988) was used to test for differences between cats housed singly and cats housed with previously familiar conspecifics in discrete-unit housing. The differences in the overall mean stress score, in individual scores and in the occurrence of different behaviours between shelters were tested using the non-parametric two-tailed Wilcoxon signed-ranks test (Siegel & Castellan 1988) and a 0.05 critical significance level.

Agonistic encounters and sleeping/resting in close contact with a conspecific are behaviours that, by definition, require the presence of more than one individual. Fifteen of the 36 subjects at The Blue Cross were housed alone. In testing for differences between housing conditions for agonistic and contact behaviours, the Wilcoxon signed-ranks test was undertaken using only the data from the 21 Blue Cross subjects housed with conspecifics and their matched pairs.

Results

Discrete unit housing

In discrete-unit housing, there was no difference between cats housed singly and cats housed with previously familiar conspecifics in overall and individual stress scores, or in the following behaviours: eating, drinking, grooming, toilet use, hiding, playing and pacing (Mann-Whitney *U*-test, not significant). Both resting/sleeping in close contact and agonistic behaviour require the presence of more than one individual and so were not included in this analysis.

Comparison of discrete and communal housing

Stress score

The overall stress score was higher in cats housed communally than in cats housed in single units alone or with previously familiar conspecifics (Figure 3) (Wilcoxon signed-ranks test $t = 562$, n = 36, $P = 0.001$).

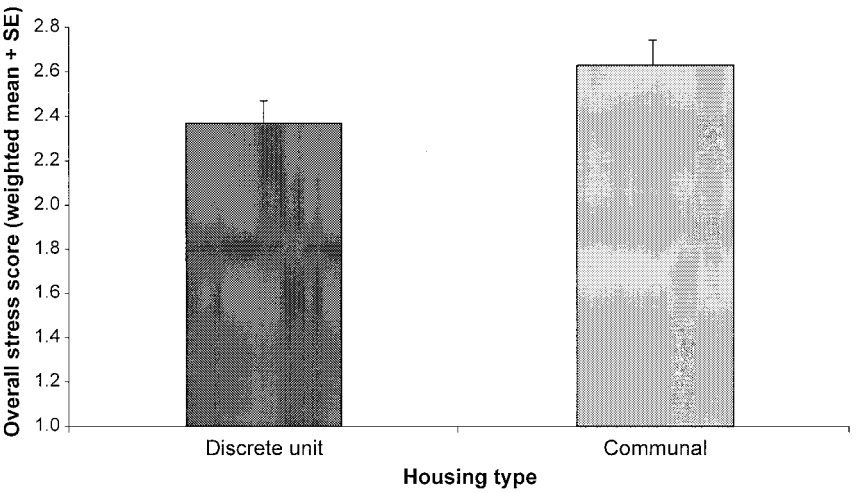

Figure 3 **Overall stress score in each type of housing (weighted mean of instances + SE).**

Comparison of individual stress scores between shelters (Figure 4) indicated that there was no difference between housing conditions in the percentage of instances in which scores 1 and 3 were observed (Wilcoxon signed-ranks test: not significant). The percentage of instances in which score 2 was observed was higher in discrete-unit housing than in communal housing (Wilcoxon signed-ranks test $t = 141$, n = 36, $P = 0.01$). The percentage of instances in which scores 4 and 5 were observed was higher in communal housing than in discrete-unit housing (score 4: Wilcoxon signed-ranks test $t = 563$, n = 36, $P = 0.001$; score 5: Wilcoxon signed-ranks test $t = 120$, n = 36, $P = 0.01$). Scores 6 and 7 were not observed at either shelter.

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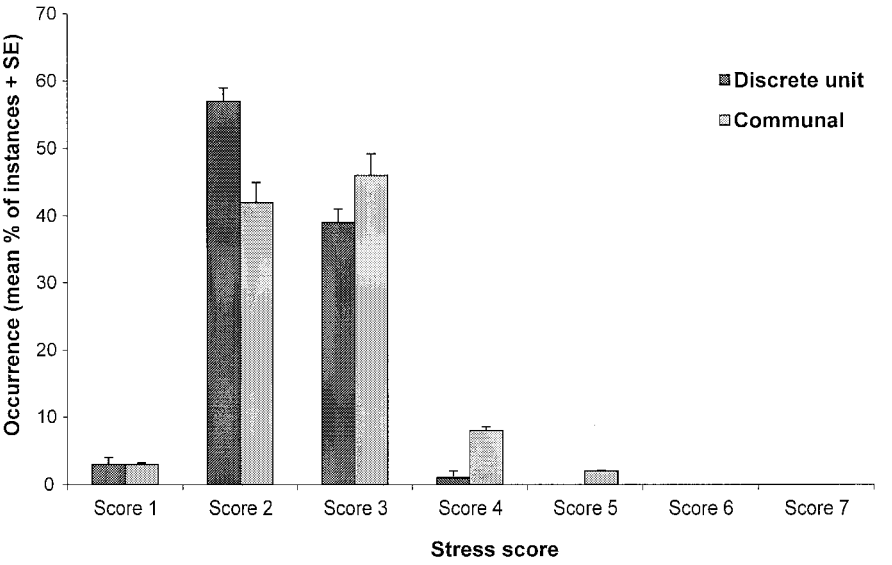

Figure 4 **Relative occurrence of individual stress scores for each housing type (mean % of instances + SE).**

Time spent hidden

The percentage of instances in which cats were hidden was higher in communal housing than in discrete-unit housing (Figure 5; Wilcoxon signed-ranks test $t = 455$, n = 36, $P = 0.001$) despite the relative availability of hidden space being similar at the two sites.

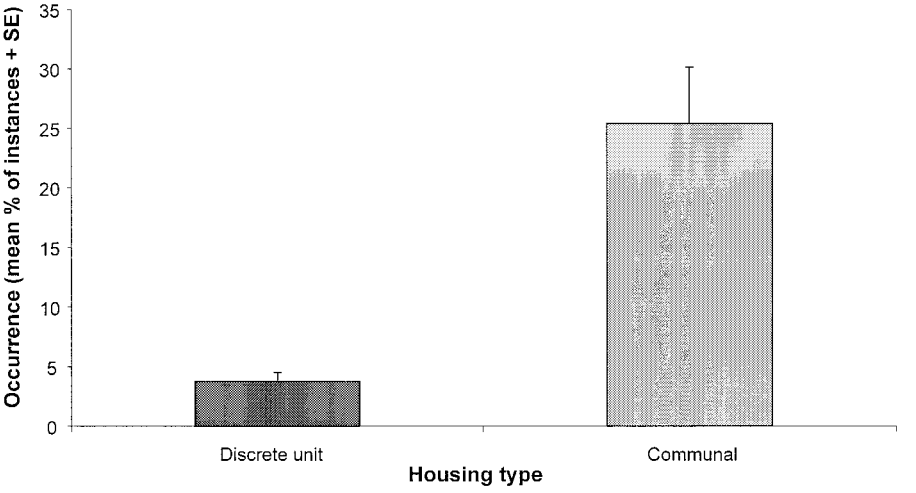

Figure 5 **Time spent hidden in each type of housing (mean % of instances + SE).**

Behaviours

Play and resting/sleeping in close contact (Figure 6) were both observed in more instances in discrete-unit housing than in communal housing (play: Wilcoxon signed-ranks test $t = 78$, n = 36, $P = 0.01$; resting/sleeping in close contact: Wilcoxon signed-ranks test $t = 6$, n = 21,

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$P = 0.01$). Agonistic encounters (Figure 6) were observed in more instances in communal housing than in discrete-unit housing (Wilcoxon signed-ranks test $t = 153$, $n = 21$, $P = 0.001$). There was no difference in stereotypic pacing between housing conditions (Wilcoxon signed-ranks test: not significant), and no difference in eating, drinking, grooming or toilet use between housing conditions (Figure 6; Wilcoxon signed-ranks test: not significant).

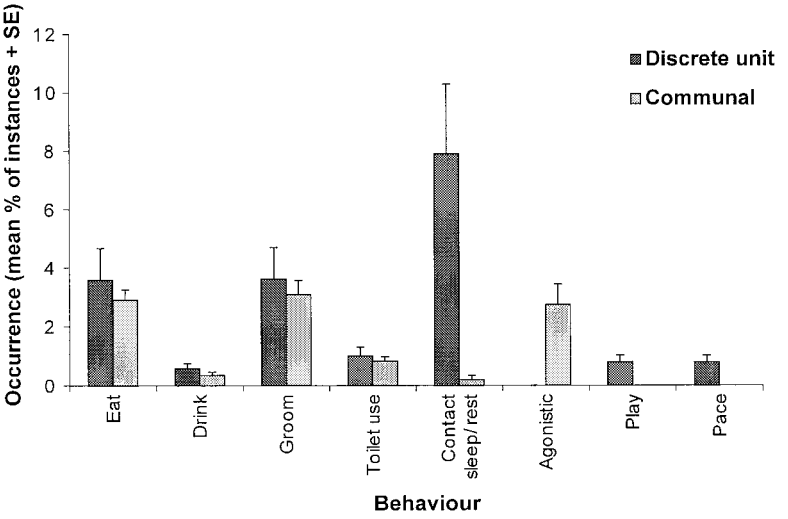

Figure 6 **Relative occurrence of different behaviours in each housing type (mean % of instances + SE).**

Discussion

Stress, as defined by Broom and Johnson (1993), is "an environmental effect on an individual which overtaxes its control systems and reduces its fitness or appears likely to do so". The subjects used in this study were neutered on admission to their respective shelters, so their direct fitness (in that they were incapable of producing offspring) from that point on was zero. For the purposes of this study, therefore, I will redefine stress as "an environmental effect on an individual which overtaxes its control systems and would be likely to reduce direct fitness if the animal was unneutered". There are, however, many circumstances in which welfare is poor without this having any effect on biological fitness (Broom & Johnson 1993). The following discussion takes this into account when interpreting the results of the study.

Stress scores

The seven categories of Kessler and Turners' (1997) Cat Stress Score can be grouped into broader categories and related to welfare and the effect of stress as defined by Broom and Johnson (1993) (Table 2). The overall mean stress score was higher for cats in communal housing than for cats housed in discrete units, although the mean score for cats in both housing types was below score 3, indicating that all cats in the study could regulate their internal environment with ease and were not stressed (Table 2). However, more insight is gained by looking at differences in individual stress scores. There was no difference between shelters in the percentage of instances where both scores 1 and 3 were allocated, but cats in

discrete-unit housing, whether alone or with previously familiar conspecifics, gained a higher percentage of instances in the score 2 category.

Table 2 Kessler and Turner's (1997) Cat Stress Score related to welfare.

Stress score	Activity level	Internal environment	Ease of response	Stress description	Implications for welfare
1,2	1: Sleeping or resting 2: Sleeping, resting, active, playing	Stable	No response needed	Not stressed	Welfare unaffected
3	Resting or actively exploring	Slightly unstable	Easy regulation	Not stressed	Welfare unaffected
4,5	Cramped sleeping, alert resting, actively exploring or trying to escape	Unstable	Regulation with difficulty	Stressed	Poor welfare
6,7	Actively prowling or motionless, alert	Unstable	Unable to regulate	Extremely stressed	Very poor welfare

Scores 1, 2 and 3 all indicate that stress was not experienced by the cats and their welfare remained unaffected. It can be concluded from the results of these three scores together that cats in discrete-unit housing spent more time in a state where welfare is unaffected than did cats in communal housing.

Cats housed communally with unfamiliar conspecifics gained a higher percentage of instances in the score 4 category. Score 4 indicates that, although stress was experienced, the cats were coping and regulating their internal environments, but with difficulty. As a consequence, their welfare was compromised.

Score 5, indicating that cats were unable to cope and were experiencing stress and poor welfare, was allocated exclusively to cats in communal housing, although in only 2% of instances. No cats housed under either condition scored 6 or 7, indicating that extreme stress was not experienced by cats housed either communally or in discrete units.

In this study, the results obtained from the Cat Stress Score indicate that cats in communal housing spent more time in states in which welfare is poor than did cats in discrete-unit housing. Cats housed communally experienced some moderate stress; cats housed in discrete units did not. The differences are significant, but analysis of the difference between shelters in the cats' locations and behaviour patterns gives further insight.

Location

Cats housed communally spent more time hidden away (26% of instances) than did cats housed in discrete units (4% of instances; Figure 5). Bradshaw (1992) states that hiding behaviour correlates with enhanced adrenocorticotrophic hormone (ACTH) response and increased level of urinary cortisol and is reliable evidence of stress. Hiding is a form of coping with and alleviating stress, so the welfare of a stressed and fearful cat that hides is likely to be better than the welfare of a stressed and fearful cat that cannot hide. The welfare

of a cat that needs to hide frequently or for long periods is, however, poorer than that of a cat that does not experience the fear and stress-inducing stimulus which motivates it to hide. If an animal spends most of its time hidden away, its ability to find food, water and mates is greatly impaired, reducing its fitness substantially.

Behaviour

Broom and Johnson (1993) list behavioural attempts to cope, lack of behavioural indicators of pleasure, behavioural pathology, and suppression of normal behaviour among measures of poor welfare. When cats are housed in communal shelters with unfamiliar conspecifics, they are in a restricted environment where it may be impossible for them to withdraw from each other, thereby increasing the likelihood of social conflict (Mertens & Schar 1988) and of agonistic encounters. Agonistic encounters were observed only among the communally housed cats (3% of instances), and can be viewed as behavioural attempts to cope by resolving the conflict.

Colonies of farm cats are nearly always closed societies, with replacement from births rather than from immigration (Wolski 1982). The population of cats in shelters is constantly changing and being added to. This does not pose a problem when cats are housed singly or with previously familiar conspecifics, as any newcomers are housed in separate units and have no direct contact with established residents. However, the enforced social contact of cats housed communally with frequent newcomers may result in animals encountering conditions that they are motivated to resolve or avoid; but, being unable to do either, they resort to unprovoked attacks on conspecifics and other behavioural attempts to cope, such as hiding away.

Play was observed exclusively in cats housed singly or with previously familiar conspecifics in discrete units, but only in 1% of instances. Martin and Caro (1985), in their study on the functions of play, found that play behaviour usually indicates that an animal is in good physical and mental health and, in some circumstances, can be a behavioural indicator of pleasure. Stress in cats has been shown to suppress play behaviour (Carlstead *et al* 1993). The total absence of play behaviour among the subjects housed communally with unfamiliar conspecifics might therefore be indicative of poor welfare and mental health, but adult cats typically spend little time playing. The functions of play in the cat are thought to be in the behavioural development of kittens and can be divided into three categories: motor training, cognitive training and socialisation (Bradshaw 1992). All the cats in this study were adults (over one year old), probably explaining the low incidence of play overall.

Studies of farm colonies have shown that female cats, especially, choose to be in close bodily contact with one or more other cats for more than half of their total resting and sleeping time (Macdonald & Apps 1978), indicating that they benefit from and are motivated to perform this behaviour. Bradshaw (1992) suggests that sleeping in close contact may strengthen social bonds between conspecifics. Only 21 of the 36 subjects at the Blue Cross had the opportunity to sleep or rest in close bodily contact with another cat. Therefore, the high frequency of occurrence of this behaviour among cats in discrete-unit housing (8% of instances) compared to its rare occurrence among cats housed communally (0.5% of instances) would suggest that conditions at the former were more conducive to social bonding.

Behavioural inhibition of eating, drinking, grooming and toilet use is evidence of extreme stress (Bradshaw 1992). These behaviours are essential for survival and their suppression leads to reduced fitness. There was no significant difference in the occurrence of these

behaviours between the two shelters (Figure 6), indicating that although some stress was experienced by cats housed communally, it did not interfere with normal functioning.

Stereotypic pacing is a behavioural pathology (Broom & Johnson 1993). It was observed in only one animal housed alone in a discrete unit (1% of instances) and was never observed in cats housed communally. Although the difference was not significant it may be an indication that some cats experience poor welfare when kept alone in a very restricted environment. Mertens and Schar (1988) have suggested that a cat kept strictly indoors should have a minimum of two rooms so that it cannot see every point in its surroundings from one position. This could be applied to individual shelter accommodation if space allows, encouraging the cat to separate spatially its various activities and stimulating its curiosity to explore the unseen area.

Although the difference between housing types in terms of stress scores, time spent hidden and behavioural indicators of poor welfare is significant, the actual percentage of instances in which scores 4 and 5 were allocated to cats in communal housing was low (Figure 4). Similarly, the percentage of instances in which agonistic behaviour was observed in communal housing was low (Figure 6). These results indicate that only moderate levels of stress were experienced by cats in communal housing. It is unlikely, therefore, that a long-term reduction in fitness would result. Hiding behaviour was observed in 26% of instances in communal housing (Figure 5), which indicates that a long-term reduction of fitness would be likely to occur. The lack of significant difference between housing types in eating, drinking, grooming and toilet use, however, suggests that fitness was not substantially reduced, as the cats still performed these basic maintenance behaviours which are necessary for survival. The overall conclusion from this study is that cats experienced moderately higher stress levels and found it more difficult to cope when housed communally with unfamiliar conspecifics than when housed in discrete units. The welfare of the communally housed cats was thus poorer, but it appears that the stress experienced was neither extreme nor prolonged.

Neutering is known to reduce agonistic behaviour and territoriality in male cats (Hart & Barrett 1973), indicating that neutered individuals are less motivated to confront unfamiliar conspecifics. When feral cat colonies are neutered, aggression towards members of neighbouring groups seems to be reduced (Bradshaw 1992). The staff of the shelters involved in this study neutered all entire male and female cats on admission, and this is likely to account for the fact that extreme and prolonged stress did not seem to be experienced by cats housed communally.

The results from this study are not in agreement with the findings of Smith *et al* (1990) who, in their research on communal housing at the St Francis Animal Welfare Shelter (Horton Heath, Hampshire, UK), found no behavioural patterns in long-term resident cats that could be interpreted as resulting from stress. The use of the sensitive Cat Stress Score and the comparative nature of the present study may help to explain this discrepancy. However, the main difference that is likely to affect the results is stability. The subjects at the St Francis Animal Welfare Shelter were part of a long-term stable group residing permanently at the shelter. This group did not experience a constant influx of newcomers, unlike in the present study.

Kessler and Turner (1997) found no difference in the mean daily stress scores of cats housed singly, in pairs or in groups. The cats in Kessler and Turner's study mostly had previous experience of the housing conditions studied, and were assessed for two weeks after entry to the cattery. The control group, which had low mean daily scores over the 14 days of the study, was a relatively stable group with no admissions or discharges in the five days

prior to observation. There are important differences between Kessler and Turner's (1997) study and our study which may explain the conflicting results. First, in the present study, the cats would have been unlikely to have previous experience of group housing. In the UK, it is usual for cats in boarding catteries to be housed either singly (if they come from a single-cat household) or with previously familiar conspecifics (D Ottway, personal observation). Second, the cats in our study had all been resident for at least one month prior to observation. Upon entry to a cattery or shelter, adaptation to the unfamiliar environment is likely to override any other considerations. Once a cat is used to its new environment, baseline stress levels can be determined. Lastly, the cats in communal housing in the present study had constant changes to their group structure (Table 1), with individuals frequently leaving or being admitted to the runs. This situation is not unusual during busy periods in rescue shelters.

In a follow-up study of stress and adaptation in shelters and boarding catteries, Kessler and Turner (1999a) found that cats that were not previously socialised with conspecifics had a negative effect on the other group members by increasing their stress levels in the first few days after the non-socialised cats were admitted. The social background of the cats entering the communal shelter in the present study was unknown but was probably mixed, with some individuals being previously socialised and some not. It may well have been these non-socialised cats which were responsible for the higher stress levels found in the cats in communal housing.

Density has been found to affect stress levels considerably. Kessler and Turner (1999b) recommended a maximum group density allowing each cat 1.7 m^2 floor space. In the present study, density in communal housing allowed approximately 4 m^2 per cat, while each cat in discrete-unit housing had 4.5 m^2, 2.25 m^2 or 1.5 m^2 floor space depending on the number of cats occupying each unit (one, two or three, respectively). In this study, the amount of space available did not affect stress levels. However, Kessler and Turner's (1999b) study recorded stress levels for stable groups and for cats on entry to the shelter.

Kessler and Turner (1999b) pointed out that other spatial and social factors may also influence the stress levels of cats housed in groups and may lead to lower or higher critical group density. The instability of the cats housed communally in this study was likely to be the factor negatively influencing stress levels, and further study is needed to determine whether, given this level of instability, a lower critical group density can be determined. Group size may also be an important factor. The groups in this study contained between 33 and 65 individuals, many more than is typically found in a free-living colony, although in a survey of 300 colonies in the UK, 7% contained over 50 cats (Bradshaw 1992). It is interesting to note that after this study was completed, the shelter in which cats were housed communally made the independent decision to lower cat density, and thus group size, considerably. The effects of this action on stress levels are unknown.

Although the cats in this study had all been residents of the shelter for a minimum of one month, the results do not necessarily apply to cats housed in shelters for further extended periods. A useful future study could monitor the stress levels of cats residing in shelters for a longer minimum period. This would determine, first, whether further habituation to the physical environment and to group living *per se* can reduce the stress effects of group instability and, second, whether the level of stress experienced by cats housed in discrete units increases with increasing shelter-residence time.

We would suggest that in any further research undertaken in this area, attempts should be made to include physiological measures to reinforce the behavioural implications. These

measures could include heart rate, blood and/or urine corticosteroid levels and immune system function; however, obtaining the necessary samples for analysis without subjecting the animals to stress and thus confounding the results might be difficult.

Animal welfare implications

In this study, cats housed communally with unfamiliar conspecifics in unstable groups experienced moderately higher stress levels than cats housed in discrete units. Discrete-unit housing is not without welfare problems, however, and the cost of providing environmentally enriched single units may be prohibitive for the organisations involved. Welfare could be improved among cats housed communally if shelters adopted a policy of integrating several newcomers at once, on a weekly or bi-weekly basis, thereby reducing the frequency of stress-inducing introductions. To achieve this, incoming cats should be housed separately when first admitted, several individuals subsequently being moved into the established group simultaneously. Further research is necessary to determine whether the results of this study are altered by an increase in shelter residence time, or by changes in group size and/or density.

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