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Development of existing scoring systems to assess behavioural coping in shelter cats

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ABSTRACT

Assessing how cats cope with the housing and husbandry at shelters is an important part of maintaining good animal welfare. There are non-invasive methods to assess how cats cope with their environment. The aim of this study was to investigate the reliability of the behaviours used in an extended Stress Assessment protocol for cats to detect stress. Looking at which behaviours are salient and possible to observe accurately, and which correlate with time until adoption. The study was carried out at a non-governmental medium sized cat rescue shelter in Midwestern USA. The shelter had a no-kill policy with screening of cats before intake from county shelters. The observed cats were either group-housed in five rooms (n = 70) or singly housed in double cages (n = 13). Observations were carried out during both morning and afternoon sessions, during which two 1-min observations recorded if cats performed any of 85 behavioural elements (BEs). Time at shelter and if cats were declawed or not were collected from shelter records after the observations. Statistical analysis of the BEs that best predicted the total time at shelter was calculated using the Survival Analysis based on the Cox proportional hazards regression model using a stepwise regression analysis separately for each scoring. The median time at shelter for group-housed cats was 26 days (IQR = 6–54) and for single-housed cats 29 days (IQR = 7–97). In total, 24 % of the BEs (20 of 85) were never recorded, however there were significantly more BEs recorded in group-housed cats (63 BEs) than in single-housed cats (49 BEs, $p < 0.05$). The survival analysis found 16 unique BEs to predict "Short time at shelter" (14 BEs in group-housed, two in single-housed), 14 were positively correlated meaning that they increased the chance of early adoption and two were negative meaning that they decreased the chance of early adoption. The survival analysis also calculated "Long time at shelter" and found 14 unique BEs where 12 BEs were in group-housed cats and three BEs were in single-housed cats. Seven of these were positively correlated meaning that they decreased the chance of early adoption, whereas seven were negatively correlated meaning that they increased the chance of early adoption. The conclusion is that the extended Stress Assessment could be used to detect BEs indicating stress of cats at shelters, and that there are BEs that can predict shorter time at the shelter. However, further investigations could help reduce the number of BEs needed.

1. Introduction

The domestic cat is one of the most popular companion animals in the United States of America (USA), Canada and Western Europe (Lyons and Kurushima, 2012). It has been estimated that in the USA only, 3.4 million cats enter animal shelters annually (ASPCA, 2016). Animal shelters aim to rescue and care for companion animals no longer desired by society. Optimally, this should be organised in a way that promotes the welfare of the animals. Housing and handling are common sources of stress in captivity and become important aspects in the maintenance of good animal welfare (Gourkow and Fraser, 2006). Failure to cope with environmental challenges most likely results in exposure to stress (Broom, 1986). McEwen (2000) defines stressas "an event or events that are interpreted as threatening to an individual and which elicit physiological and behavioural responses" .

To evaluate the effect of different housing and husbandry practices in the cat shelter there is a need for a validated non-invasive tool that can be used by researchers as well as personnel without influencing the animal or the indicators measured. Kessler and Turner (1997) developed the seven-level Cat-Stress-Score (CSS) based on the Cat Assessment

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Score (McCune, 1994). It was first described as the Global Assessment Score (GAS) in McCune (1992) as a method to detect and assess behavioural stress in cats. The CSS has been regarded as a static and subjective measurement of behaviours displayed over the short term (Broadley et al., 2013). It has been used extensively to evaluate the level of welfare for cats in shelter settings (e.g. Kessler and Turner, 1999a; 1999b; McCobb et al., 2005; Gooding et al., 2012; Tanaka et al., 2012; Broadley et al., 2013; Loberg and Lundmark, 2016). There is still a discussion as to how the scoring relates to stress (McMillan, 2012). Scoring may also be influenced by differences in housing systems, as cats housed in traditional caging systems cannot be expected to be able to display the same range of behaviours compared to cats in group-rooms which allows more free movement.

Although the CSS is commonly used, no correlation has been found between individual shelter cat's stress scores and urinary cortisol to creatinine ratio (C:Cr) (McCobb et al., 2005), latency to approach a novel object (Gooding et al., 2012) or length of stay at a cat shelter (Broadley et al., 2013). However, Tanaka et al. (2012) found an association between higher scores on the CSS and development of upper respiratory disease (URD) and decreased food intake. Euthanized cats had higher CSS than other outcome groups in Gourkow and Fraser (2006) but not in McCobb et al. (2005) or Moore and Bain (2013). Therefore, the CSS might not clearly correlate with physiological stress, as seen by difficulties to validate the scores, but it may be an indication of coping with environmental challenges in cats (for review see Hirsch, 2016). Differences in the findings could also relate to the implementation of the CCS.

The connection between CSS and the development of URD (Tanaka et al., 2012) and decreased food intake indicates that behaviours included in the score can be used to distinguish cats struggling to adjust within a shelter environment. Spending as short time in the shelter as possible is likely the best option from both a welfare and resource perspective. Time spent in a shelter increases risk of contracting infectious disease., For example, after 1 week in a shelter, the proportion of cats actively shedding Feline herpesvirus-1 went up from 4% (at entry) to 52 % (Pedersen et al., 2004) as cats usually become lifelong carriers (Thiry et al., 2009) resulting in recrudescence during times of stress. Shelters usually have limited space, and it is clear that crowding increases the transmission of respiratory disease (Cohn, 2011).

Other factors may also affect time until a cat is adopted. For instance, Fritscher and Ha (2016) found that declawed cats had an average increase of 12 days until adoption compared to cats with claws. In cats coming to a veterinary clinic, 29 % were found to be declawed (Strickler and Shull, 2014). In a study on privately owned cats in Indiana 4.8 % of the cats were declawed on all limbs, and 40.2 % were declawed on the forelimbs only (Patronek et al., 1997). As there are not many studies on the effect of declawing on people's perception and willingness to adopt a cat from a shelter this was of interest to record in this study.

The aim of this study was to determine which behaviours should be included in an *extended Stress Assessment* (eSA) to assess coping in shelter cats by identifying behaviours relating to the time until a cat is adopted. The objectives in detail were to determine (i) what behaviours best predict *Time at shelter* (the time from available for adoption until adoption), (ii) what behaviours are salient enough and can be recorded during a 1 min observation and (iii) what the similarities and differences in recorded behaviours are in group- and singly-housed cats. *Time at Shelter* was selected as the outcome, as this is important from a shelter and animal welfare perspective. Further, the proportion of declawed cats was also investigated.

2. Material and methods

This study was carried out within a larger ethical approval by the institutional animal care and use committee at the Department of Animal Sciences, Purdue University. An informed consent was collected from the shelter manager agreeing to the setup of the study. The care and husbandry of the cats, as well as availability for adoption, were not affected by the study but followed the shelter routines.

2.1. Study site

The study took place at a medium-sized rescue shelter (Midwestern United States, USA) between August 18 and September 16, 2014. The shelter is a non-governmental shelter, funded exclusively by donations with a no-kill policy and without open admission (i.e., cats are screened before intake and collected from county shelters). In 2014, the shelter adopted out 1600 cats, took in 475 surrendered and 479 stray cats as well as transfer cases (unknown number). The shelter was open to the public Monday-Wednesday and Friday 13:00−19:00 and Saturday-Sunday 11:00−16:00, except during public holidays, meaning that the public were only present during afternoon observations.

The shelter had both group- and single-housing of cats as well as rooms with single-housing for quarantine of new cats as well as sick cats. Healthy cats were moved to the adoption rooms and placed in either group- or single-housing. Cats that were not openly aggressive towards other cats were placed in group-housing, whereas cats that had not been socialised to other cats or that showed aggression against other cats were placed in single-housing. The shelter had the following groups of employees; cat staff that cared for the cats, customer service staff that handled adoptions and a cat behaviourist that decided on group composition and re-grouping. The shelter had an animal clinic with veterinarians that also treated visiting animal patients. Cats were cared for primarily by the shelter staff, however volunteers helped in interacting with cats, cleaning litterboxes and cages. Regroupings of cats, due to e.g. adoption or sickness, and moving from evaluation- or sickness ward to an adoption area took place at any time during the day. Group compositions and changes in them were decided by the cat behaviourist and regroupings were executed by either cat staff or customer service staff. Adoptions took place during public opening hours.

2.1.1. Group-housing

Group-housed cats were housed in five separate rooms of different sizes (Table 1). These rooms were situated either on the adoption floor

Table 1
Description of the five different group rooms concerning size, density, number of cats, temperature, accessibility by visitors, catio, windows to outside, staff taking care of the cats and disturbance from dogs. Y denotes yes, and N denotes no in the table.

	Room 1	Room 2	Room 3	Room 4	Room 5
Size*					
Indoor room (m^2)	16	20	16	50	20
Outdoor area (m^2)	16	16	12	–	–
Density (indoor area)					
min. m^2/cat	1.8	2.5	1.6	6.3	2.9
max. m^2/cat	2.7	6.7	3.2	12.5	6.7
Number of cats					
Mean	7.9	5.3	7.2	5.3	5.4
min.	6	3	5	4	3
max.	9	8	10	8	7
Temperature (°C)					
Mean (± SE)	21 (±1)	22 (±1)	21 (±1)	23 (±1)	22 (±1)
min.	17	20	16	20	20
max.	24	26	24	26	27
Accessible by visitors	Y	Y	Y	N	N
Catio (outside enclosure)	Y	Y	Y	N	N
Windows to outside	Y	Y	Y	Y	Y
Cared**	CS	CSe	CS	CS	CS
Proximity dogs***	Y	Y	Y	N	N
Dog noise****	Y	Y	Y	Y	Y

* Approximation based on measurements and blue print.
** Performed by: Cat Staff, CS; Customer Service Staff, CSe.
*** Proximity dogs: dogs were walked past catios, windows and doors to cat rooms.
**** Dog noise: barking of dogs could be heard.

(Group room 1–3) which was freely accessible by visitors, or on the second floor in a more secluded low stress area (Group room 4–5) which was not open to public visits and only accessible by request.

The three rooms on the adoption floor all had adjoining outdoor enclosures accessible to the cats during shelter opening hours (Table 1). The two rooms on the second floor (defined as a 'low stress area' as they were not open to public visits), did not contain outdoor enclosures for the cats. All rooms had windows facing both the outside as well as corridors. Rooms contained litterboxes, food and water bowls, climbing structures, elevated resting areas and hiding places e.g. boxes and covered beds, on different levels as well as toys and scratch poles and carpets for claw abrasion. The number of resources changed during the study, and was not always related to number of cats in the group. Outdoor enclosures contained climbing structures, resting and hiding places. Group-housed cats were provided water *ad libitum* and food according to the number of cats (approx. 0.6–1.2 DL dry food per cat in the same number of bowls as cats). Cleaning and feeding took place once a day at 07:00−10:00 in Group rooms 1, 3–5, and in Group room 2 at 10:30−11:30.

2.1.2. Single-housing

Single-housed cats were in two cage racks containing four double cages each built into the walls on two opposite sides of an adjoining part of Group room 2. The group-housing part was separated by wire mesh restricting physical, but not visual or olfactory, contact between single- and group-housed cats. The mean temperature in the single cat area was 21 °C (± 0.2), range between 17° (min.) to 24° (max.). Cats were housed in double stainless steel cages, comprised of two horizontal cages (70 × 70 × 70 cm) connected via a circular opening (9 800 cm^2 in total). The floor of the cages were covered by towels, and one side contained the litterbox, the other side food and water bowls mounted on the cage door and a resting area with a Kuranda™ bed with bedding on top as well as underneath or a plastic sleeping box with bedding inside. Scratchboards were mounted on the cage door for claw abrasion. Smaller toys and stuffed animals were provided but not in a structured way. Cats in single-housing were provided water *ad libitum* and fed dry food based on weight, with addition of wet food if cats refrained from eating. Cleaning and feeding took place once a day in the morning at 10:30−11:30.

2.2. Animals

The study included a total of 91 neutered cats, 75 housed in groups and 16 housed singly. Inclusion criteria were (by shelter staff deemed) healthy cats over 6 months of age housed singly or in one of the adoption rooms (Group room 1–5). Of the group-housed cats, five did not include complete individual observations as they were moved before data collection was finished. Of the single-housed cats three were not individually observed as they were moved before data collection was finished. Of the remaining 83 cats, 70 were group-housed and 13 were single-housed. Group-housed cats consisted of domestic short- (n = 46), medium- (n = 5), long-haired (n = 1) or mixed breed (n = 9) cats, 50 females and 20 males aged 9–120 months (mean ± SD, 45.8 ± 3.4 months). Single-housed cats consisted of domestic short- (n = 11), long-haired (n = 1) or mixed breed (n = 1) cats, 6 females and 7 males aged 6.5 months to 119 months (mean ± SD, 54.2 ± 10.5 months).

2.3. Data collection

General information, including *Time at Shelter* and whether cats were *declawed* or not, for each cat was collected from the shelter records after the observational part of the study was finished. The observer was therefore blind to length of stay and declawing status of cats during the data collection. Health related issues, for example signs of illness, were noted continuously during the study by the observer.

2.4. Behavioural observations

The data set included 80 h of direct behavioural observations collected during 20 days. Observations were alternated between group- and single-housed cats each observation day. For observations of group-housed cats, the researcher stood quietly and still inside the group room and for single-housed approximately 1.5 m from the cages. The observer had to stand inside the group-rooms to be able to overview the full area at once. Three of the five groups or three of the single-housed cats were observed each observation day, Monday-Wednesday and Friday 09:00−11:40 and 15:00−18:40, and Saturday 08:00−10:40 and 14:00−16:40. Each session was 40 min. long, beginning with 10 min. habituation for both single- and group-housed cats (Fig. 1). Detailed description on how the behavioural observations were conducted are given separately for group-housed cats (section 2.4.1) and single-housed cats (section 2.4.2).

Observations were planned so that an *extended Stress Assessment* (eSA) could be used in accordance with the original set-up of the CSS (Kessler and Turner, 1997) where each cat was scored one at a time four times on a single day, during a morning (am, observation number 1 and 2) and afternoon (pm, observation number 3 and 4) session. Each scoring was performed during 1-min and took place 15 min. apart within each session (Fig. 1). In total, 85 behavioural elements (BEs) were included in the protocol (see Table 2), based on the CSS (Kessler and Turner, 1997), with additional BEs included from previous studies on the behaviour of shelter cats ((McCune, 1992;and Gourkow et al., 2014a).

2.4.1. Group-housing observations

Each morning of group-house observation, seven cats were pseudo-randomly selected, using a random number generator (Random Number gpv1.0.11 by Saranomy) to include as many unique individuals as possible, from each of the three group-housing rooms that would be observed on the specific day. The first five cats were included in all behavioural observations, and the last two cats only in observations of social interactions (Table 3) and activity. After the 10 min. habituation, the session continued with five 1-min instantaneous eSA for the first 5 cats, 10 min. social interaction and activity for all seven cats, five 1-min instantaneous eSA for the first 5 cats and 10 min. social interaction and activity for all seven cats, a total of 40 min. of observation (Fig. 1). Activity levels were recorded as each time a cat changed location within the group-room (Fig. 1). Interactions with other cats than the ones randomly selected in the rooms were also noted. Social interactions were recorded on a social matrix (Table 3) adapted from a previously used ethogram for group-housed shelter cats (Loberg and Lundmark, 2016).

2.4.2. Single-housing observations

Each morning of single-house observation, three cats were pseudo-randomly selected, using the same random number generator, to include as many unique individuals as possible. After the 10 min. habituation, the session continued with 1-min instantaneous eSA, 14 min. activity, 1-min instantaneous eSA and 14 min. activity, in total 40 min. of observation (Fig. 1). Activity was recorded as each change of either location within the cage or behaviour(i.e. behavioural transition). One cat at a time was observed.

2.5. Statistical analysis

Basic calculations including summaries for recorded BEs from the eSA, activity and social interactions, mean room temperature and median length of stay, where performed using Excel and Minitab statistical software (version 17 2016 Minitab Inc.). Of the original 83 cats, 64 group- and 13 single-housed cats included complete sets of observations, using the Social Interactions/Activity and eSA protocols. One single-housed cat did not have a record and therefore could not be included in the analysis of time to adoption. The statistical units are cats for all

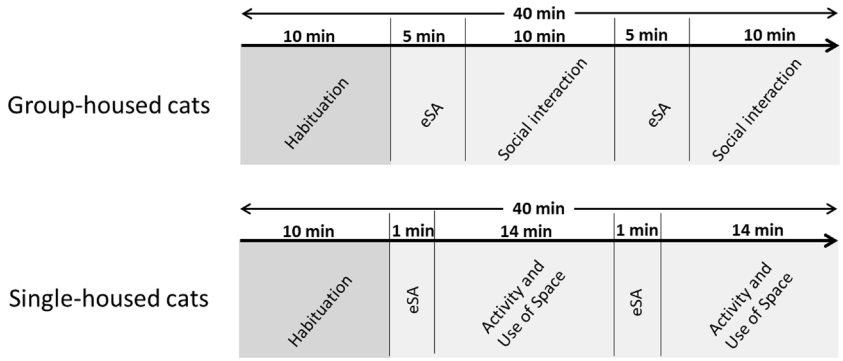

Fig. 1. Time lines describing the observations of cats in group- versus single-housing over days (A) and during one observation day (B).

measures relating to the eSA but on group level (for each room) for calculation of activity for group-housed cats.

The BEs that best predict *Time at Shelter* was based on the data from each cat's first day of observation, four separate eSA, unlike Kessler and Turner (1997) basing their calculations on mean values. Calculations were made using the Survival Analysis based on the Cox proportional hazards regression model using a stepwise regression analysis (**proc phreg** package, SAS ® 9.4). Each of the four scorings (1 and 2 during the am observation and 3 and 4 during the pm observation) of the eSA was calculated separately. The Survival Model estimates parameters, which describe the relationship between our predictors (the BEs) and *Time at Shelter*. Two different starting points are used to find variables (BEs) that are most important for explaining the different times until adoption. The stepwise model finds the most important BEs by using the parameter estimates of the Hazard Ratios used to predict *Time at Shelter*. Time at Shelter (T_x) is used to calculate variables relating to short time until adoption. To calculate which behaviours describe long time until adoption, the cat with most days until adoption that is, longest *Time at Shelter* (T_x), for group-housed and single-housed cats respectively, had its time set as a starting point (T_0). T_0 was then used to calculate a new alternative Time (T_y) for each cat according to $T_y = T_0 - T_x$. Higher Hazard Ratio relates to higher 'risk' (i.e. here chance) for short time until adoption (*Time at Shelter*) in cases where a BE was recorded. Data from these calculations are presented as Parameter Estimates, Hazard Ratios and p-values from Chi2-tests. P-values < 0.05 were regarded as significant and <0.1 were regarded as tendencies.

Only cats where journal information was available (one group-housed cat missing) and that ended up being adopted (two group-housed cats euthanized and one single-housed cat was returned to previous owner) were included in the survival analysis (group: n = 61, single: n = 12).

Social behaviours are shown as mean number per hour and cat for each of the five rooms.

Comparison of proportion of declawed cats in the sample population compared to the general cat population in the USA (Patronek, 2001) was calculated by hand using the "Goodness of Fit" Chi-Squared Test.

3. Results

3.1. The extended stress assessment (eSA)

The median *Time at Shelter* (available for adoption until adopted) for group-housed cats was 26 days (IQR = 6–54) and for single-housed cats 29 days (IQR = 7–97) days. Group-rooms differed in the median *Time at Shelter*, group 1 44 days (IQR = 29–75), group 2 39 days (IQR = 6–82), group 3 21 days (IQR = 5–51), group 4 11 days (IQR = 3–27) and group 5 18 days (IQR = 7–43). Of the 85 BEs included in the behavioural protocol, 20 in total (24 %) were never recorded. These BEs belonged to all seven-levels of the original CSS as well as from the GAS and BEs taken from literature (Table 4). BEs never recorded overlapped to a great extent between cats housed in single- and group-housing. BEs that were not recorded during the observation time were significantly fewer in group-housed cats (26 %, n = 22) than in single-housed cats (42 %, n = 36) (Mann-Whitney test, $p < 0.05$).

The survival analysis using T_x (i.e. longest *Time at Shelter*, most days until adoption) as Hazard Rate found 16 distinct BEs from the eSA to predict short *Time at Shelter*, 14 in group-housed and two in single-housed cats (Table 5). Of these, 14 were positively correlated meaning that presence of BEs increased chance of fast adoption and 2 were negative meaning that presence of BEs decreased chance of being adopted (Table 5). The BEs were from four observation sessions and in group-housed cats some BEs occurred in several sessions, for example head moving and eyes closed (3 sessions), eyes half open and vocalisation: none/quiet (2 sessions). In single-housed cats only ears being pricked increased chance of being adopted, whereas ears normal decreased chance of being adopted (Table 5).

Using T_y (i.e. new alternative Time where $T_0 - T_x$) as Hazard Rate revealed 14 distinct BEs, predicting long *Time at Shelter*, 12 BEs in group-housed and three in single-housed cats of which one was present in group-housed cats (Table 6). Of these, seven were positively correlated meaning that presence of BEs decreased chance of fast adoption, and seven were negatively correlated meaning that presence of BEs increased chance of being adopted (Table 6). The BE "ears erect to back" was positively correlated in three observation sessions (Table 6).

Looking at the BEs found to be relating to *Time at shelter* (short (T_x) or long (T_y) time) and what stress level they correspond to in the original CSS (Kessler and Turner, 1997) reveals that they belonged to all seven original stress levels. Of the BEs positively correlating to short *Time at Shelter*, 83 % belonged to stress levels 3 or lower, and 44 % positively correlating to long *Time at Shelter* belonged to stress levels 4 or higher.

3.2. Social interactions

There were differences in the number and type of social interactions that took place in the five rooms with group-housing. In general, there were more vocalisations than actual physical interactions (Fig. 2).

Social play, cats playing with the same toy or together, was only recorded in Room 1 where it primarily took place between one study cat and one juvenile cat not included due to age. Room 5 (the low-stress room) included most recordings of negative (0.47 per cat/h) and positive interactions (0.41 per cat/h).

3.3. Activity

Activity levels in group-housed cats, as calculated by number of changes of location within the room during the 10 min. × 2 observations in the am and pm session, included few recordings of changes. Median number of changes of placement in the room were zero for all rooms. Room 1 contained the most active cats with median (IQR, max.) 0 (0–2, 20), followed by Room 3: 0 (0–2, 15), Room 5: 0 (0–1, 9), Room 4:

Table 2
Protocols and their behavioural elements (BE) from previous studies.

Protocol	Behavioural element (BE)		Reference
Cat-Stress-Score	Body	On back On side On stomach Sitting Standing Moving Crouched (all fours) Shaking	Kessler and Turner, 1997
Global Assessment Score		Laid out on back 'Tense' 'Stiff' Flattened	McCune, 1992*
Cat-Stress-Score	Belly	Exposed Not exposed Slow normal ventilation	Kessler and Turner, 1997
Global Assessment Score		Fast ventilation	
Cat-Stress-Score	Legs	Fully extended/stretched out Front legs laid out Hind legs laid out Standing, extended Standing, bent Bent near surface	Kessler and Turner, 1997
Global Assessment Score		Paws turned in	
Cat-Stress-Score	Tail	Extended Loosely wrapped around body Up Loosely downward	Kessler and Turner, 1997
	Head	Laid down (on surface) Chin upward Near surface Over body Moving On plane of body (somewhat crouched) Lower than body (crouched)	
Global Assessment Score		Flattened	
Cat-Stress-Score	Eyes	Pressed together Closed Half open Slow blink Normal (open) Wide open Fully open	Kessler and Turner, 1997
	Pupils	Normal Partially dilated Dilated Fully dilated	
	Ears	Erect to front Erect to back Partially flattened Fully flattened	
Global Assessment Score		Normal Pricked Back on head	McCune, 1992
Cat-Stress-Score	Whiskers	Lateral Forward Back	Kessler and Turner, 1997
Global Assessment Score		Normal	McCune, 1992
Cat-Stress-Score	Vocalisation	None/quiet Meow Plaintive meow Yowling	Kessler and Turner, 1997
Global Assessment Score		'Greet' Purring	McCune, 1992
Cat-Stress-Score	Activity	Sleeping/resting Awake Alert Playing Cramped sleeping Trying to escape Actively prowling Motionless alert	Kessler and Turner, 1997
Global Assessment Score	Other	Completely relaxed Drool Close-crouched look Hair flattened All out defence 'Aware' 'Rage'	McCune, 1992
–	Belly	Not visible	Gourkow et al., 2014
	Activity	Hide Groom Rub Allo-groom Knead	

* Only unique behavioural elements absent from the Cat-Stress-Score are mentioned as included from the Global Assessment Score.

Table 3
Ethogram of social behaviours observed during social interaction sessions (based on Loberg and Lundmark, 2016).

Behaviour	Description
Positive Social (PS)	Cat sniffs, rubs head/body, lies/sits with body contact with other cat, or licks other cat on any body part
Negative Social (NS)	Cat hits with paw once or more towards other cat without putting down paw, lies belly against belly with front paws wrapped around each other, may kick or bite, jumps at other cat or lunges, runs after other cat
Positive Vocalisation (PV)	Meow or purr; sound varying in pitch or purring sound
Negative Vocalisation (NV)	Hiss, growl, scream; hissing sound, dull burring sound and/or monotonous sound
Social Play (SP)	More than one cat plays with the same toy/object without pause for more than 3 s.
Play (P)	Cat plays on its own with a toy/object without pause for more than 3 s.

0 (0–1, 5) and Room 2 containing the least active cats 0 (0−0, 4).

Activity levels in single-housed cats, as calculated by number of changes of location and behavioural transitions during the 14 min. × 2 observations for the am and pm session, differed between individuals with median (IQR, max.) of 3 changes (0–10, 40) and the most active cat 16 changes (3–20, 28) and least active cat 0 changes (0–1, 8).

3.3.1. *Declawing*

Of the group-housed cats, 36 % were declawed on the front and/or back paws, from the single-housed cats no cats were both front and back

Table 4
The number of behaviour elements (BEs) in each level, BEs not recorded for either group-housed or single-housed cats and BEs not recorded in both group- and single-housed cats (Identical BEs).

Scoring level	No BEs*	Group	Single	Identical (G and S)
Cat Stress Score level (Kessler and Turner, 1997)				
1	16	2	5	2
2	30	2	9	2
3	24	1	5	1
4	26	3	6	2
5	21	5	7	4
6	16	5	8	5
7	15	5	8	4
Global Assessment Scale (McCune, 1992)	15	10	12	9
Gourkow et al., 2014	5	2	2	2

* BEs could belong to multiple stress levels, the total number > 85.

declawed but 31 % were front declawed. The proportion of declawed cats in the study compared to the general population in the USA (24.4 %, Patronek, 2001) was significantly, higher (χ^2 (1, n = 82) = 5.36, p = 0.025).

4. Discussion

The aim of this study was to determine which behaviours (BEs) are relevant to include in a future protocol (*extended Stress Assessment*) to assess the stress levels of cats in group- and single-housing.

The results showed that of the initial 85 BEs included in the *extended Stress Assessment* (eSA), 26 % were never recorded in group-housed cats and 42 % were never recorded in single-housed cats. 16 unique BEs in total, 14 in group- and two in single-housed cats were found to be best predictive of short time to adoption. Higher Hazard Ratio relates to higher 'risk' (i.e., here chance) for short time until adoption (*Time at Shelter*) in cases where a BE was recorded. Looking at BEs indicative of cats spending longer time at the shelter, that is, decreased chance of quick adoption, the Survival Analysis found 14 unique BEs, 12 for group-housed and 2 for single-housed cats. One BE (*Body: standing*) was found in both group- and single-housed cats. The majority (83 %) of the BEs related to short *Time at Shelter* belonged to stress levels of 3 (*Weakly tense*) or lower on the original CSS whereas about 44 % of the BEs positively correlated to long *Time at Shelter* belonged to 4 or higher. As level 3 has previously been set as the acceptable experienced level of stress for cats (Kessler and Turner, 1999a) this is an indication that *Time at Shelter* is related to stress as measured by the CSS.

Hiding was not one of the BEs relating to *Time at Shelter*; therefore there is no support for the belief that providing hiding places will decrease cats' chances of adoption. These results support previous findings, for example that providing hiding places does not decrease the time cats spend visible to visitors and they still approach the front of the cage when called (Moore and Bain, 2013).

The temperature was above 15 °C at all times, so there is no reason to assume that the temperature affected the displayed BEs from the eSA considerably. When temperatures reach below this, cats cannot be assumed to keep relaxed positions (Kessler and Turner, 1997).

Housing seemed to have an effect on observation of BEs from the eSA as significantly fewer were recorded in single-housed cats. This, together with the fact that only one BE was related to *Time at Shelter* in both group- and single-housed cats, might be an indication that separate behavioural protocols should be used for group- and single-housed cats. At least when cats are single-housed in traditional style caging systems. Whether differences are caused by different underlying stress levels or an inability of single-housed cats to display all BEs found in the eSA cannot be determined by the data, due to the low number of single-housed cats. The BEs utilised for the further developed protocol were both positively and negatively correlated to short and long time housing. This means that BEs of both more positive states as well as signs of not coping, for example frustration and stress, will be included. To include presence of normal behaviours when assessing cats has previously been suggested as important (McCune, 1994).

Some BEs, found mostly in single-housed cats, could be related to

Table 5
Predictions using Analysis of Maximum Likelihood Estimates with T_x as Hazard Rate where presence of Behavioural Elements (BEs) correlated with increased chance of spending shorter time at the shelter and having a quick adoption. Bold denotes negative correlation, presence of BE is indicative of longer Time at Shelter. BEs only included when p < 0.05.

Housing	Observation No	Behaviour Element	DF	N	Parameter Estimate	Hazard Ratio	Pr > ChiSq
Group	1	Body: sitting	1	59	0.88	2.42	0.01
		Head: moving	1	59	1.44	4.22	0.00
		Eyes: half open	1	59	1.00	2.71	0.01
		Eyes: closed	1	59	0.80	2.23	0.03
		Ears: erect to front	1	59	0.81	2.24	0.01
		Vocalisation: none quiet	1	59	1.60	5.0	<0.00
	2	Head: moving	1	58	1.56	4.75	<0.00
		Eyes: pressed together	1	58	1.98	7.25	0.00
		Eyes: closed	1	58	0.74	2.1	0.03
	3	**Legs: standing extended**	**1**	**59**	**−1.77**	**0.2**	**0.03**
		Tail: loosely wrapped around body	1	59	3.34	28.4	0.01
		Head: on plane of body	1	59	1.48	4.41	0.02
		Pupils: partially dilated	1	59	6.40	603	<0.00
		Vocalisation: none quiet	1	59	1.29	3.63	0.00
	4	Legs: fully extended, stretched out	1	56	3.25	25.7	<0.00
		Legs: front legs laid out	1	56	2.35	10.5	0.00
		Legs: standing extended	1	56	5.40	219	<0.00
		Tail: loosely downward	1	56	2.75	15.6	0.00
		Head: moving	1	56	2.24	9.35	0.00
		Eyes: half open	1	56	1.15	3.15	0.01
		Eyes: closed	1	56	1.12	3.06	0.00
Single	1	–	–	–	–		–
	2	**Eyes: normal**	**1**	**12**	**−2.25**	**0.11**	**0.01**
		Ears: pricked	1	12	2.76	15.8	0.02
	3	–	–	–	–	–	–
	4	–	–	–	–	–	–

Table 6
Predictions using Analysis of Maximum Likelihood Estimates with T_Y as Hazard Rate where presence of Behavioural Elements (BEs) correlated with decreased chance of spending short time at the shelter and having a quick adoption. Bold denotes negative correlation, presence of BE is indicative of shorter Time at Shelter. BEs only included when $p < 0.05$.

Housing	Observation No	Behaviour	DF	N	Parameter Estimate	Hazard Ratio	Pr > ChiSq
Group	1	**Body: Sitting**	**1**	**59**	**−0.99**	**0.37**	**0.02**
		Legs: paws turned in	**1**	**59**	**−1.16**	**0.32**	**0.00**
		Head: moving	**1**	**59**	**−1.00**	**0.37**	**0.01**
		Ears: erect to front	**1**	**59**	**−1.13**	**0.32**	**0.00**
		Ears: erect to back	1	59	1.24	3.44	0.03
		Whiskers: normal	1	59	2.94	18.9	0.00
		Vocalisation: none quiet	**1**	**59**	**−1.131**	**0.32**	**0.00**
	2	Body: standing	1	58	2.28	9.74	0.00
		Legs: hind legs laid out	1	58	2.29	9.85	0.03
		Head: over body	1	58	5.53	253	0.00
		Eyes: slow blink	1	58	4.34	76.6	0.00
		Ears: erect to back	1	58	1.78	5.91	0.00
		Ears: partially flattened	1	58	1.42	4.13	0.03
	3	–					
	4	Ears: erect to back	1	59	1.46	4.31	0.02
Single	1	–	–	–	–		–
	2	–	–	–	–		–
	3	**Activity: Sleeping/resting**	**1**	**12**	**−1.86**	**0.16**	**0.03**
	4	Body: standing	1	12	3.30	27.1	0.04
		Belly: not exposed	**1**	**12**	**−2.80**	**0.06**	**0.01**

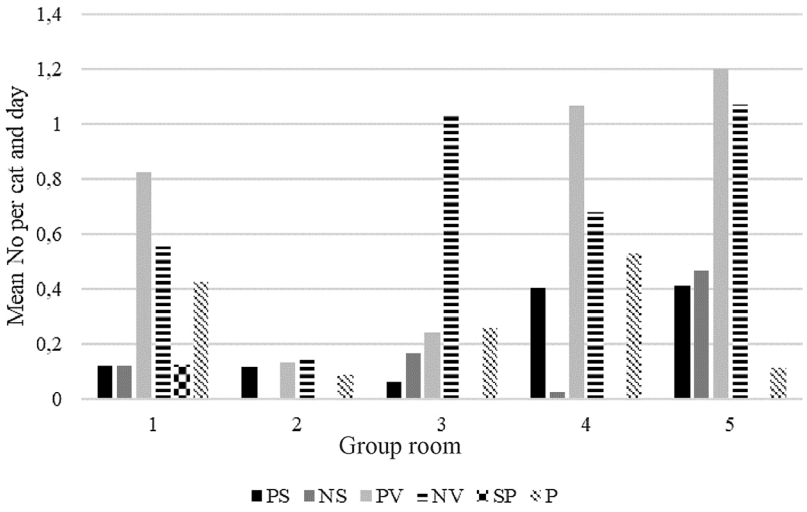

Fig. 2. Mean number of recorded social interactions per hour within each of five rooms divided by number of cats housed in the group room at each observation. Excludes interactions that were clearly directed towards humans. PS, positive social; NS, negative social; PV, positive vocalisation; NV, negative vocalisation; SP, social play; P, play.

frustration, for example not being able to escape or control the situation. Frustration has been seen as a result of caging in approximately 6% of cats entering a shelter (Gourkow and Phillips, 2016) and can be expressed for example, through attempts to escape, pacing or persistent vocalisation (McCune, 1992; Kessler and Turner, 1997; Gourkow et al., 2014a). Cats rated as frustrated were in Gourkow and Phillips (2016) related to increased risk for apathy, with abnormally long periods of sleeping and absence of normal behaviours such as feeding and grooming. Frustration was also connected to lower salivary IgA levels (Gourkow and Phillips, 2016) and due to that increased risk of developing respiratory disease (Gourkow et al., 2014a).

The discussion whether the scoring system is related to stress or fear (McMillan, 2012) might not be that relevant from a cat welfare perspective, as both can decrease an animal's welfare. More important to discuss is what the behaviours included reveal about the outcome for the cat. In this study, outcome was measured by time from available until adoption (*Time at Shelter*). The reason for this was that all cats included in the study except three were eventually adopted. Of the three cats not adopted, one was returned to the previous owner and two were euthanized. Due to the strict selection of cats taken in by the shelter a survival analysis using different outcomes (adoption, euthanasia or returned to owner) as Hazard Rate could not be performed, since too few cats were euthanized or returned to owner. A similar set-up would likely be valuable to perform at an open access shelter, were cats are more likely to differ in their behavioural repertoire. Some cats would then likely be less suited for the shelter environment and display more behaviours included in the eSA related to not coping.

The findings described here, 24 % of the BEs present in the eSA were never recorded, shows that it is possible to simplify the scoring protocol, by removing these BEs, as it is very difficult to take note of all BEs during the 1 min observation. This would indicate that BEs that were never recorded might not be salient enough to observe during this short period. However, as previously described, it could also relate to conformity of the study sample, and suggest a need for further study in a more diverse group of shelter cats. The BEs that turned out to be predictive of time until adoption are likely a good foundation in the

development of a new assessment protocol. The aim would then be to investigate which cats are coping, and which are not and likely in need of further intervention, for example change of environment (e.g., group- or single-housing) or addition of resources.

There might have been a confounding effect from care and routines in the different rooms as customer service staff seem to have less time to clean the single cages and Room 2, and seemed to be under more time constraint compared to cat staff. The customer service staff also included more individuals, which differed between days. These types of unpredictability have previously been shown to be stressors for cats (Carlstead et al., 1993; Stella et al., 2011) and can have a negative effect on cats.

There are some potential risks with using the CSS in that it is built on instantaneous sampling (Loberg and Lundmark, 2016) where longer duration behaviours are at risk of becoming over represented (Martin and Bateson, 2007). Further validation of behaviours to be included in the future assessment tool are needed. In this initial step, investigation of which BEs that are salient enough to be recorded accurately during the 1 min observation (according to the original CSS methodology [Kessler and Turner, 1997]) was performed, and how this differed in group- and single-housed cats. During the next step it would be valuable to investigate how stable and robust these BEs are within an individual, as the original scoring system has not been validated against additional signs of stress (e.g., McCobb et al., 2005). There is a need to find BEs that not only reflect short-term states, but also overall coping/long term stress.

Social interactions were observed according to the ethogram in Loberg and Lundmark (2016) to be able to compare results between the studies. There were few social interactions in general, which can relate to that cats housed in unstable groups can become more passive as a way of avoiding interactions. This is strengthened by the low general activity level of the group-housed cats. An increase in hiding behaviour has been related to cats feeling threatened (van den Bos and De Cock Buning, 1994) and negative interactions were reported to be more frequent in housing where cats had little opportunity to avoid each other or claim personal space (Gourkow and Fraser, 2006). However, it has also been discussed that low activity can be related to cats finding favourite spots and claiming personal space (Loberg and Lundmark, 2016). Claiming personal space and becoming restricted in movements and space use was described by Bernstein and Strack (1996) where 14 cats living in a house were found to divide available space into smaller 'home-ranges' that sometimes overlapped. The observed higher activity in the single cats might be connected to frustration, in attempts to escape and gain control over the environment. The clear difference in activity levels between cats within single-housing might be connected to the different coping styles, reactive and proactive (Koolhaas, 2008), although this has not clearly been found as stable traits in cats (Kiddie and Casey, 2010). Social interactions directed at humans were not included in the analyses which can be seen as a limitation of the present set-up.

Significantly more cats in this study were declawed (36 % for group and 31 % for single cats) than in the general population in the USA which is approximated to 24 % (Patronek, 2001). Besides potential welfare issues connected to declawing, a recent study found that declawed cats spent in average 12 days longer at a shelter before adoption (Fritscher and Ha, 2016). The potential reason discussed was that adopters might have the belief that de-clawing is related to undesired behaviours. Looking at the proportion of declawed cats in the present study, there is no support of the previous findings that declawing protects cats against relinquishment as previously suggested (Patronek et al., 1996).

One limitation of the present study was that the shelter selects which cats are taken in by the shelter. This might have caused a bias in the shelter population as the most un-socialised, stressed or fearful cats might not have been accepted and could be a reason why several BEs were never noted. Still, many of the cats ended up staying for a long time at the shelter. *Time at Shelter* until adoption in the study had a median of 26 days for group-housed and 29 days for single-housed cats. This is relatively long compared to previous studies, for example by Tanaka et al. (2012) with a mean of 15.4 days, and 22 days in a larger survey of North American shelters (Spindel et al., 2013). This is surprising as the shelter was not open access (i.e., the shelter selected which cats were accepted), but could be due to the screening process of potential adopters. There was a large difference in the time from available for adoption until adopted. If there were behavioural components behind this difference, the cats that displayed behaviours connected to spending longer time at the shelter might need further interventions such as additional or different resources.

As the study took place in an active shelter there were limitations relating to factors outside of our control. The number of resources available to the cats, such as litterboxes or hiding places, changed in relation to the number of cats housed in each group during the study. This was the result of removal or addition of cats throughout the study. Competition over resources, not being able to get away (Gourkow and Fraser, 2006), and unstable groups (Ottway and Hawkins, 2003) are factors known to induce stress in group-housed cats which could have influenced our results. Interactions with humans can have a positive effect on socialised cats (e.g. Gourkow et al., 2014b), but not if handling is unpredictable (Carlstead et al., 1993). As presented, the observer had to stand inside the group-rooms to be able to observe the cats due to the layout of the rooms. During the 10 min. habituation period at the beginning of each observation cats lost interest in trying to initiate contact with the observer. Still, there might have been an influence on the recorded cat behaviour.

5. Conclusion

In conclusion, out of the 85 behavioural elements (BEs) included in the 1-min observations of shelter cats 22 BEs were never observed in group-housed cats and 36 BEs were never observed in single-housed cats. There were 14 BEs in group-housed cats that predicted short *Time at shelter* and among those head moving, eyes closed or half-open and not vocalising were recorded in more than one session. There was only one BE in single-housed cats that predicted short *Time at shelter* and this was ears pricked. The proportion of declawed cats were higher in these shelter cats than in the general population of USA. Our findings indicate that there are differences in recordings of BEs related to stress in group- and single-housed cats. This difference in scoring could indicate the need of different assessment protocols for group- and single-housed cats. However, this needs further investigation as only 12 cats were observed in single housing in the present study.

As the shelter was not open access, and cats were selected before admission, not all levels of stress found in the cat shelter population might have been represented in the sample. Despite these shortcomings, there seem to be BEs related to short *Time at Shelter* which also positively correlated to acceptable levels of stress in the original CSS, and BEs related to long time related to higher levels of stress. After further investigation they can be used to form an assessment protocol to determine if cats are coping, and likely will become adopted, or in need of additional intervention to become adopted.

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