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The perception of cat stress by Italian owners

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Highlights

- Owner perceptions of their pet cat's welfare has been neglected in research
- One-hundred-ninety four owners were interviewed about the welfare of their cats
- Owners tend to overlook certain signs of stress regarded as crucial by behaviorists
- The preconceptions owners have about the ethology of normal cats affects the recognition of stress

22 Abstract

23 The welfare assessment of owned pet cats has been neglected in research. The aim of this study was
24 to assess owners' perception and recognition of impaired welfare in their own cats.

25 One-hundred-ninety four cat owners were interviewed face-to-face by a veterinary behaviorist,
26 completing a 42-item questionnaire.

27 Most owners (71.1%/N=138) correctly included both physical and psychological features within
28 their definition of stress, but 9.8% (19) thought that stress had no consequences for the cat.

29 When asked to rate the overall stress level of their own cats in a non-numerical scale based on
30 frequency, 56.7% (N=110) chose low, 38.1% (N=74) chose medium, and 5.2% (N=10) chose high.

31 Owners whose cats played little or not at all were more likely to rate the level of stress of their cats
32 as high (90.0%) than to rate it as low or medium (33.2%/64; $\chi^2 = 13.290$; $p < 0.001$). Similarly,
33 owners whose cats showed over-grooming were more likely to rate the level of stress of their cats as
34 high (30.0%/58 vs 7.6%/15; $\chi^2 = 4.948$; $p = 0.015$). The display of aggression or house-soiling was
35 not associated with the owner's rating of stress level.

36 The number of signs recognized by respondents as potential indicators of stress in cats and the
37 rating of the level of stress in their own cats were weakly correlated ($\rho = 0.217$; $p = 0.002$). This
38 may be due to possible biases in the interviews as well as to an overall good welfare in the cat
39 sample associated to a moderately good understanding of feline signs of stress in owners.

40 A principal components analysis applied to the listed signs of stress identified four components
41 which were termed: body posture, social avoidance, house soiling, and self-directed behavior.

42 However, some of the signs that behaviorists regard as crucial in their anamnesis, such as scratching
43 the furniture, freezing, mydriasis and recurrent cystitis, were the least recognized signs of stress by
44 cat owners. Only very prominent, common or potentially disturbing behaviors such as excessive
45 vocalization, posture with the ears back, and urinating out of the litter tray were regarded as
46 potential signs of stress by more than two thirds of owners. These findings suggest that owners tend
47 to overlook certain signs, and that owners' perception of stress partially depends on their false

preconceptions about cat normal ethology (e.g., playfulness, social relationships, aggression et cetera). This ill-informed perception is likely to prevent owners from correctly indentifying, and intervening in, situations of poor welfare.

Key words: behavior; cat; owner; questionnaire; stress; welfare.

Introduction

Due to the huge discrepancy between the ancestral environment of the domestic cat and its modern day lifestyle as a pet, a wide range of potential stressors may give rise to poor welfare in this species (Casey & Bradshaw, 2005).

Welfare, based upon subjective states experienced by the animal, can be indirectly assessed using behavioral and physiological measures of stress (Casey & Bradshaw, 2005). Behavioral measurements are of particular interest for the assessment of welfare in pets, because they can be easily and noninvasively collected (Beerda et al., 1997, 1998).

Most of the research on the welfare of cats has focused on shelters and catteries (Vinke et al., 2014; Guy et al., 2014; Damasceno & Genaro, 2014). For example, animal behavior indicators have been used to confirm that husbandry practices are strongly correlated with body and coat condition (Arhant et al., 2015).

Compared with shelters, the welfare assessment of owned pet cats has been quite neglected in research. Being responsible for care-giving, cat owners strongly influence the welfare of their pets. In addition, when treating behavioral problems, behaviorists usually rely on the owner's descriptions and assessments of the pet in situations in which behaviorists themselves are not present. So, the role of owners in the evaluation and protection of pet welfare is crucial.

Owner-completed questionnaires are used in the assessment of behavior and welfare, based on the assumption that owners know their animals' behavior better than anyone else (Serpell and Hsu, 2001).

Recent studies have investigated dog owners' perception of stress in their dogs through the use of questionnaires (Mariti et al., 2012) and have compared owner assessments with those of a behaviorist and with the behavioral analysis of video recordings of dogs (Mariti et al., 2015). Although owners can provide information that would otherwise not be easily accessible to people who were not acquainted with that specific animal, their ability to recognize subtle signs of stress in dogs and to identify the level of stress of their own dogs was called into question.

To our knowledge, this kind of study has not been carried out in pet cats. So, the aim of the current study was to assess owners' perception and recognition of impaired welfare in their own cats.

Materials and methods

Protocol

A questionnaire previously used for assessing the perception of stress in dog owners (Mariti et al., 2012) was adapted for this study, to create a 42-item questionnaire. A draft version was piloted on ten cat owners. Some minor adjustments were then made leading to the final questionnaire (Table 1). Items were mostly multiple choice and included information about the owner and cat, the environment and husbandry, the cat's behavior and the owner's perception of stress.

When administering the final version of the questionnaire to the test population, cat owners were first briefly briefed about its operating methods and purpose (namely collecting data on cat management and behavior in Italy), and their written consent was collected. Respondents were recruited by personal contact and from the client databases of two veterinary clinics in Central and South Italy. For the latter, as performed by Mariti et al. (2015), clients bringing their cat to the vet for scheduled visits (e.g., vaccination) were selected, in order to avoid cats with known health problems. If respondents owned more than one cat, they were asked to answer the questions with reference to the oldest in the household. Each cat owner was interviewed face-to-face by one of two veterinary behaviorists who read out the items and recorded the answers provided by the respondent. In the case of multiple-choice items, the interviewer read the question and ticked the

answer chosen by the respondent. In the case of open questions (such as “how do you understand that your cat is stressed?” and “in which situations is your cat stressed?”), the interviewer wrote the respondent’s exact words and then reformulated a summarized answer, asking the respondent whether this accurately summarized what the respondent wanted to express. For the items “Is your cat stressed in X situation?” (for the list, see fig. 1) and “In your opinion, can X be a sign of stress in cats?” (for the list, see fig. 2), the question was repeated for a list of potentially stressful situations and feline signs of stress; owners who replied yes were also requested to attribute a score of 1 to 5.

Participants

The questionnaire was completed by 194 cat owners. Respondents were mainly women (145 versus 49 men), in the range of 30-50 years old (38.5 ± 13.4), and educated (49.0%/95 high school, 34.0%/66 advanced degree).

The population of cats was quite equally distributed for sex; 45.9%/89 female (41.8%/81 neutered and 4.1%/8 entire) and 54.1%/105 male (47.4%/92 neutered and 6.7%/13 entire). The cats were mostly adults (76.0 ± 56.2 months old) and of domestic short or long-haired breed (84.0%/163). Apart from those born at home ($n = 7$), the age of adoption was very variable, the average being 5.5 ± 10.9 months old.

Only 8.2%/16 of cats lived with one owner, while most cats lived in a family with 2-4 members (79.9%/155). In 20.6%/40 of cases, there were children (0-12 years old) living in the house. The majority of cats lived with other animals in the household, especially dogs (62.3%/121) and other cats (73.6%/143). The total number of cats in the household, including the analyzed cat, varied from 2 (33.6%/65) to 15 (0.7%/14); the number of cats in the same household was inversely proportional to the percentage of households with that composition (2 to 5 cats represented the 64.2%/121 of households).

Cats were almost equally divided between those who lived strictly indoors (45.4%/88) and those who had both indoor and outdoor access (50.5%/98). The remaining 4.1%/8 lived exclusively outdoors.

The majority of cats had the opportunity to access high places in household rooms (90.2%/175), but fewer than half of cats (40.2%/78) had a dedicated resting place that owners provided to them. There was a minimum of 1 litter-tray per cat in half of the households (52.6%/101). Most cats had free access to food (68.0%/132), with the remainder being fed more than once per day (twice: 4.1%/8; 3 times: 19.1%/37; more than 3 times: 8.8%/17).

Statistical analysis

The statistical analysis was performed using the Chi-square test with Bonferroni correction (with $p=0.0125$ as the threshold for significance) in order to assess the possible presence of factors affecting the owner's rating of the level of stress in their cats. Spearman's rank test ($p<0.05$) was used to explore potential correlations between the rating of the level of stress and the number of signs recognized by owners as feline indicators of stress. In addition, an exploratory principal component analysis (PCA) was carried out using the stress score (1-5) attributed by each owner to each listed sign of stress.

Results

Cat behavior

Almost half of the cats had shown aggression (45.4%/88) including biting (19.0%/37). The targets of aggression were usually dogs/cats (15.0%/29) or familiar people (24.1%/47).

Around one third of cats were described by their owners as playing little (28.4%/55) or not at all (7.7%/15), and a similar proportion showed house-soiling, including urine and feces (10.3%/20), only urine (8.2%/16) or only feces (9.8%/19) outside of the litter-tray. A small, but still notable, number of cats displayed overgrooming (8.8%/17).

Perception of stress

When asked, using a closed-question, about their definition of what constitutes stress, the majority of owners (71.1%/138) correctly included both physical and psychological features within their definition, while 15.5%/30 considered stress to be a purely psychological phenomenon, and 3.6%/7 considered it to be only a physical phenomenon. Approximately one in ten owners (9.8%/19) thought that stress had no consequences for the cat.

When asked to rate the stress level of their own cats using the scale provided, 56.7%/110 chose low, 38.1%/74 chose medium, and 5.2%/10 chose high.

Owners whose cats played little or not at all were more likely to rate the level of stress of their cats as high (90.0%/175) than to rate it as low or medium (33.2%/64; $\chi^2 = 13.290$; $p < 0.001$). Similarly, owners whose cats showed over-grooming were more likely to rate the level of stress of their cats as high (30.0%/58) than to rate it as low or medium (7.6%/15; $\chi^2 = 4.948$; $p = 0.015$). The display of aggression (70.0%/136 vs 44.0%/85; $\chi^2 = 2.583$; $p = 0.108$) or house-soiling (30.0%/58 vs 19.6%/38; $\chi^2 = 0.643$; $p = 0.423$) was not associated with the rating of stress level.

The majority of respondents (76.6%/149) stated their cat was stressed in certain situations, while 11.7%/23 considered their cats never to be stressed, and a further 11.7%/23 were not able to give an answer. However, when they were presented with a list of potentially stressful situations, 42 out of the 44 owners who had stated that their cats were never stressed, or who were unable to answer selected at least one situation that they regarded as potentially stressful for their cat. The percentages of respondents considering the listed situations as stressful for their own cat are reported in fig. 1.

Owners were also presented with a list of potential signs of stress in cats, as previously described in the cat-stress score for caged or confined cats (Kessler & Turner, 1997) and a set of undesirable behaviors commonly regarded as feline stress indicators (Casey & Bradshaw, 2005; Mills et al., 2014; Amat et al., 2015). Owners were asked to evaluate whether each sign was generally indicative of stress in a cat (the results are reported in fig. 2).

The Spearman's rank test revealed a significant correlation between the number of signs recognized by respondents as possible indicators of stress in cats and the rating of the level of stress in their own cats, but the correlation was weak ($\rho = 0.217$; $p = 0.002$).

Using the 1 to 5 score attributed by owners to the listed signs of stress, a Principal Components Analysis (PCA) with varimax rotation was carried out. A good model was obtained ($KMO = 0.855$; $p < 0.001$) and most of the variance was explained by four components (total variance explained = 61.6%/120; see table 2). The first component included ears back, tail close to the body, mydriasis, panting and trembling; this component was named "body posture". The second component included not staying in the room with other animals, not eating in their presence, hiding and showing aggressive behavior when scolded; this principal component was named "social avoidance". "House soiling" represented a component on its own, with loadings from feces in an inappropriate place and urine in an inappropriate place. Overgrooming, recurrent cystitis, hypervocalizing and freezing all showed positive loadings for the fourth component, and scratching the furniture had a negative loading. This component was therefore a combination of more disparate signs, perhaps indicating inhibition, and the title "self-directed behavior" was chosen as it summarized the main aspects.

Discussion

"Stress" is a general term that is understood by most people but which has many nuances. As it is used in scientific literature, the term stress is an ambivalent phenomenon that includes both a positive form (eustress) and two forms of negative stress (overstress and distress; Selye, 1974). However, the word stress was borrowed from engineering by Selye in 1936 to describe the nonspecific response of the organism to a noxious stimulus and, since then, stress tends to be generally associated with negative factors, and specifically with describing the response of an organism to an internal or external threat (Selye, 1936).

This study deals with the perception that owners may have of cat stress and it did not aim to assess the welfare of pet cats or diagnose their behavioral problems. For this reason, the tools were

constructed to be simple enough that they could be understood by average cat owners. For instance, the word stress was used in the questionnaire instead of the word welfare, because stress was considered to be more commonly used and more easily understood by average Italian cat owners (welfare does not have a translation in Italian, only the term well-being exists). The description of cat behavior was kept as simple as possible and, where necessary, the interviewer could help the respondent by using other words. In order to get more reliable information, some questions focused on the same topic were repeated and expressed differently (as suggested by Mariti et al., 2015).

The use of a face-to-face interview, compared with other means of data collection, presents some advantages and disadvantages (for a review see Opdenakker, 2006). In the current study the face-to-face method was chosen because it involves a synchronous communication, that makes the interviewee's answer more spontaneous and without an extended reflection (Opdenakker, 2006). Bias coming from the interviewer can be diminished by using an interview protocol (e.g. a structured questionnaire) and through the awareness of the interviewer of this effect (Opdenakker, 2006). However, the use of a face-to-face interview does have disadvantages, such as being time and cost-consuming, which reduces the number of participants.

This study represents a first attempt to gather information on how owners perceive stress in their own cats, and therefore the findings have to be interpreted cautiously. Due to the relatively low number of interviewees and to the specific recruitment area, there are limitations in interpreting and in generalizing results.

Many factors, such as sex, education and age, can affect the way people perceive and relate to animals; for example influencing empathy (Taylor and Signal, 2005) or interaction style (Herzog, 2007). However, the population recruited in the present study (mainly educated, adult, female owners) reflects a common profile of cat owners (Murray et al., 2010); this increases the likelihood that our sample is representative of the wider population of cat owners. Other factors, such as having children, seem to affect the ability of owners to recognize and rate stress in their pets (Carlone et al., 2015), and cultural and individual features are likely to affect the psychology of

ownership. All these matters have implications for pet welfare, but they are beyond the scope of the present study, and investigating the effect of the owner's characteristics on their perception of cat welfare will require further research.

Our first key finding is that most owners were able to identify the correct definition of stress in a closed-question, which included both physical and psychological features, and the possibility that stress can have detrimental effects on the cat. However, one in ten owners thought that stress had no consequences for the cat, which suggests that those owners will not apply any interventions to reduce it.

When asked to rate the level of stress experienced by their own cat by using a provided scale, most owners stated that their cats were stressed rarely or only in specific situations. Few owners (5.2%/10) reported that their cats were highly stressed, and this answer corresponded with the owners' opinion that their cats were often or always stressed. This proportion may seem to be low but, considering that seven million people in Italy own at least one cat (source: Eurispes, 2014), it corresponds to hundreds of thousands of cats living in potentially very poor welfare conditions. This suggests that the welfare of pet cats is a highly important issue, with a need for much work on their protection, especially in improving the owner's knowledge about, and ability to provide for, their needs. Our findings are particularly alarming in light of the fact that none of the interviewed owners were recruited through a behavioral service. This suggests that these owners were not actively asking for advice on how to improve their cats' welfare. In addition, the reported proportion of cats living in poor welfare conditions is probably an underestimation, as it is more likely that owners underestimate rather than overestimate stress and welfare problems. The data may have been compromised by participant bias, especially as it was collected in an interview, was not anonymous and the participants knew the study purpose. Thus some participants consciously or subconsciously may have provided answers they think the investigator wants, or to avoid being perceived by the interviewer as a bad owner of a stressed cat. This bias may also be responsible for the weak correlations between the number of recognized signs of stress and the level of stress as

assessed by the participating cat owners. Such weak correlation may be depend on other reasons, e.g. an overall good management of cats (feeding times, hiding places etc.) leading to few cases of very low welfare associated to a moderately good understanding of feline stress signals by interviewed owners. However, when assessing the welfare of cats, as well as during a behavioral consultation, veterinarians should aim to an accurate description of the cat's behavior and of the situation rather than just relying on the owners' evaluation.

Behavioral changes associated with stress can be very annoying for owners, especially if this involves aggression, compulsive disorders, urine marking (Amat et al., 2015; Skeritt & Jemmet, 1980) or scratching the furniture (Mengoli et al., 2013). In contrast, stress often inhibits the performance of normal behaviors, so owners may not be aware of the discomfort being experienced by their cat (Amat et al., 2015).

Some of the signs that behaviorists regard as crucial in their anamnesis, such as scratching multiple items of furniture, freezing, mydriasis and recurrent cystitis, were the least recognized signs of stress in cat owners. Only prominent, common or potentially disturbing behaviors such as excessive vocalization, ears back and urinating out of the litter tray were regarded as potential signs of stress by more than 2 out of 3 owners. It is also remarkable that panting, trembling, avoiding other animals, and baldness caused by over-grooming were not signs of stress recognized by half of respondents (and other owners admitted that they did not know whether or not they were potential signs of stress). Signs of stress usually are not pathognomonic, so a specific behavior can be ambiguous, expressing different inner states (e.g. excitement or stress) or due to various physical causes; for example, overgrooming can be due to stress as well as to parasitism or environmental contamination (Mariti et al., 2015). Similarly, scratching the furniture can be normal, especially if the cat is not provided with a scratching post, or it can be a sign of stress when the behavior presents certain feature (sudden onset, involvement of multiple items etc.). However, this study showed that many cat owners did not know that such behaviors could also be indicative of stress. These findings suggest that owners often have a very limited knowledge about cat behavior, similar

to findings in dog owners by Mariti et al. (2012). This is likely to prevent owners from properly assessing and intervening in situations of poor welfare.

Behaviorists know that there is a strong link between welfare and behavioral problems, but this perspective does not seem to be shared by owners: the statistical analysis revealed that the presence of aggression and house soiling did not influence the owner's rating of stress level. Owners were instead more likely to rate stress as high if their cats played little or not at all, or if they showed over-grooming. Such findings are probably related to the preconceptions owners have of a cat's normal behavior; cats are regarded as playful, so when cats do not play it means there is a problem, whilst displaying aggression, even towards familiar people, is probably considered "normal" in cats and not possibly indicative of poor welfare. The hypothesis that an owner's ability to recognize behavioral signs of stress is related to their interpretation of cat ethology is corroborated by the results of the PCA. This indicates that certain owners attached more importance than others to socially-induced stress; some owners probably considered cats as non social animals and therefore considered the avoidance of other animals as normal and not stressful in domestic cats. It is not entirely surprising that the display of house soiling did not affect the rating of stress level, and that it represented a component on its own in the principal component analysis, as owners interpret this behavior in a number of ways, from being a prank to being a medical problem.

Notably, the percentage of people answering "I don't know" to questions was generally very high. This could be due to an inability to judge the cat's emotional state, but it could be due to other factors such as not having seen the cat in that situation.

Behaviorists believe that the stressors most commonly encountered by cats include changes in the environment (both physical and social changes), inter-cat conflict, a poor human-cat relationship, the cat's inability to perform highly motivated behavior patterns (e.g. a barren environment) (Amat et al., 2015), and lack of control and predictability (Carlstead et al., 1993). In the home environment, both changes in the husbandry routine and inconsistency in the owner's reaction to the cat's behavior may cause chronic stress (Amat et al., 2015). In the current study these factors were

recognized as potentially stressful by fewer than 40% of respondents, highlighting the importance of educating owners about what to do, and what to avoid doing, in order to optimize their cat's welfare.

It is not surprising that the situations considered by owners to be the most stressful were going to the veterinary clinic and travelling. In a recent study (Mariti et al., 2016a), it was found that cat welfare is impaired throughout all phases of a visit to the veterinary clinic, from leaving the house to returning back home, and it has a negative impact on the cat's response to all other experiences of transport. Considering its numerical importance and its negative impact on health assessment, the protection of cat welfare at the veterinary clinic is imperative for everybody involved in cat management and concerned with animal welfare. Although recent studies suggest that examinations at home are less stressful for cats (Nibblett et al., 2015), this is not always possible and it is not the only solution. There is in fact growing evidence that providing simple, standardized advice to kitten owners at the first veterinary check is effective in preventing welfare and behavioral problems in adult cats. This includes building the cat's tolerance to handling and the procedures that make up the veterinary examination (Gazzano et al., 2015). In addition, the behavior of veterinary surgeons can be addressed in order to minimize stress during the veterinary visit (Mariti et al., 2016a; Nuti et al., 2016).

An owner's ability to recognize behavioral signs of stress is important, as it enables the owner to help the animal to avoid stressful situations, and it favors a rapid recovery of psycho-physical homeostasis by interrupting the progression to overstress and distress. As already found in dogs (Mariti et al., 2012), our findings show that some owners already help in protecting the welfare of their pets, but that many owners would benefit from additional education to improve their ability to interpret their pets' behavior and to know where help is available. However, general veterinary practitioners may not be well versed in the assessment of pet welfare and behavior (e.g. for Portugal see Da Graça Pereira et al., 2014; and for Italy see Mariti et al., 2016b), so both they and pet owners

would benefit from further education provided by behaviorists (Gazzano et al., 2015; Mariti et al., 2016a).

Conclusions

The majority of cat owners know what the term stress means, but they often do not know how to recognize whether their cat is stressed and they tend to overlook certain signs. The understanding of potential signs of stress by cat owners seems to depend partially on the preconceptions that owners have about cat normal ethology. Though there were similarities found between dog and cat owners in the recognition of signs of stress, a difference did emerge. For dogs, the signs most frequently missed were the subtle behaviors, whilst for cats the unrecognized signs were those behaviors perceived by owners as normal for the species.

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The idea for the article was conceived by C. Mariti and A. Gazzano. The experiments were designed by C. Mariti, C. Sighieri, S. Diverio and A. Gazzano. The experiments were performed by F. Guerrini and V. Vallini. The data were analyzed by C. Mariti and J.E. Bowen. The article was written by C. Mariti, A. Gazzano, J. Fatjò, and J.E. Bowen. All authors have approved the final article.

Ethical considerations

Under the requirements of the host institution this study did not require ethical approval. However, prior to data collection participants were briefed about the process and how data would be used and that no personally identifying data would be collected. Their written consent was obtained. On

reflection, a debriefing sheet should have been provided, advising participants of cat signs of stress and where to seek help if they were concerned about their cat's welfare. This would have provided a more robust ethical approach to the welfare of the human participants and their cats.

Conflict of interest

We have read and understood this journal's policy on declaration of interests and declare that we have no competing interests.

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- 431

432 Table 1: the questionnaire used to interview cat owners.

433

Owner details	1) Age:..... 2) Gender: <input type="checkbox"/> male <input type="checkbox"/> female 3) Education: <input type="checkbox"/> degree <input type="checkbox"/> high school <input type="checkbox"/> middle school <input type="checkbox"/> other
Cat details	4) Name:..... 5) Age (in months): 6) Breed:..... <input type="checkbox"/> domestic short or long hair cat 7) Age at adoption (in days): 8) Sexual status: <input type="checkbox"/> entire male <input type="checkbox"/> neutered male <input type="checkbox"/> entire female <input type="checkbox"/> spayed female
Cat environment and management	9) How many people live in the same house where the cat live? 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> other 10) Are there children in the household? <input type="checkbox"/> yes <input type="checkbox"/> no How old are the children? <input type="checkbox"/> 0-1 year old <input type="checkbox"/> 1.5-3 year old <input type="checkbox"/> 3.5-6 year old <input type="checkbox"/> 6.5-9.5 year old <input type="checkbox"/> 10-12 year old 11) Does the cat live with other animals? <input type="checkbox"/> yes <input type="checkbox"/> no a) If yes, which ones? <input type="checkbox"/> cats (n=...) <input type="checkbox"/> dogs (n=...) <input type="checkbox"/> other 12) Where does the cat live? <input type="checkbox"/> strictly indoors <input type="checkbox"/> indoors + outdoors <input type="checkbox"/> strictly outdoors 13) Has the cat a dedicated resting place? <input type="checkbox"/> yes <input type="checkbox"/> no 14) Can the cat access high places in the house (e.g. on the furniture) ? <input type="checkbox"/> yes <input type="checkbox"/> no 15) How many litter-trays are available to the cat/group of cats? <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> other 16) Has the cat free access to food? <input type="checkbox"/> yes <input type="checkbox"/> no If no, how many times per day do you provide food to the cat? <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> other
Cat behavior	17) Does your cat play? <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> little 18) Has your cat displayed any aggressive behaviors? <input type="checkbox"/> yes <input type="checkbox"/> no If yes, what kind of behavior has the cat shown? <input type="checkbox"/> hissing <input type="checkbox"/> scratching <input type="checkbox"/> biting <input type="checkbox"/> other 19) Does the cat defecate at home out of the litter-tray? <input type="checkbox"/> yes <input type="checkbox"/> no 20) Does the cat urinate at home out of the litter-tray? <input type="checkbox"/> yes <input type="checkbox"/> no 21) Does the cat show overgrooming? <input type="checkbox"/> yes <input type="checkbox"/> no

Perception of stress	<p>22) Do you ever notice that your cat is stressed? <input type="checkbox"/> yes <input type="checkbox"/> no</p> <p style="padding-left: 40px;">If yes, how do you understand that your cat is stressed?</p> <p>23) Are there any situations in which your cat is stressed?</p> <p style="text-align: right;"><input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know</p> <p style="padding-left: 40px;">If yes, in which situations is your cat stressed?</p> <p>24) Is your cat stressed in the following situations?</p> <ul style="list-style-type: none"> ✓ Visiting the veterinary clinic <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much is your cat stressed in this situation (1=not at all; 5= very much)? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ When a stranger enters the house <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ In case of loud noises <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ During a thunderstorm <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ When travelling (e.g. by car) <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ In a novel environment <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ If kept in a limited space <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ In contact with animals of other species <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ In contact with other cats of the same sex <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ In contact with other cats regardless of their sex <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ When handled <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ When furniture/decorations are modified <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ If the cat is not allowed to go out when asking <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 <p>25) In your opinion, which of the following are potential signs of stress in the domestic cat:</p> <ul style="list-style-type: none"> ✓ urinating in inappropriate places (out of the litter tray, e.g on the bed, sofa, carpet) <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much stressed is a cat showing this sign (1=not at all; 5= very much)? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ defecating in inappropriate places (out of the litter tray, e.g on the bed, sofa, carpet) <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ trembling <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ hypervocalizing <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5 ✓ recurrent cystitis <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> I don't know <ul style="list-style-type: none"> ▪ If yes, how much? <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4 <input type="checkbox"/>5
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- ✓ overgrooming to baldness ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ not staying in the room with other animals ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ showing dilated pupils (mydriasis) ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ not eating in the presence of other animals ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ scratching the furniture ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ showing ears back ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ having the tail close to the body ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ panting ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ aggressive when scolded ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ staying alone/hiding ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5
- ✓ freezing ☐ yes ☐ no ☐ I don't know
 - If yes, how much? ☐1 ☐2 ☐3 ☐4 ☐5

26) Which definition of stress you believe is the most correct?

- ☐ stress is a short or long alteration of the physical balance of the cat
- ☐ stress is a short or long alteration of the psychological balance of the cat
- ☐ stress is a short alteration of the psycho-physical balance without consequences on the cat
- ☐ stress is a short or long alteration of the psycho-physical balance that can lead to health problems in the cat

27) Which is the level of stress in your own cat?

- ☐ high (the cat is often stressed)
- ☐ medium (the cat is stressed only in specific situations)
- ☐ low (the cat is seldom stressed)

436 Table 2: Results of the Principal Component Analysis on the 1-5 score to the possible signs of
 437 feline stress.

	Component			
	1	2	3	4
Ears back	0.775 ¹	0.173	0.112	0.118
Tail close to body	0.766 ¹	0.124	0.254	
Mydriasis	0.709 ¹	0.299		
Panting	0.609 ¹	0.101	0.267	0.353
Trembling	0.438 ¹		0.303	0.283
Not staying in a room with other animals	0.275	0.725 ²	0.279	0.150
Aggressive when scolded	0.193	0.699 ²		
Not eating in the presence of other animals	0.167	0.628 ²	0.323	
Stay alone/hiding	0.139	0.582 ²		
Faeces in inappropriate place	0.143	0.230	0.894 ³	0.149
Urine in inappropriate place	0.183	0.204	0.889 ³	0.151
Scratching the furniture		0.401		-0.704 ⁴
Recurrent cystitis		0.468	0.172	0.677 ⁴
Overgrooming to baldness	0.230	0.237	0.421	0.624 ⁴
Hypervocalizing	0.364	0.264		0.435 ⁴
Freezing	0.320	0.352		0.427 ⁴

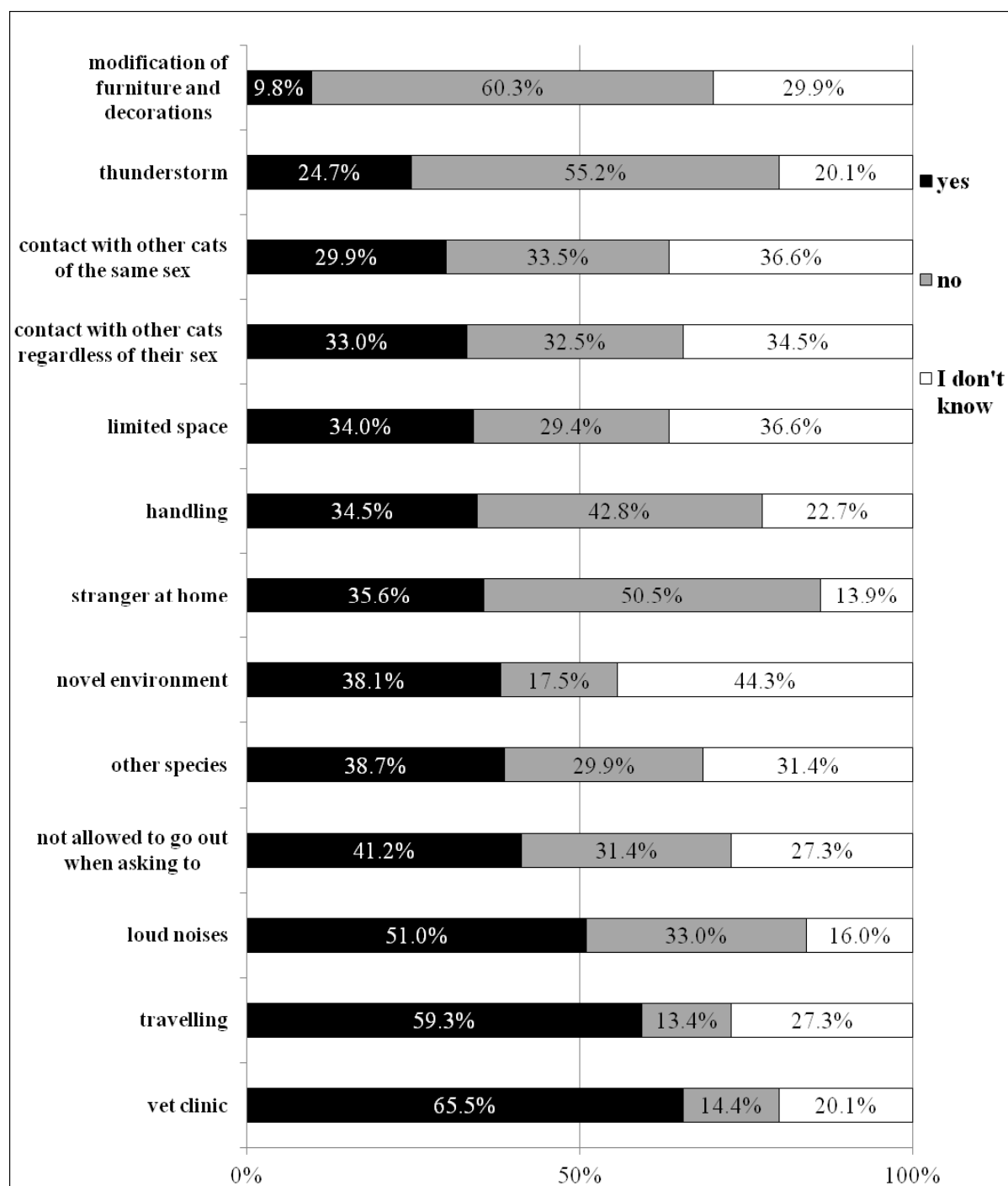
438 ¹=Component 1, named "body posture"; ²= Component 2, named "social avoidance"; ³=
 439 Component 3, named "housesoiling"; ⁴= Component 4, named "self-directed behavior"
 440

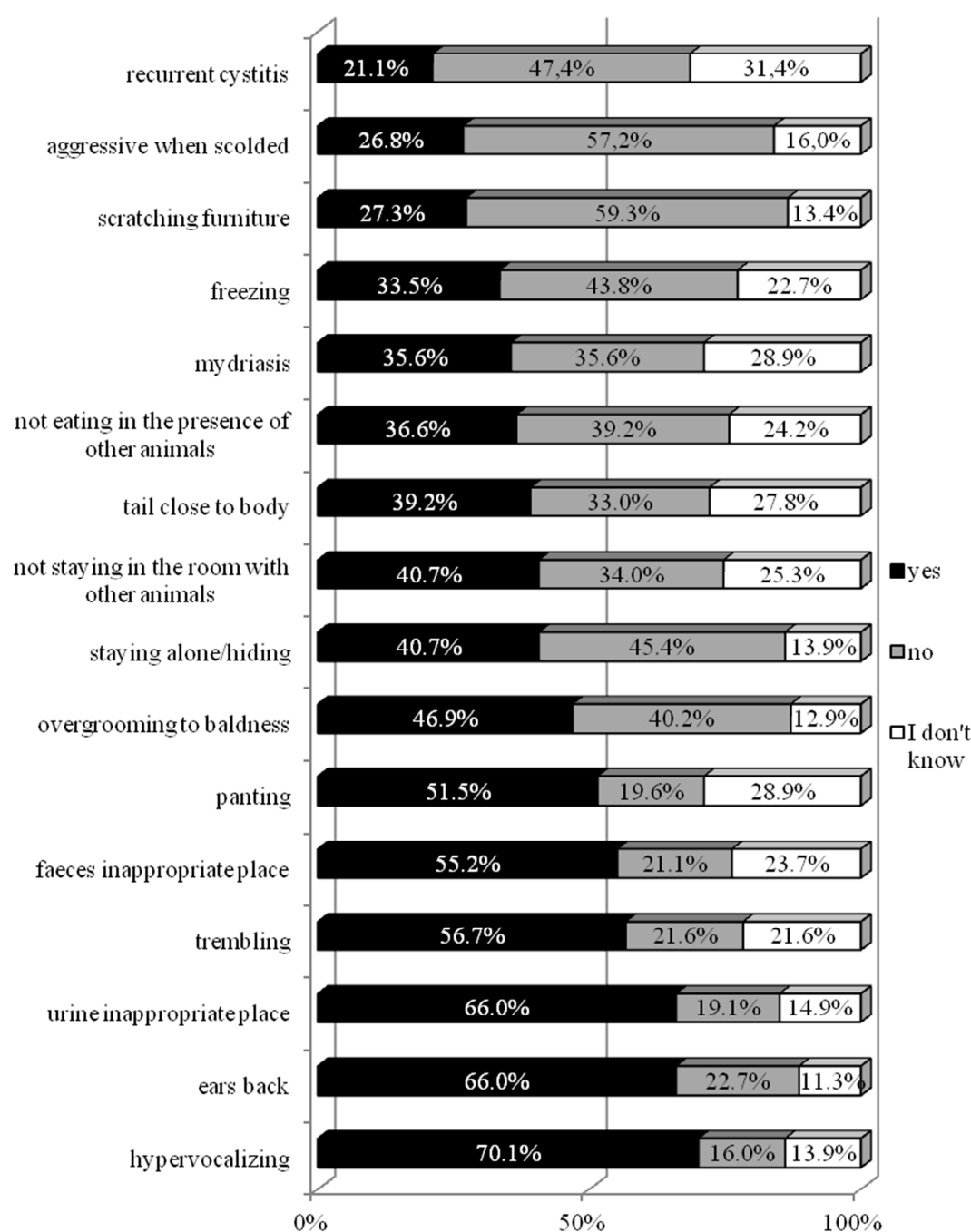
441 Fig. 1: Percentages of owners who answered “yes”, “no” or “I don’t know” to the item “Is this
442 situation stressful for your cat?”.

443

444 Fig. 2: Percentages of owners who answered “yes”, “no” or “I don’t know” to the item “Is this a
445 possible sign of stress in domestic cats?”.

446





Highlights

- Owner perceptions of their pet cat's welfare has been quite neglected in research
- One-hundred-ninety four owners were interviewed about the welfare of their cats
- Owners tend to overlook certain signs of stress regarded as crucial by behaviorists
- The preconceptions owners have about cat normal ethology affects the recognition of stress