



# Effect of single-cat versus multi-cat home history on perceived behavioral stress in domestic cats (*Felis silvestrus catus*) in an animal shelter

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## Abstract

This study investigates the effect of living with other cats in a prior home on stress levels of cats recently surrendered to an animal shelter. A total of 63 cats was evaluated using a Cat-Stress-Score and an approach test. Cats were categorized in terms of previous home history with or without other cats. No significant difference was found in stress scores between cats from single-cat households and those from multiple-cat households, although single cats that had been in the shelter less than 4 days demonstrated higher stress levels. No significant difference was found between the two groups in terms of approach results. Results of this study suggest that, in traditional individual cage settings, cats that are not accustomed to living with other cats may experience more stress in the initial few days of attempting to adjust to shelter existence. Through the use of such assessments, shelter personnel may develop an increased awareness to the needs of these cats and attempt to provide measures to improve their well-being within the shelter environment.

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## Introduction

Annually, millions of cats are believed to enter animal shelters across the USA, a high percentage of which may be considered adoptable by individual shelter standards.<sup>1–3</sup> Such cats may have originated from a variety of household backgrounds and be relinquished for a variety of reasons.<sup>4–8</sup> Regardless of prior history, confinement within a shelter combined with novel experiences and changes in routine can be stressful for many of these cats.<sup>9–12</sup> In particular, inconsistencies in husbandry schedules and limited contact from caretakers have been found to contribute to increased stress levels in confined cats. Such stress has been measured in terms of both physiological and behavioral parameters, including increased urinary cortisol to creatinine ratio,<sup>11,13</sup> more frequent hiding and vigilance, and a reduction in play and exploratory activities.<sup>14</sup>

Numerous studies over the last 15–20 years have focused on the general impact of stress on an animal's well-being, the welfare of animals in shelters, and the need to develop accurate tools for assessing stress levels in shelter animals as a means of improving living

conditions in those facilities and facilitating the successful placement of those animals.<sup>15–21</sup> Regarding cats, in particular, higher stress levels can have far-reaching consequences for shelter outcomes, including a decrease in perceived adoptability by the general public<sup>19,22</sup> and development of medical conditions ranging from feline interstitial cystitis<sup>23</sup> to upper respiratory infection.<sup>24,25</sup>

In general, the Kessler and Turner cat stress score (CSS) has been a commonly employed non-invasive stress measurement tool. In their original 1997 study, the authors used the CSS to compare mean scores of shelter

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cats housed singly, in pairs or in groups. Other studies using the CSS have considered high- or low-density group housing,<sup>9</sup> extended stay (>1 month) singleton or familiar paired cats in discrete cage units versus group living arrangements,<sup>26</sup> correlation of urine cortisol:creatinine ratio to CSS<sup>11</sup> and effect of hiding options in living quarters to CSS values.<sup>12</sup> Moreover, several of the aforementioned studies have examined such variables in terms of feline demographics — namely, age, sex, reproductive status and/or source (stray or previously owned).

In light of these data, housing guidelines have been established for shelter cats, including the recommendation to use such stress assessments to tailor the living environment to an individual cat's needs.<sup>10</sup> Taking into account the varied backgrounds of cats that enter shelters, the objective of this study was to examine those owner-surrendered cats with a known history of previously having lived in either a single- or multi-cat home and to compare measured stress levels through the use of the CSS. Implications include using this data in conjunction with household history to make additional accommodations whenever possible to help shelter cats in their adjustment process, in the hopes that a reduction in stress will translate into reduced susceptibility to infection and, ultimately, to adoption into a new home.

## Materials and methods

### Study site

A total of 63 domestic cats were assessed at one shelter location. This shelter is an open-admission, high-volume urban shelter that accepts approximately 200 cats/month during July, the time period in which cats were assessed for the current study. The majority of the shelter's cats were individually housed in one of three holding areas with access limited to staff and volunteers; one cat was located in a single cage in an adoption room, which the public could visit during open hours. In this shelter, cages were against a wall facing outward, with limited, if any, views of other cats in either back holding areas or adoption rooms. Implements in the cages included food and water bowls, a back or side shelf for perching, litter box, blanket or towel and, in some cases, toys and/or an additional bed or cardboard box. Some cages had window views to the outside. Most cages were composed of stainless steel throughout, while the one adoption room cage was primarily made of a laminate material with stainless doors and consisted of four shelves.

### Cat selection

For the 2-month duration of this study, the shelter location was visited at least once weekly. Cat subjects were identified on the basis of having been owner-surrendered by a shelter patron, as indicated by a

signed relinquishment form and/or intake profile. Those identified as either stray or abandoned were excluded owing to their unknown history of living alone or with other cats. Each of the cats was at least 8 months of age at the time of the study and in apparent good health (ie no cats in isolation areas for illness were included). All cats had entered the shelter within the previous 7 days and were housed singly in cages. As the nature of the behavioral assessments utilized in this study were observational, cats noted to be 'staff only' in terms of handling were included; for these cats, only the head-pat portion of the test was omitted.

### Behavioral assessment

Each assessment began with an approach test, based on one used by Kry and Casey.<sup>12</sup> The researcher stood approximately 30.48 cm (12 inches) away from the closed cage door and looked inward for 60 s, making some eye contact, but not directly staring at the cat. The cat's response was noted as 'approach' (with time elapsed until approach), 'interest', 'neutral' or 'withdrawal'. The cage door was then opened, the cat's head was briefly stroked and the same responses were noted. Following the approach test, each cat was scored through a closed cage door using the CSS rubric<sup>11,18</sup> (Supplementary data) in the form of a circled-response scoring sheet (Supplementary data). Utilizing observations including body posture, eye and ear position, vocalization and activity level, a score was assigned from 1 ('fully relaxed') to 7 ('terrorized'), with a score <3 suggestive of baseline stress levels.<sup>9</sup> The assessment for each cat was performed at a standard time (12.00–3.00 pm), as it has been found that other stress measures (ie, cortisol levels) have natural daily fluctuations.<sup>11</sup> Moreover, using this time-frame provided an opportunity for cats to settle after daily cleaning regimens had been completed, but before opening hours in order to avoid heightened shelter traffic as much as possible. Owing to scheduling logistics at the shelters, and both staff and public flow, assessments were performed on each cat once.

### Additional information

In addition to sex, age, neuter status and prior home exposure to one or more other cats, the following information was recorded on each subject: number of days elapsed between intake and assessment; reason for relinquishment to the shelter; exposure to dogs in the past home. The latter two variables were part of each cat's intake profile and were not used further in the current study. Other than original intake date and identifying information (animal name with an identification number), all other data were obtained after an animal's behavioral assessment. Score results were used for the sole purpose of this study, were not added to a cat's profile and did not influence an animal's outcome

(eg, adoption, foster, transfer to another shelter, euthanasia) at the shelter.

### Statistical analysis

Prior to enrolling subjects, several test cats had been rated by both the researcher (HB) and an experienced observer (EM) to ensure accuracy of scoring. The relationship between these test scores was compared by using simple correlation analysis. Training was considered sufficient based on previous work<sup>18</sup> with a Pearson rank sum correlation coefficient of 0.62 ( $P = 0.03$ ). In a previous study the interobserver reliability using rank sum correlation of the CSS was 0.9 with trained observers and 0.75 when applied by shelter staff with less training.<sup>18</sup>

After scoring was completed, cats were placed into one of two groups: those from a single-cat home versus multi-cat home, as indicated by the intake profile information obtained by shelter staff with the assistance of the shelter's computer database (Chameleon; Chameleon Software Products/HLP) and/or personal communication with staff where applicable. All continuous variables were examined for normality using visual inspection of graphs and comparison of mean and median values. The mean stress scores for the single- versus multiple-cat household group of cats were calculated, and the difference between means for single- and multi-cat household cats was tested using an independent samples *t*-test. Similarly, age and length of stay were also compared for the two groups. In addition, a  $\chi^2$  analysis was performed to compare the two groups in terms of sex, neuter status, the initial approach (approach, interest, neutral, withdrawal responses) and head-pat tests. Linear regression was performed to assess the linear relationship between days in shelter, as well as age, with stress score for all cats and by subgroup. A *P*-value of  $<0.05$  was considered significant. The statistical tests were performed using Excel (Data Analysis Toolpack, Excel 2007) and Stata SE 12 (64 bit).

## Results

### Classification of cats

Table 1 shows the characteristics of the cats in each group. Twenty-three cats were in the single-cat home group, with ages ranging from 8 months to approximately 9 years, with two adult cats without a specific age. Forty-one cats were placed in the multi-cat home group, with ages ranging from 8 months to 13 years. In this latter group, the number of other cats in the prior home ranged from one to five (mean 1.9, median 1.0) in 39 households, with an unspecified number of other cats in the remaining two homes as evidenced by statements on their intake information ('one other cat plus her kittens', 'a lot of cats'). In a limited number of cases (6/41), this information also included details on whether cats in

**Table 1** Summary of subjects

	Multi-cat homes	Single-cat homes
Cats (n)	41	23
Age (y)		
Mean	2.97	4.45*
Median	2.00	5.00
Intact males (n)	7	3
Neutered males (n)	10	7
Intact females (n)	14	1
Neutered females (n)	10	12
Days since intake		
Mean	3.78	4.00
Median	4.00	4.00

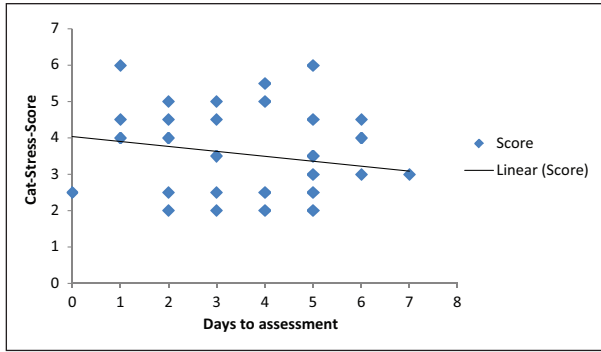
\*Two were missing specific ages

the prior home were compatible. The remaining 10 cats were excluded from the study following assessment for various reasons: incomplete/missing profile ( $n = 3$ ), abandoned or stray ( $n = 3$ ), more than 7 days since intake ( $n = 2$ ), too young ( $n = 1$ ) or duplicate evaluation performed ( $n = 1$ ). Considering sex in conjunction with neuter status, a significant difference did exist between the two groups ( $P = 0.013$ ) with a disproportionate number of intact female cats among the multi-cat household group. However, there were no other significant differences between the two groups in terms of age ( $P = 0.05$ ), or days since intake ( $P = 0.62$ ).

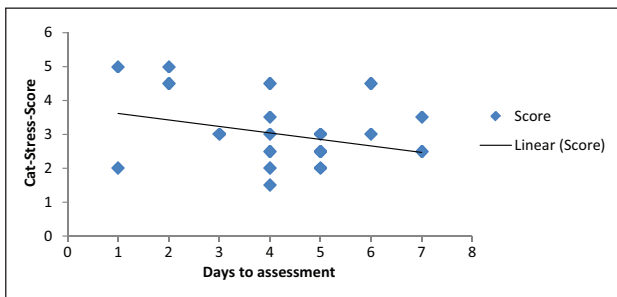
### CSS

For the multi-cat-home group, CSS results ranged from 2.0 to 6.0 (mean 3.5, median 3.0). Single-cat CSS values ranged from 1.5 to 5.0 (mean 3.0, median 3.0). Overall, CSS results were not significantly different for those cats originating from single-cat homes versus those from multiple-cat homes ( $P = 0.18$ ). There was no significant difference in the stress scores of intact females (mean score of 3.6) and the mean stress score of all other cats (3.3;  $P = 0.3$ ). CSS was significantly associated with age, with CSS decreasing with increasing age ( $R^2 = 0.07$ ,  $P = 0.04$ ). When single- and multi-cat households were analyzed separately, single-cat households tended to have a significant association ( $R^2 = 0.17$ ,  $P = 0.06$ ) with decreasing CSS and increasing age; multi-cat households did not ( $R^2 = 0.02$ ,  $P = 0.4$ ), indicating age as a potential confounding factor in this analysis.

Cats that were in the shelter for more days had lower stress scores than more recently admitted cats. However, a clear correlation between overall length of shelter stay (0–7 days), and stress score was not found in either the multi- or the single-cat home groups [ $R^2 = 0.04$ ,  $P = 0.20$  (Figure 1);  $R^2 = 0.08$ ,  $P = 0.19$  (Figure 2); overall  $R^2 = 0.05$ ]. In examining the figures, there seemed to be a change in inflection at 4 days. Therefore, the data were divided



**Figure 1** Length of shelter stay and cat stress score for multi-cat home cats



**Figure 2** Length of shelter stay and cat stress score for single-cat home cats

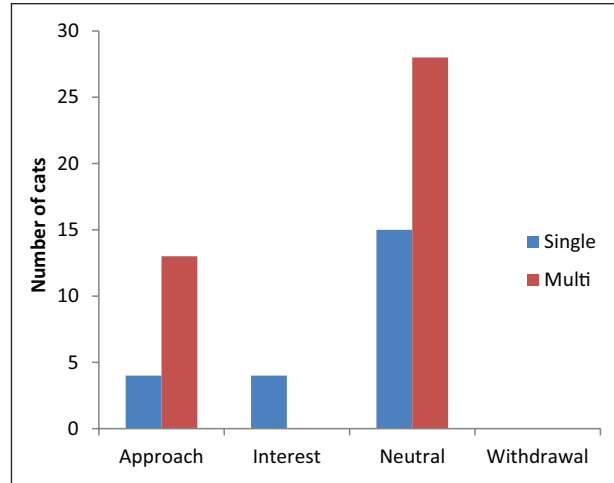
into two groups of  $<4$  or  $\geq 4$  days, and a *t*-test was used to compare these two groups. A length of stay of  $<4$  days was significantly associated with higher stress scores overall for both groups of cats taken together ( $P = 0.008$ ) with a median score of 3.9 versus 3.1. Further stratifying by household history, cats from multi-cat homes had a similar CSS after day 3 compared with before (median of 4.3 versus 3.0,  $P = 0.2$ ) but single cats were more stressed in the first 4 days (median of 4.5 versus 2.5,  $P = 0.01$ ), indicating a potential confounding effect of length of stay on stress scores.

**Approach and head-pat tests**

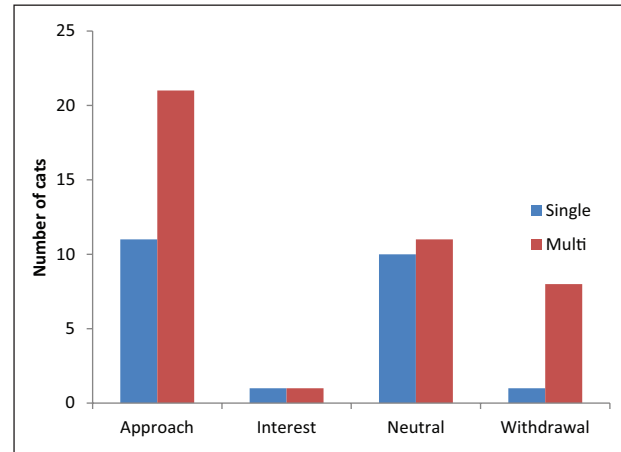
Results of the initial approach test are given in Figure 3 and those of the head-pat test are given in Figure 4. With regard to the approach test, cats from single-cat homes were found to display more interest ( $P = 0.02$ ), whereas responses for the head-pat test were not significantly different between the two groups ( $P = 0.3$ ).

**Discussion**

The results of this study suggest that there appears to be no difference in stress levels between shelter cats originating from homes in which they were the only cat and those from multi-cat households in terms of the CSS within the first week. However, length of stay may have some influence on stress scores; cats from single cat



**Figure 3** Initial approach test results for cats from single-cat and multi-cat households



**Figure 4** Head-pat test results for cats from single-cat and multi-cat households

homes in particular had significantly lower scores after day 3 compared with the first 3 days. This lends some support to a previous study,<sup>13</sup> which found that urinary cortisol:creatinine ratios as a measure of stress decreased to within the normal range in quarantined cats after the first 3 days. Such findings may have important implications in terms of meeting the needs of cats during initial adjustment periods in a shelter setting.

Cats have long been considered solitary creatures by nature and as a species may show great variation in how they react to their external surroundings.<sup>27,28</sup> At our study site, much effort has been made by the staff on a daily basis to maintain a clean, quiet environment for their new arrivals. Presumably, cats were able to smell and hear other cats in nearby cages; this may have contributed to higher initial stress scores in the single cats in the current study. However, visual exposure was limited and unfamiliar cats were not paired or grouped into

cages. While limited contact may be a favorable arrangement for some cats from single-cat households and factor into their more significant decrease in terms of the CSS after a few days in the shelter, a lack of direct contact with conspecifics — or, in some cases, a specific feline companion from a former living arrangement — may be a factor contributing to the relatively higher initial stress levels observed in those from the multi-cat homes in this study. Yet, not all cats accustomed to living with other cats will necessarily be less stressed by being paired with them in a shelter cage. Familiar cats may not get along in such close quarters; in some cases, confinement with another cat in this manner could potentially contribute to even higher stress levels.

Aside from such individual idiosyncrasies, inherent features of the CSS likely influenced the results of the current study. The CSS, as developed by Kessler and Turner, is a point-of-care assessment — a non-invasive and convenient, yet static, evaluation of a dynamic species. It has been noted previously that one indicator of stress known as feline inhibition behavior, that is reduction in daily grooming, feeding, mobility and elimination, can vary in duration from days to months in cats entering a shelter, cattery or hospital.<sup>29</sup> Meanwhile, the CSS is, by design, a subjective assessment of those behaviors that are displayed over a brief period of time; one must take care to correctly interpret such inhibited or withdrawn behavior. Such cats, while outwardly appearing quiet, may, in reality, be more unsettled and take longer to acclimate to a new environment.<sup>30</sup> Conversely, a more energetic cat could score higher on certain aspects of the CSS, such as activity level; this may account, at least in part, for the relationship found between decreasing scores and increasing age in the current study. A more complete picture of a given cat's temperament may be attainable by spending additional time with that cat at different periods throughout the day and on multiple days,<sup>19</sup> and, admittedly, in a more established home environment over time.<sup>31</sup>

In terms of combined sex and neuter status, a significant difference existed and was most apparent in terms of the disproportionate number of intact females in multi-cat households. This difference does not appear to be due to age, as median age for intact females from multi-cat households was 2 years and for those from single cat households it was 0.9 years. It is unknown whether these females had been bred, thus contributing to the number of cats in such homes, or if other factors may have contributed to this disparity. No cats in the current study were noted by either shelter staff or the researcher to display apparent estrous behaviors, such as increased vocalization or arching of the back.<sup>32</sup> However, for an untrained observer, it is possible that such behaviors could be interpreted as higher-stress numerical scores on the CSS. Other factors that may have had an effect on findings include the order in which testing was

performed, as well as cage setup and circumstances surrounding an individual cat's intake information. Performing the head-pat portion of the assessment in advance of the CSS required opening the cage door; this action may have disturbed some cats that had been relaxed up until that point. For example, in some cases, activity levels and vocalizations were subjectively observed to increase. However, it has been previously noted<sup>11</sup> that such direct interaction may enhance the interpretation and utility of the CSS in terms of identifying feigned sleep behavior by stressed cats and applying the assessment more as shelter employees would. As for cages themselves, some cats were noted to have toys and/or a cardboard box in their cage; such forms of enrichment may contribute to a cat's well-being in a caged environment, and, presumably, to lower stress levels.<sup>10,12</sup> This is a notable limitation in the current study, as such features were not documented for each cage and may change during an individual cat's stay in the shelter. However, the presence or absence of these enrichment items was not due to the CSS, as shelter staff did not have access to this information.

Intake profiles on individual cats were also quite variable — some had information completed by shelter staff, while others appeared to have been written by an owner or other surrendering individual. Again, cats from single-cat homes had a tendency to show decreasing stress scores with increasing age. This emphasizes the utility of getting a good cat history on intake when that is feasible, as a means of assessing whether activity level or other factors — temperament or certain aspects of their past home environment — may play a role here. In some cases, owner-reported information may not always be accurate, as one may wish to represent their pet in the best possible light in the hopes of a positive outcome in the shelter.<sup>33</sup> The number of days elapsed before assessment may be yet another factor, as stress levels have previously been shown to decrease in the initial 4 days of confinement.<sup>13,18</sup> In the current study, those from single-cat homes in particular demonstrated a significant decrease in stress levels after day 3 in the shelter.

Likewise, it is important to note that the shelter study site is a high-volume, open-admission facility and that this study was performed in the summer, which is traditionally a high-intake season for cats in this region. In general, shelters vary greatly in terms of numerous factors, including type (eg, private foster home, municipal), public accessibility (appointment-only, regular operating hours) and admission policies (open versus limited). As such, noise levels, numbers of cats, and presence of or proximity to other species such as dogs may differ substantially, both among shelters and even within a given shelter at various times throughout the year. These factors need to be considered in light of the results of current study.



In addition to performing the CSS on consecutive days and generally spending more time evaluating an individual cat over those days in a variety of shelter environments, the evaluation could be performed on these two study groups in combination with another, more objective parameter, such as urinary cortisol:creatinine ratio and<sup>11,13</sup> salivary<sup>19</sup> or fecal cortisol.<sup>34</sup> Many shelters have incorporated group-housing or colony-type living situations into their facilities. Another option would then be to compare stress levels in both groups of cats residing in this type of shelter environment as opposed to the more traditional cage setting used in the shelters in this study. The CSS could also be used to test adoption floor cats during open hours; such cats are regularly exposed to the public, perhaps making them vulnerable to additional stressors and in need of further staff intervention to help stave off stress-related behaviors or illness.

## Conclusions

The results of the current study emphasize the need to take known background information on individual cats into account as they attempt to adapt to life in a shelter environment. In terms of other factors such as potential for disease transmission, it would not necessarily be prudent to mix cats upon intake in an effort to maintain a level of cat-to-cat social contact for those cats more accustomed to it. However, cats, regardless of their home history, may require additional forms of enrichment during the initial adjustment period, particularly within the first few days of arrival to a shelter. The CSS has been shown to be one useful tool that shelter staff can employ as a means of quickly identifying cats in need, making changes to their environment and monitoring their progress during their shelter stay. Such improvements in welfare may subsequently translate into lower stress levels, lower incidence of illness and placement into a new adoptive home.

**Supplementary data** Scoring the cat using the CSS rubric and scoring sheet

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**Conflict of interest** The authors do not have any potential conflicts of interest to declare.

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