EFFECTS OF DENSITY AND CAGE SIZE ON STRESS IN DOMESTIC CATS (*FELIS SILVESTRIS CATUS*) HOUSED IN ANIMAL SHELTERS AND BOARDING CATTERIES

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This study investigated the influence of density and floor area on stress and the adaptation process of cats in animal shelters and boarding catteries. Sixty-three rescued cats were observed on 113 days in a shelter at group densities of 0.3–0.9 animals m^{-2}. In addition, 49 rescued cats were observed during their first week after being admitted to a control group housed at a density of 0.5 or 0.8 animals m^{-2}, and 44 boarding cats were observed in single cages of either 0.7 or 1.0 m^2 floor area during their first week in a cattery.

Group density was highly correlated with the stress level of animals housed in groups. A stress level of 'weakly tense' was reached when the group density reached 0.6 animals m^{-2}. During the first week of their stay, stress levels among cats which had been newly admitted to groups housed at 0.5 or 0.8 animals m^{-2} did not differ significantly. On days 1, 2 and 6 after admission, boarding cats housed in single cages with a floor area of 1.0m^2 had significantly lower stress levels than animals in cages with a floor area of 0.7m^2.

Group density was clearly shown to influence the adaptation process of cats which were housed for several weeks in groups. In order to avoid high stress levels, a group density of 0.6 animals m^{-2} should not be exceeded. However, the minimum spatial requirement for singly housed cats remains unknown.

Keywords: *animal husbandry, animal shelter, animal welfare, cat, housing space requirements, stress*

Introduction

The popularity of the domestic cat as a pet has increased over the last decades (Marchand & Moore 1991). As a corollary, animal shelters are confronted with an increasing number of homeless and unwanted cats. The social organization of free-living domestic cats consists of groups of related females with spatially, but not temporally, overlapping home ranges and of solitary cats which are non-socialized towards conspecifics (Kerby & Macdonald 1988;

Bradshaw 1992). The home range of free-living domestic cats varies between 200m^2 and 1.7km^2 (see overviews in Liberg & Sandell [1988]; Bradshaw [1992]). A temporary stay in an animal shelter or boarding cattery, therefore, presents far more restricted living conditions than those experienced in a free-ranging territory or a private home.

In an animal shelter, the adjustment process to either the single- or the group-housing condition takes 2–5 weeks, but shows great individual variation among cats (Smith *et al* 1990; Rochlitz *et al* 1995; Kessler & Turner 1997). However, factors influencing the adaptation of cats to animal shelters have received little attention. Roy (1992) studied spatial factors influencing the welfare of cats in shelters, and recommended the provision of hides as well as elevated shelves made of wood. Leyhausen (1979) found that density affects the social behaviour of cats in group enclosures. He concluded that the more limiting the space for a group, the stricter the social hierarchy. However, the frequency of fighting between the cats was not particularly increased under limited spatial conditions. McCune (1994) found that short travelling times of the animal to the shelter, short waiting times (before caging in the shelter) and previous experience of caging helped to reduce stress among singly caged cats during their first days in a shelter. However, there are no clear guidelines on the minimum space required and optimum group density in boarding catteries and animal shelters.

This study represents the third part of a project studying stress and adaptation of cats in animal shelters and boarding catteries (see Kessler & Turner [1997; 1999]). The present study investigated the adaptation process and the stress levels among newly admitted and more established cats housed at different densities in an animal shelter. The course of stress in boarding cats housed in two different cage sizes for single cats was also studied. To assess stress levels, a seven-level Cat-Stress-Score (see Kessler & Turner [1997]) was applied.

Methods

Subjects and housing

One hundred and twelve rescued cats (1–15 years old) which were group-housed, and 44 boarding cats (1–16 years old) which were housed singly were observed (Table 1). The subjects which were housed in groups were brought to the shelter as unwanted or homeless animals. They were individually integrated into a group enclosure after a 2–6 week stay (mean 23 days) in a quarantine station with single cages.

A group was defined as a *control group*, if all members of the group had lived in the group enclosure of the shelter for at least 2 weeks and if no discharges had occurred over the 3 days prior to the introduction of a new cat and the start of the observations. Cats which repeatedly showed unfriendly behaviour towards conspecifics during their first few days were removed from the group enclosure and not observed (see Kessler & Turner [1999]). Our definition of the control group's 'stability', therefore, refers to temporal but not social stability.

Continuous observations were conducted over several months in the group enclosure, but data were only analysed for periods in which the control group fulfilled the previously defined stability criteria. This was the case on 113 observation days. Sixty-three rescued cats were observed for between 1 and 5 days (mean 2 days) in a control group. The density of the control groups was between 0.29 and 0.87 animals m^{-2} (ie 7–21 cats), with a mean of 0.61 animals m^{-2}. This was within the usual range of densities in the shelter.

During the first week after admission to the group enclosure, 49 rescued cats were observed in control groups of 'low' or 'high' densities. Based on the available range of

group densities in the shelter and this study's findings about the critical density in more established cat groups (see, *Results*), we compared a high density group of over 0.7 animals m^{-2} (mean 0.81, range 0.74–0.91 animals m^{-2}) and a low density group of less than 0.60 animals m^{-2} (mean 0.49, range 0.25–0.58 animals m^{-2}).

The 44 boarding cats housed in single cages of two different floor areas were observed during their first week in the cattery (Table 1). Eighty-six per cent of the cats in cages measuring 1.0m^2 and 87 per cent of the cats in cages measuring 0.7m^2 had been previously boarded in the same shelter. Animals which had boarded in the same shelter within the past 3 months were not included in the analyses, in order to avoid influences due to experience with the shelter (McCune 1992).

Table 1 Subjects observed under single- and group-housing conditions.

	Cats newly admitted to single cages		Cats newly admitted to control groups		Cats established in control groups
	1.0m^2	0.7m^2	Low density	High density	
Animals m^{-2}	1.02	1.43	0.49	0.81	0.29–0.87
Floor area (m^2)	0.98	0.70	23.9	23.9	23.9
Total subjects (n)	29	15	19	30	63
Neutered males	13	8	11	14	29
Neutered females	16	7	8	16	34
Average age (years)	5.01	4.76	3.74	3.65	4.15

The rescued cats housed in control groups were observed at the shelter of the Swiss Animal Ambulance (Zurich, Switzerland). The group enclosure (23.9m^2 in area) consisted of a main room (3.8x4.6x2.3 m) connected to a smaller room (3.4x1.9x1.8 m) by an open passage (0.2x1.8 m). The enclosure contained various elevated shelves, retreat areas, scratching posts, toys and litter trays.

The singly housed boarding cats were observed in 14 single cages (0.7x1.4x0.6 m) in the Weiermatt shelter (Zurich, Switzerland) and 7 single cages (0.7x1.0x0.6 m) in the Allenspach shelter (Zurich, Switzerland). In both shelters, cages contained a litter tray and a hiding place for retreat. There were no shelves in these cages.

Cat-Stress-Score

The stress level of the cats was recorded by a non-invasive Cat-Stress-Score (Kessler & Turner 1997) which describes seven stress levels based upon postural and behavioural elements of the cat. The behaviours described in the Cat-Stress-Score are based on the ethogram of the UK Cat Behaviour Working Group (1995). The same observer performed all the scoring in this study.

The Cat-Stress-Score was developed by Kessler and Turner (1997), and is based on the Cat-Assessment-Score of McCune (1994). The seven levels of the Cat-Stress-Score are scored as follows: 1 = fully relaxed; 2 = weakly relaxed; 3 = weakly tense; 4 = very tense; 5 = fearful, stiff; 6 = very fearful; and 7 = terrorized. The Cat-Stress-Score contains a detailed description of each stress level and allows a fine differentiation of the levels, including active and passive behavioural and postural elements.

For the development of the Cat-Stress-Score, observations were made on about 300 cats under single-, pair- and group-housing conditions in animal shelters and boarding catteries. The recorded behavioural and postural elements were added to McCune's Cat-Assessment-Score (McCune 1994), resulting in a more detailed description of each stress level and

allowing a finer differentiation of the levels. In particular, active behavioural elements and a tense sleeping posture were added under score 4. The behaviour of the cats towards humans was not used in this appraisal in order to avoid the influence of socialization of the cats towards humans on scoring.

The Cat-Stress-Score can be applied in all housing forms in an animal shelter or boarding cattery, but not when temperatures drop below 15°C because the animals do not assume a relaxed posture when it is cooler. Kessler and Turner (1997) reported an inter-observer reliability of 0.90 for the scoring, when applied by two trained observers. Observations by shelter staff with less training resulted in a reliability of 0.75.

Procedure

The Cat-Stress-Score of every cat in the control group was assessed four times a day over a total of 113 days. Observations were made at 1000h and 1500h, with an interval of 15min between the two assessments conducted at each session. On the first observation day, the cats were admitted to the single- or group-housing condition between 0730h and 0930h. Cat-Stress-Scores of cats which had been newly admitted to control groups and of cats which had been newly admitted to single cages were assessed daily in the same manner for their first 7 days in the shelter/cattery. Cat-Stress-Scores for the group-housed cats were assessed at 1000h and 1500h; and Cat-Stress-Scores for the singly housed cats at 1100h and 1630h.

The Cat-Stress-Score was assessed after a 1-min observation period without visual interaction between the cat and the observer. Before data collection began, the observer spent 10min at the observation points (invisible to the cats) inside the boarding room, or in front of the group enclosure to give the cats a chance to become accustomed to the observer's presence.

Statistical analysis

The four Cat-Stress-Scores on an observation day were averaged for each cat, since the scores from any one day did not differ by more than one level. Even though the Cat-Stress-Score itself is not a linear system, we assumed that an increase or decrease of the scores within this small range approximated a linear system, in order not to lose too much information. Medians were calculated from the daily mean scores for further analyses of the Cat-Stress-Scores under different housing conditions.

Because comparisons of single days were of interest, Mann-Whitney *U* tests were used to detect differences between the daily mean Cat-Stress-Scores of newly admitted cats to different cage sizes or group densities. Correlations between the daily median Cat-Stress-Score of a control group and its density were analysed by a simple regression. Six of the 63 cats observed in control groups contributed data to two different group densities.

Since the range of daily Cat-Stress-Scores was small, both within and between the various groups, effects at the level of the individual animal were not analysed (see, *Results*). StatView 4.0® (Abacus Concepts Inc, Berkeley, California, USA) was used for the statistical analysis. All comparisons are two-tailed, unless otherwise stated.

Results

Effects of group density (rescued cats)

The median Cat-Stress-Score of the animals (n = 63) housed in control groups at densities of 0.3–0.9 animals m^{-2} during the 113 observation days was 2.99 (range 2.48–3.54, mean 2.97). *Group density and the daily medians of the groups'* Cat-Stress-Scores were highly correlated

(n = 63, r = 0.80, $P < 0.001$). The Cat-Stress-Score 'weakly tense' (score 3.0) was reached at a group density of 0.63 animals m^{-2} (Figure 1).

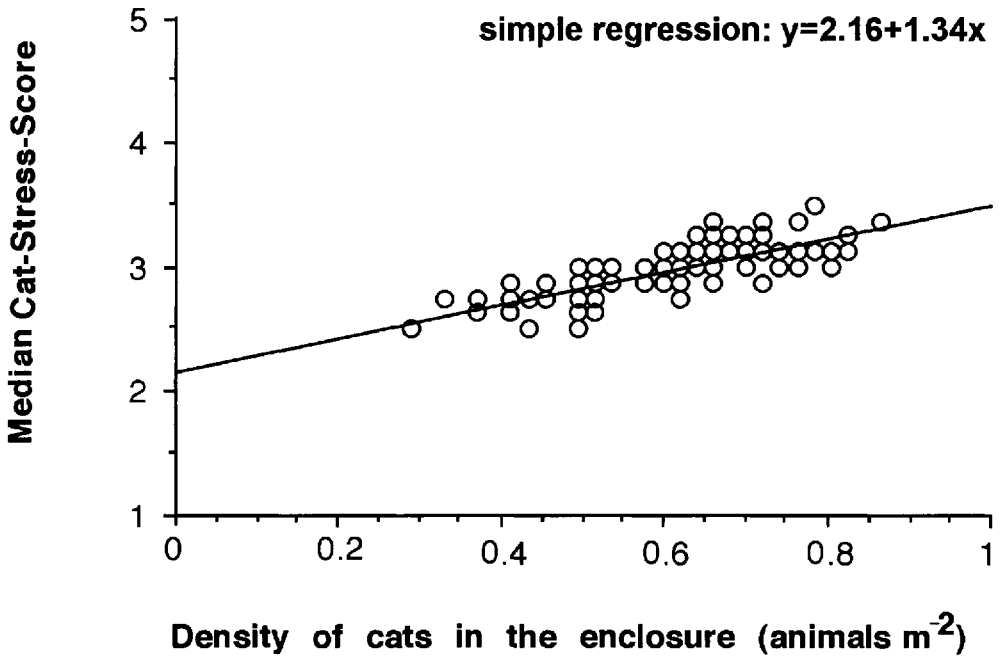

Figure 1 **Group density and Cat-Stress-Scores in rescued cats (n = 63) housed in control groups. The daily medians of the stress scores were assessed over 113 observation days in control groups of different densities.**

Cats which had been newly admitted to control groups housed at a density of 0.49 animals m^{-2} (n = 19) and 0.81 animals m^{-2} (n = 30) did not differ in their Cat-Stress-Scores on any observation day ($-1.0 < z < -0.1$, $0.30 < P < 0.92$). Cats admitted to control groups of 0.81 animals m^{-2} (n = 30) had a median score of 3.38 (range 2.63–4.83) during the observation week. Among cats newly admitted to groups housed at densities of 0.49 animals m^{-2} (n = 19), the overall median Cat-Stress-Score during their first week was 3.25 (range 2.50–4.83).

Effects of cage size in boarding cats housed singly

Significant differences between the daily Cat-Stress-Scores for singly housed cats in cages measuring 1.0m^2 (n = 29) and in smaller cages measuring 0.7m^2 (n = 15) were found on day 1 ($z = -2.5$, $P < 0.05$), day 2 ($z = -2.3$, $P < 0.05$) and day 6 ($z = -2.2$, $P < 0.05$) during the first boarding week (Figure 2). Among cats which had been newly admitted to the larger cages, the overall median Cat-Stress-Score for their first week was 3.25 (range 2.50–5.50, mean 3.36). For animals which had been newly admitted to the smaller cages, the overall median Cat-Stress-Score for their first week was 3.75 (range 3.00–5.83, mean 3.78).

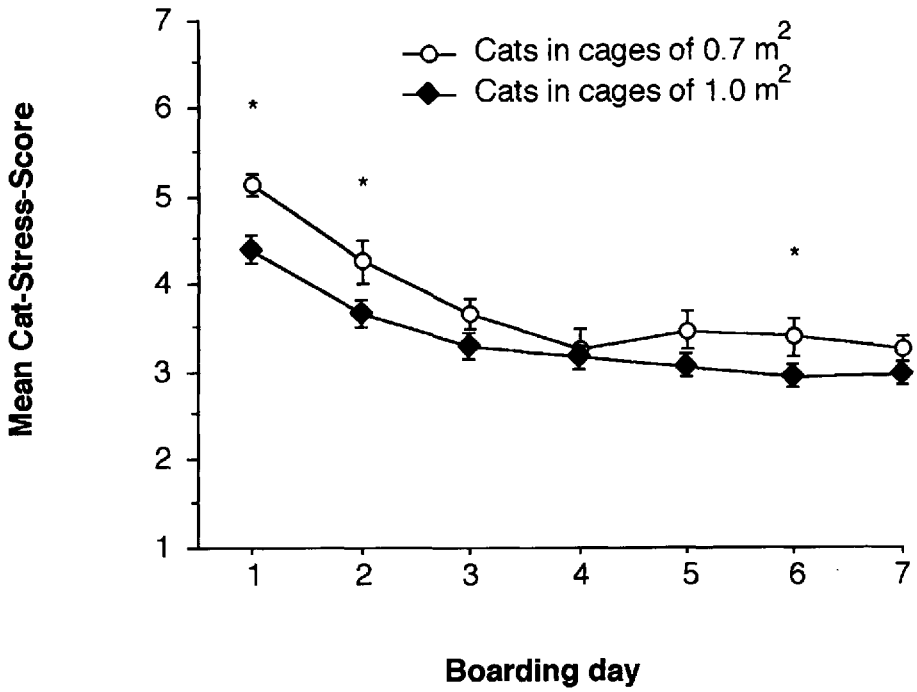

Figure 2 **Course of stress (mean ± SEM) in singly housed boarding cats in cages of 0.7m² (n = 15) and 1.0m² (n = 29) floor area. *$P < 0.05$.**

Discussion

Effects of group density (rescued cats)

This study represents a first attempt to clarify the quantitative spatial factors influencing the welfare of cats housed in shelters. A positive correlation between stress score and group density among cats housed in groups was clearly shown.

Welfare can be defined as the state of an individual animal with regard to its ability to cope with its environment (Broom 1988). When coping strategies are overtaxed, animals become stressed and welfare problems arise (Bradshaw 1992). We considered Cat-Stress-Scores of up to 3.0 (ie 'weakly tense') as generally acceptable in terms of the stress experienced by the cats. Up to this stress level, cats' eyes are open normally, their ears are not flattened, their pupils are not dilated and their movements are not reduced; whereas these signs of stress are associated with higher stress scores (McCune 1992; Kessler & Turner 1997; 1999). Therefore, we recommend that average stress levels in group-housed cats should not exceed this 'weakly tense' level. This implies a maximum group density of 0.6 animals m^{-2} (or an allowance of 1.7m^2 $animal^{-1}$). In the present study, this density was found in a group of 14 animals in a room with a floor area of 24m^2.

However, other spatial and social factors may also influence the stress of cats housed in groups and might lead to a lower or higher critical group density. First, it has been postulated that the 'quality' of space in an enclosure might influence the amount of space required (Mertens & Schär 1988; Turner 1995). It is presumed that more space is required for cats in group-housing rooms of lower quality. Higher quality rooms offer maximum utilization of all three dimensions, hiding places, scratching boards etc (the group-housing rooms in the present study were considered to be of higher quality.) Second, the socialization of a cat

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affects its social behaviour towards conspecifics (Karsh & Turner 1988; Kerby & Macdonald 1988), and non-socialized cats housed in groups increase the stress levels of other group members (Kessler & Turner 1999). In this study, cats which were obviously non-socialized towards conspecifics were not kept in the group enclosure. Even more space (or a lower density) is to be recommended when non-socialized cats are to be included. Finally, the cats in this study were observed in relatively 'stable' control groups. Cats entering or leaving a group probably disturb the social relationships between group members and may, therefore, lead to higher stress levels than reported here.

Quite unexpectedly, cats which had been newly integrated into control groups of different densities did not differ significantly in their stress levels. This may be because the difference between the densities studied might not have been great enough to produce an effect of group density in a two-way comparison. However, we suspect that adaptation to the spatial environment of a new enclosure might be more important than forming social relationships with other group members during the first week of a stay in the shelter. This may explain our results in the first part of the project (Kessler & Turner 1997), where no differences were found between cats housed singly, pairwise or in groups during the first 2 weeks of a stay in a boarding cattery.

In the present study, the median Cat-Stress-Scores of the animals which had been newly admitted to the control groups (with densities of 0.5 animals m^{-2} and 0.8 animals m^{-2}) were clearly higher than the stress scores of the control cats, which had lived in the enclosure for at least 2 weeks. Smith *et al* (1990), McCune (1992) and Kessler and Turner (1997) also reported high stress levels at the beginning of the stay in a shelter. This indicates that the spatially and socially different environment at an animal shelter or boarding cattery provides a situation that normally leads to stress in the animals. However, this general stress reaction can gradually disappear as cats adjust to their new environment.

Whether an adjustment takes place after the first stress reaction and how it subsequently proceeds, depends upon many interacting factors related to the animal itself, its environment and the time spent in the shelter. Some factors are already known, eg several aspects of the quality of the housing (Smith *et al* 1990; Roy 1992). Furthermore, several characteristics of the animal, such as its socialization towards conspecifics and humans (McCune 1992; Kessler & Turner 1999), genetic factors, and any previous experience with shelters have been found to influence stress levels among cats in shelters (McCune 1992; 1994; Kessler & Turner 1997).

However, many more factors are suspected of influencing stress and the welfare of cats in shelters. These include: individual relationships within a group, social stability, total room size and the absolute number of cats in a group, human relationships, and the total duration of the time spent in the shelter and in its quarantine facilities. In order to optimize housing conditions for an individual cat, all known quantitative and qualitative aspects of spatial and social requirements should be given due consideration.

Effects of cage size in boarding cats housed singly

Cats housed in single cages measuring $0.7m^2$ exhibited a higher stress level than cats in cages of $1.0m^2$ on days 1, 2 and 6 of a 1-week stay in the shelter. Although these results indicate that cage size has an effect on stress in cats housed singly, they give no indication of the minimum cage size required to reduce that stress. It has also been suggested that certain qualitative aspects of the housing environment may have an important influence on reducing stress among singly housed animals (Smith *et al* 1990; Roy 1992; Loveridge 1994). All the

single cages in this study were probably of lower quality, in terms of their qualitative spatial environment, because no elevated shelves were present within their confines. Further investigations are necessary to clarify the quantitative and qualitative spatial requirements of singly housed cats.

Animal welfare implications

This final part of a three-part study on stress and adaptation of cats in animal shelters and boarding catteries represents a first attempt to clarify quantitative spatial factors influencing the welfare of cats housed in these environments. In the group-housing conditions we studied, a positive correlation between group density and stress level was clearly shown. In order to avoid high stress levels, a group density of 0.6 cats m^{-2} (ie a space allowance of 1.7m^2 cat^{-1}) should not be exceeded. Although cage size was shown to influence the cats' adaptability to the surroundings under single-housing conditions, the minimum spatial requirement for cats in single cages remains unknown.

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