Will a hiding box provide stress reduction for shelter cats?

Master research project – Faculty of Veterinary Medicine – Utrecht University

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January 2013 – June 2013

Abstract

It is well described in the literature that cats can experience stress in captivity, especially in case of entering-and stay in animal shelters. The knowledge that the experience of stress can have major impact on the welfare of animals has ensured that researchers tried to find a solution for this potential welfare problem. Promising results were found in the experiments of Kry and Casey (2007) executed in a British animal shelter. These researchers were the first who studied the primary effect of the application of a specific environmental enrichment structure; namely *a hiding box*. As the Dutch situation differs in housing conditions of the shelter cats, the present research had been a derivative of the study of Kry and Casey (2007).

The purpose of present study has been to determine the potential effect of a hiding box on the stress levels of newly arrived cats in a Dutch animal shelter. Our hypothesis was that cats that had the ability to hide in a hiding box would show significantly lower stress levels in comparison to cats that did not had this ability. Therefore, 19 newly arrived shelter cats had been divided into two research groups; namely an experimental group whereby the animals were provided with a hiding box (N=10) and a control group (N=9) whereby the animals had no hiding box in their cage. To determine the stress levels of the research animals, behavioral observations had been done during a 14 day period with the help of the Cat-Stress-Score ethogram, developed by Kessler and Turner (1997).

The outcome of this study was that the two research groups differed significant in the mean Stress Score on observation day 3 and 4, whereby the experimental group showed an overall lower mean Stress Score in time, compared to the control group. Additionally, the mean Stress Score of the experimental group showed minimal variance and decreased much faster over the 14 day observation period, compared to the control group. These findings suggest that cats provided with a hiding box may be more able to cope effectively with a stressful new environment, than the cats without a hiding box. Another important finding was that the control group showed a kind of "replacement hiding activity", which was positioned at the only possibility in the cage, in this case behind the litter box. This alternative behavior was also seen in previous research (Carlstead et al., 1993; Gourkow & Fraser, 2006; Kry & Casey, 2007) and might show that the shelter cats were highly motivated to execute hiding behavior; however, this alternative behavior appeared to be inadequate and less effective compared to hiding in a hiding box in all four studies.

Conclusively, the findings of the present study showed that the hiding box is an important enrichment type for the cat (*Felis silvestris catus*) to cope effectively with stressors in a shelter environment and that hiding behavior may even be classified as a behavioral need for this species.
Further research is needed to study the effect of a hiding box within group housing systems since group housing appears to become a standard in many Dutch animal shelters.

Preface

I have performed this 5 month research project during my Master program, as a part of the Veterinary Medicine study that I follow at Utrecht University, the Netherlands. I have chosen for a research topic that involves both animal behavior and animal welfare. In particular, I wanted to learn more about the behavior of cats. The present research helped me to become more familiar with the behavioral repertoire of cats and their associated emotional status.
Five months before, I had almost no knowledge about scientific research. During this project I learned a lot about the development and implementation of a research project, performing statistical analysis of the collected data and writing of a scientific report.

I would like to thank a number of people for their help during my research project:
At first, I want to give special thanks to both of my supervisors; Dr. C.M. Vinke and Drs. W.J.R. van der Leij; for their enthusiastic encouragement, the valuable meetings and discussions we have had and for their criticism and useful comments on the preliminary pieces of the present report.

I am also very grateful for the assistance of Annemarie Baars (analyst, department DWM) during the preparations of my research project with solving technical problems of the recording equipment and for borrowing me materials that were needed during the observations.

My gratitude also goes to Dr. Kessler for the personal contact we have had and for sending me her studies about cats in animal shelters.

Major thanks are also extended to the employees and volunteers of Animal Rescue Centre Tilburg (DOC-T), who provided me a working place for the data collection of the present study. Their interest and cooperative attitude made this period of my research project very pleasant and successful.

Finally I want to thank the Dutch Society for the Protection of Animals for providing of the hiding boxes that were used during this experiment.

Lotte Godijn

Utrecht, 31 May 2013.

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Introduction

In 2010, the number of pets in the Netherlands was estimated around 29.7 million animals (Werkgroep Feiten en Cijfers, 2011). The owned cat population of 2.9 million animals forms a large part of this total number, with 34% of Dutch households providing a home for an average of 1.7 cats (NVG rapport, 2011, cited in: Werkgroep Feiten en Cijfers, 2011).
Despite this popularity, a large number of cats end up as stray animals or become unwanted and are being relinquished: organizations like the Dutch Society for the Protection of Animals rescue these cats. The number of animals that are being rescued in animal shelters that are part of this Dutch Society is currently estimated to be around 35.000 animals per year (Dierenbescherming Nederland, 2012a).
Bradshaw (1992) and McCune (1992; cited in Kessler & Turner, 1997, p 244) have established that the environment of an animal shelter can contain many *stressors*, particularly for cats. This can mainly be attributed to *the novelty aspects*; many contacts with unfamiliar people, animals and new objects in an unknown environment; all kinds of circumstances that can be very stressful for a cat (Carlstead et al., 1993; Neilson, 2002 and McCune, 1992; cited in Kessler & Turner, 1997, p244).
According to the statistics of the Dutch Society for the Protection of Animals, the number of yearly rescued cats in the Netherlands, unfortunately, is still increasing (Dierenbescherming Nederland, 2012b). This fact emphasis the importance of defining the meaning of the stressors for cats in animal shelters, to have better insight into the consequences for the cats' welfare on the short and on the long term and to find solutions.

First of all, it has to be determined what the term *stress* implies. Stress has been defined by Moberg (2000) as *"a biological response which will be elicited when an individual perceives a threat of its homeostasis*" (p1). The threat in this definition has been called *a stressor* (Moberg, 2000).
Stress, however, is not by definition disadvantageous. In fact, it could actually be very functional for the individual by activating a biological stress response; initiating physiological and behavioral reactions, enabling the animal to cope with the stressors in its environment and preserving homeostasis (Koolhaas & Wiepkema, 1993; McCune, 1992; cited in Ottway & Hawkins, 2003, p174): an active adaptive process that is named *allostasis* (Korte et al., 2005).
Koolhaas and Wiepkema (1993) mentioned that this process, on the long term, also "stimulates learning and memory processes that allow the animal to react more adequately to a similar stressor in the future" (p207). Due to these adaptive functions of *stress*, it is likely that the ability to experience stress could and would eventually guaranty the survival of the species.
Bradshaw (1992), Koolhaas and Wiepkema (1993) and Broom and Johnson (1993) described that stress becomes a problem when a stressor cannot be dominated by the particular individual.
This situation could lead to a pathological condition that is characterized by a prolonged activation of physiological stress mechanisms and the associated biological costs, called *distress* or *chronic stress* (Koolhaas & Wiepkema, 1993; Moberg, 2000). Consequently, the well-being of the animal will be threatened (Koolhaas & Wiepkema, 1993; Moberg, 2000).

Being free of chronic stress is one of the five freedoms that have been estimated by the Brambell-committee in 1965 (Brambell Committee, 1965; cited in Ohl & Van der Staay, 2012, p14).
According to this commission, all five freedoms are considered to be essential to preserve animal welfare. The present opinion about animal welfare of the faculty of veterinary medicine (Utrecht, Netherlands) has been defined as follows: "*an individual is in a state of welfare when it is able to adapt itself to its living conditions and could achieve a state that is experienced as positive"* (Ohl & Hellebrekers, 2009, p754).
A general definition, however, does not regard to individual differences, therefore, some aspects of importance urge to be highlighted: firstly, the individual capability should be mentioned and the

differences in capability between individuals to adapt themselves to certain living conditions; *coping* (Broom & Johnson, 1993; Wechsler, 1995); secondly, this adaptability of an animal will be determined by a variety of factors, including the animal's *perception* (Levine, 2008).
Perception is being formed by the intermingled influences of genetics, individual life history, physiologic state and the context the animal is living in (Beerda et al., 1999; Koolhaas et al., 1999; Levine, 2008; Moberg, 2000). An example of the influence of the individual life history is presented by Dybdall et al. (2007), who estimated with the help of behavioural parameters that cats surrendered by their owners experienced greater stress levels after entering a shelter environment than stray animals, from which can be concluded that previous experiences influence "the neuro-psychobiologic development" of the animal (Levine, 2008, p 1068) and hereby influence the perception of the animal in a new environment (like an animal shelter) which indirectly determines its coping ability (see also: Beerda et al., 1999; Moberg, 2000; Ohl & van der Staay, 2012).
Beerda et al. (1999) determined in their research that the circumstances wherein an animal finds itself in; *the context*, may influence the perception and thereby the physiological response as a reaction to a potential stressor: a group of dogs that were subjected to a period of social and spatial restriction under bad weather conditions, showed lower stress response than another group of dogs which were subjected to the same restrictions, but under pleasant weather conditions. This shows that a previous bad experience could make a following stressor of less relevance for the animal, due to the small contrast between the two negative stimuli.
Summarized; its important in the assessment of animal welfare, that the influence of *the context* and *the individual life history* of the animal on its perception and coping ability are always taken into account. However, practice shows that the individual life history of most stray animals entering an animal shelter is unknown and assessment of animal welfare, unfortunately, has to be done without this information. The fact that each particular animal may react differently upon arrival can though be explained now by above mentioned aspects.

As mentioned before, does the experience of chronic stress manifests itself by behavioral (-and physiological) responses in answer to a stress-inducing stimulus or situation, but without a sufficient result reducing the stressor. In this perspective, the reactions can be interpreted as maladaptive. Mostly, cats will react to stressors with apathetic behavior (McCune, 1992 and Rochlitz, 1997; both cited in Rochlitz, 1999, p 2 and in Rochlitz, 2000, p 214), *learned helplessness* (Bradshaw, 1992); the animals show reduced activity and natural behaviors such as "play behavior, active exploration and self-maintenance (e.g. feeding, grooming) are inhibited" (McCune, 1992 and Rochlitz, 1997; both cited in Rochlitz, 1999, p 2 and in Rochlitz, 2000, p 214) and the animal seems to have lack of interest in its external environment (Broom & Johnson, 1993; Rochlitz et al., 1998). Next to inhibition of behavior patterns in reaction to stressors, deprivation of environmental stimuli could also disable the animal to perform natural (adaptive) behavior (Bradshaw, 1992; Carlstead et al., 1993). In the case of long term deprivation to express natural behavior specific for the species*; behavioral priorities*, this could also be stressful for the animal (Bracke & Hopster, 2006; Koolhaas & Wiepkema, 1993).
Behavioral disorders in cats, although less frequently seen, could also develop during to chronic stress. These disorders include for instance stereotypes, Obsessive Compulsive Disorder (OCD's) like compulsive licking (over-grooming) and extreme defensive or aggressive behavior (Bradshaw, 1992; Koolhaas & Wiepkema, 1993; Overall & Dunham, 2002; Wechsler, 1995).
These types of pathological behaviors are signals of maladaptivity (in the past and/or at present) and serve as indicators of poor animal welfare (Bradshaw, 1992; Broom & Johnson, 1993; Koolhaas &Wiepkema, 1993).
Besides the behavioral consequences, chronic stress also affects the animal's stress physiology (e.g. cortisol) with consequences for the animals' health by suppressing the immune system (Griffin, 1989; Koolhaas & Wiepkema, 1993). During a period of chronic stress a situation of physiological imbalance develops; "the costs of prolonged activation of the neuroendocrine pathway exceeds the biological reserves, resulting in impaired functioning of other biological processes (e.g. immunity) by shifting away important requirements, like glycogen" (Moberg, 2000).

Immunodeficiency increases the animal's susceptibility to infectious diseases with the risk for outbreaks within the animal shelter (Griffin, 1989; Speakman, 2005; Tanaka et al., 2012). These finding indicates that besides the effect on animal welfare, stress reduction could also play an important role in the prevention of infectious diseases in an animal shelter.

Ellis (2009) mentioned that environmental enrichment was described by previous researchers as a possible intervention which can "improve the behavioral environment of captive animals" (Ellis, 2009, p901) and so improve their welfare. There are many different types of environmental enrichment; the *provision of structures* is one example that may be a useful method for the cat, whereby the animal is able to perform species specific behavioral patterns for which it's highly motivated and otherwise giving the animal the opportunity to control its exposure to the environment (Ellis, 2009). Since controllability is supposed to be an important factor for animals to deal with stress (Koolhaas & Wiepkema, 1993), the provision of structures can potentially increase the possibilities to cope with novelty and other stressful aspects in the shelter environment.
A type of enrichment structure that has been studied previously in the domestic cats is *hiding enrichment*. Results of Carlstead et al. (1993) showed that the cats that were exposed to stressors increased their attempts to hide in frequency. This study also showed that the ability to hide behind something was negatively correlated with the concentration of cortisol in the urine of the cats; the concentration of cortisol in the animal's urine decreased when it was able to hide (Carlstead et al., 1993). In this research is suggested that hiding seems to be an important coping strategy for cats which are exposed to stress, by providing a situation in which the animal is able to control its environment. Results of Gourkow and Fraser (2006) and Rochlitz et al. (1998) support this tentative conclusion; Gourkow and Fraser (2006) found that animals not provided with hiding enrichment, still made effort to hide, by turning their litter box upside down, creating an alternative hiding place, a type of behavior that has also been seen by Carlstead et al. (1993) and Kry and Casey (2007) in their study. This supports the fact that the animals were highly motivated to perform this type of behavior. In the study of Rochlitz et al. (1998) it was found that the experimental cats spent most of their time hidden in their hiding box during the first two weeks after being housed in the novel environment. The urine cortisol creatinine ratio and the time spent hiding by the cats in this study gradually decreased during the observation time, implying that the provision of the hiding box was being used by the animals to adapt to the environment.

Due to the supposed importance mentioned before and the promising suggestions of previous researches, further investigation of enrichment that allows performance of hiding behavior and subsequently research to the effect of this on animal welfare, has become a topic of interest for the present study. An example of *hiding enrichment* in practice is the originally in Canada designed hiding box (BC ASPCA Hide and Perch box®) and a variant of this box, which has been developed by the Dutch Society for the Protection of Animals.
Kry and Casey (2007) are one of the first researchers who studied the primary effect of a hiding box in Great Britain, with the help of behavioral and postural parameters listed in the Cat-Stress-Score ethogram (Kessler & Turner, 1997). They concluded that the welfare of the cats provided with a hiding box in their cage, as determined on the basis of the stress score level (Kessler & Turner, 1997), turned out to be much better in contrast to the group of cats which were not provided with a hiding box (higher stress values). Despite this positive result, the hiding box has only been used in a few animal shelters in the Netherlands yet. The main argument against the hiding box had been presented in the study of Kry and Casey (2007, p376); "the visibility of the cat to potential adopters will be limited when the cat will hide in its hiding box and it is believed that this lack of visibility will reduce the animal's chances for adoption". Kry and Casey (2007), however, described that in the study of Loveridge et al. (1995), cats that had increased coping capacity towards stressors (for example by providing hiding enrichment) seemed to be more extroverted and friendlier.

The study of Gourkow and Fraser (2006) supported this suggestion as they found lower stress levels in the cats that showed these types of behavioral characteristics. It seems obvious that these characteristics will give the animal's better potentials for adoption which was also suggested by Gourkow and Fraser (2006), Kry and Casey (2007) and Turner (2000). Subsequently, Kry and Casey (2007) found no significant difference in adoption rate-or number between their two research groups (with and without a hiding box).
Unfortunately, above mentioned arguments and promising results about the effect of the hiding box on animal welfare, could not be extrapolated to the Dutch animal shelter systems for cats. This is due to the big differences in housing conditions for the animals between the shelters in Great Britain and in the Netherlands. For example: the experimental cats in the study of Kry and Casey (2007) did have access to an individual indoor and outdoor cage, instead of the average quarantine conditions in the Netherlands, which consists of an individual indoor cage with dimensions around 65 x 65 x 65 cm (length x width x height).Therefore this study presents research comparable with the study of Kry and Casey (2007), but in a Dutch animal shelter situation.

The purpose of present study was to determine the potential effects of a hiding box on the stress level of newly arrived cats, conform the study of Kry and Casey (2007), in a Dutch animal shelters situation. It was hypothesized that newly arrived cats housed in Dutch animal shelters which are able to hide in a hiding box will have significantly lower stress levels, in comparison to cats that don't have the ability to hide, as based on the results of the available literature (Carlstead et al., 1993; Gourkow & Fraser, 2006; Kry & Casey, 2007, Rochlitz et al., 1998).

Material and methods

NB: The experimental animals of the present study where handled following the normal procedures of the animal shelter: no adjustments to the caretaking of the animals or to the living conditions were made, except the addition of a hiding box and the extra number of towels. In consultation with the Article 14 functionary of the faculty of Veterinary Medicine (Utrecht, The Netherlands), it was decided that no DEC-statement was needed for the present research.

Research animals

For this study, the stress levels of 19 European short hair shelter cats, between 1 and 10 years of age, either housed with or without hiding box, were observed with the help of a Cat-Stress-Score ethogram developed by Kessler and Turner (1997) in order to detect differences in stress-induced behavior patterns. Most subjected cats were stray animals from origin and they arrived at the shelter either by animal ambulance or were brought in by private people or employees of the stray cat workgroup in Tilburg, the Netherlands. Two of the experimental animals had an owner, but were relinquished because the owner had passed away and the relatives could not take care of the animals.

Upon arrival at the animal shelter, three selection criteria determined if a newly arrived animal could participate in the present study:
(1) Breed: only European short hair cats were chosen as research subjects.
(2) Sex: earlier studies on other species showed that females are expected to be more sensitive to stressors than males (dogs: Beerda, 1999; rats: Bangasser et al., 2010). Therefore, this study focused in first instance on female cats. However, the number of new animals taken in by the shelter was less than expected. After two weeks of observing it was decided to use animals of both sexes based on the findings of Kessler and Turner (1997) and Kry and Casey (2007) who both did not find any statistically significant differences in results between cats of different sexes.
(3) Age: the cats were in the range of 1 and 10 years of age. Hence, exceptional old or young animals were excluded. The shelter veterinarian estimated the age of the stray animals by examining the teeth and overall body condition.
The life history of most subjects in this study was unknown due to their stray background, so no selection based on individual life history of the animal has been done.
The subjected animals were randomly allocated to two research groups; a group provided with a hiding box; named *the experimental group*, and a second research group without a hiding box; named *the control group*.

Research conditions

The behavioral observations took place at an animal shelter in Tilburg, the Netherlands, called *Animal Rescue Centre-Tilburg* (DOC-T) which is run by the Diamant-group: a company that provides social work places for people with physiological or physical disabilities or who have distance to the labor market.

Housing conditions of the animals

The research animals were solitary housed under standard shelter conditions in cages situated in two similar quarantine rooms. A small room separated these two quarantine rooms from each other and from the hallway (see figure 6), whereby all forms of contact with other employees, the public and dogs was prevented. Only the observer and the employee who took care of the cats in the quarantine room had access to the animals, for all other people the door had been locked during the whole observation period. All cages were made of stainless steel with a door consisting of vertical and horizontal bars at the front side, placed to one side of the room, so the cats did not have visual contact with each other.

Each cage [L x W x H: 70 x 74 x 72 cm] included a water dish, a food dish, three towels, a litter tray and a shelf [L x W: 25 x 74 cm] on 35 cm height (see figure 1). As a standard management in the

animal shelter, each cage was provided with a towel. For the experimental conditions, however, it was decided to provide both groups (with and without a hiding box) three towels: on the shelf, on the lasting free part of the cage and for the group with a hiding box the third towel was placed inside the hiding box. The quarantine room had natural day light through a roof window of approximately 60 cm x 60 cm (L x W) and with an artificial light bar which was on between 0800h and 1700h.
The ambient temperature of the quarantine room was not automatically but manually regulated with the aid of a radiator and the possibility to open the roof window.

Nutrition, medical treatment and cleaning proceedings
On Monday, Tuesday, Thursday and Friday a permanent employee took care of the animals in the quarantine room. On Wednesdays and in the weekend other employees took care of the cats.
The manager of the shelter did strive for the same employees on these days as much as possible.
(1) Nutrition of the animals: the experimental cats were fed with regular dry cat food (Prince Vital Care Resist®) twice daily: between 0900h and 0930h and between 1300h and 1330h. Fresh water was provided in a water dish also twice daily.
(2) Medical treatment: the animals that needed medical treatment, received their medicines before the animals were fed.
(3) Cleaning proceedings: the cages of the animals were once daily cleaned (according to a cleaning protocol) in the morning after feeding between 0930h and 1300h. During cleaning the animals were put in a cat travel basket and after cleaning they were placed back into their cages.

The hiding box (the independent variable)
The kennels of the experimental group contained a hiding box supplied by the Dutch Society for the Protection of Animals (see figure 3), which is almost similar to the BC SPCA Hide and Perch® box (Canada). The hiding box is made of cardboard and consists of a hiding place [L x W x H: 39 x 30 x 26 cm] with two possible entrances on two sides of the box. In contrast to the BC SPCA Hide and Perch® box, the hiding box supplied by the Dutch Society for the Protection of Animals provides no perching area (see figures 2 and 3). Before the animals of the experimental group entered their new housing, the hiding box had been placed at the (for the viewer) right back of the cage (see figure 2).


Figure 1


Figure 2


Figure 3

Research procedures
Behavioral observations
All cats were given an adjustment period of 24 hours before the behavioral observations started; named *day 1*, conform the method of Kry and Casey (2007). This period had been chosen by previous researchers as Kessler and Turner (1997) suggested that: "a minimum of two hours adjustment is required for Cat Stress Scores to be achieved" (cited in: Kry & Casey, 2007, pp376-377).
The behavioral observations took place after 1400h so there were no interferences with the daily cleaning and feeding procedures (all before 1330h). The observations were performed with the aid of a video camera (H.264 DVR), see figure 4. The observer scored the cat's stress level at the same time

the images were recorded, on a remote screen in the middle room between the two quarantine rooms (see figure 5 and 6). After the video camera was rightly positioned, a period of two minutes was maintained before the observation started in order to give the cat a chance accustom to the presence of the recording equipment in front of its cage. All of the behavioral observations were done by the same observer.

Figure 4

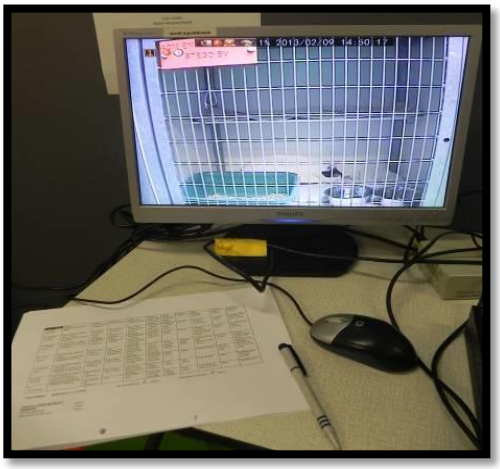

Figure 5

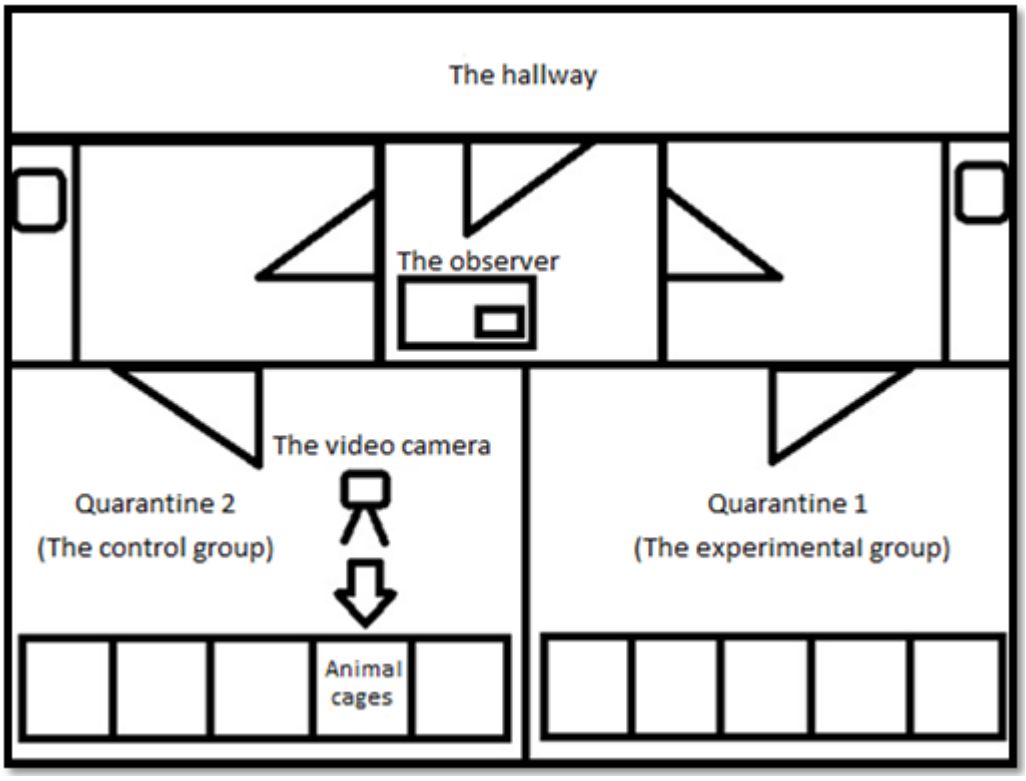

Figure 6

The Cat-Stress-Score Ethogram

During the behavioral observations, the Cat-Stress-Score ethogram developed by Kessler and Turner (1997) had been used (see appendix 1). This Stress Score represents a non-invasive method to assess the stress level of an individual cat, making use of its body posture and activity level.

The ethogram consists of seven potential stress levels whereby the minimal Stress Score 1 is defined as 'fully relaxed' and the maximal Stress Score 7 as 'terrorized' (Kessler & Turner, 1997).

The individual Stress Score levels are based on 11 components: body, belly, legs, tail, head, eyes, pupils, ears, whiskers, vocalization and activity (Kessler & Turner, 1997). Kessler and Turner (1997) based the descriptions of the components within their Cat-Stress-Score ethogram on the ethogram developed by the UK Cat Behavior Working Group in 1995 (see appendix 2).
For ratings with comparable descriptions, the observer scored the concerning component based on the median of the other components (e.g. the rating for the component 'whiskers' is described as 'lateral or forward' for scores 2, 3 and 4. If the median of the other scores was 3, subsequently score 3 was given for the component 'whiskers'.). If the frequency of two scores were equal (e.g. the median is between 2 and 3), the lowest score had been given for the component (e.g. score 2).
During the preliminary observations it turned out that if vocalization occurred it could not accurately be determined with the aid of the video camera which animal did vocalize; the animal that was being observed or any other animal in the quarantine room, consequently the component 'vocalization' was excluded from the ethogram for the experimental observations and 10 components remained (*body, belly, legs, tail, head, eyes, pupils, ears, whiskers and activity*).

To minimalize the *observer drift* and the *observer bias* (Lehner, 1998) definitions for behaviors and postures within the Cat-Stress-Score ethogram (Kessler & Turner, 1997) which has been set up by the UK Cat Behavior Working Group in 1995 (see appendix 2), were maintained and trained intensively by the observer. Definitions had also been set up by the observer for scoring of the time management. Beforehand, preliminary observations were done to further improve the *intra-observer reliability* (Lehner, 1998). The *inter-observer reliability* (Lehner, 1998) had not been tested, since all observations were done by the same observer.

The observations of each cat took place between 1400 and 1700h. The animals were observed six times, namely at day 1, 2, 3, 4, 5 and day 14 conform method Kry and Casey (2007).
During this study *focal animals* have been observed with the help of a *scan sampling* method (Lehner, 1998) whereby the whole stress index was scored four times for each individual cat during a 20 minutes observation period (sampling: 1: 5min, 2: 10min, 3: 15min, 4: 20min). If some of the components could not be scored, because they were out of sight (e.g. if the animal was lying with his head directed to the closed corner of its hiding box) or if a detailed component could not be captured by the video camera (e.g. pupil size), they were noted as *missing values*.

The time budget and place preference
In the cage, the cats could either stay [1] *on the shelf*, [2] *in the hiding box* (only applies to the experimental group), [3] or *elsewhere*. The time spent in each part of the cage was noted and expressed as a percentage of the total observation time (i.e. 20 minutes).
Making use of part [1] and [2] has been defined as: *the animal has more than two paws or more than 50% of its total body on that part of the cage.* If the animal was on a place in the cage that did not cover this definition, the time budget had been scored as *elsewhere* [3].
The first purpose of this differentiation in time budget was to register the amount of time the animals spend in their hiding box, to differentiate between the potential functions of a hiding box (e.g. a hiding place or an attractive or pleasant place to sleep or to lie on). Next to this, it could also be determined if the animals would have a difference in preference between hiding enrichment and an elevated area like a shelf, or that these two enrichment types do not meet the wishes of the animal at all (which could possibly be the conclusion if the animal spends the most of its time *elsewhere*).
For the control group [3] *elsewhere* was divided into two subgroups: lying *behind their litter box* [3a] or *somewhere else* in their cage [3b]. Lying behind the litter box has been defined in the same way as mentioned for the other places: *the animal has more than two paws or more than 50% of its total body on that part of the cage.* The purpose for this differentiation was to find out if these animals would still try to hide despite the fact that there was no hiding box in their cage, since in previous studies (Carlstead et al., 1993; Gourkow & Fraser, 2006; Kry & Casey, 2007) *alternative hiding activity* has been seen in absence of proper hiding enrichment.

Data collection
The data of the behavioral observation were stored in two separate Excel files (Microsoft Office Excel® version 2003); one Excel file per research group. The daily Cat-Stress-Scores (sampling: 1: 5 min., 2: 10 min., 3: 15 min., 4: 20 min) of all cats within one group were collected in a matrix (one matrix per group, per observation day); all 10 components (e.g. body, belly) were 7 times repeatedly noted (for stress score levels 1-7) along the horizontal axis, the research animals were listed along the vertical axis. The score that the observer had given to a particular component according to the Cat-Stress-Score ethogram (Kessler & Turner, 1997) was expressed as 1 (scored) in the Excel file; all the other scores for that component were expressed as 0 (not scored) for that sampling.
The collected Stress Scores of all 10 components were averaged to get *a mean stress score of the individual cat per sampling*. Subsequently, the four samplings (sampling: 1: 5min, 2: 10min, 3: 15min, 4: 20min) of one day were averaged to generate a *mean daily Stress Score per cat*.
Individual cat information; age, weight and sex was also listed in the Excel file.
During the behavioral observations, the time management of the animals was noted in another Excel file. The daily amount of time (in minutes) spent in each part of the cage was filled into the cells and subsequently converted to a daily percentage of the total observation time (i.e. 20 minutes).
The daily time budgets of all animals within one research group were averaged to get *a mean daily time budget* per group. Subsequently, the mean daily time budgets of one research group on the six observation days were averaged to get *a mean time budget of the total observation period* per group.

The ambient temperature during the observations had been noted as it has been described by Kessler and Turner (1997) that the Cat-Stress-Score ethogram should not be applied when the temperature drops below 15°C.

Finally, it was also noted if the animals received any medical treatment or not, because certain types of medical treatment (e.g. ears ointment or eye drops) require handling of the animal. Hereby could be determined if there would be any correlation between medical treatment and mean Cat-Stress-Score.

Data analysis
The data analysis had been done with the aid of SPSS (IBM SPSS Statistics, version 20).
Descriptive statistics were used to process the following collected data; the distribution of the mean age, weight and sex of the animals; the ambient temperature during the observations; the time management of the cats in their cage; the mean Stress Scores of the two research groups in time and the frequency of occurrence for each Stress Score within the two research groups.
Spearman's Rho correlations were used to test for potential correlations between the age; weight; sex and (possible) medical treatment of the animals and the daily mean Cat Stress Score per cat.
To examine if the daily mean cat Stress Scores of the two research groups differ significantly from each other, the Mann-Whitney U test had been used. The Friedman test and post hoc Wilcoxon Signed Ranks tests were used to examine for significant differences in mean Cat Stress Scores in time between couples of two days within one research group. All of these *inferential statistics* were two tailed performed. Because multiple tests had been performed over the same groups of animals, preferably, all results were Bonferroni corrected to exclude a type I error.

Results

Ambient temperature
The mean ambient temperature in the quarantine room of the experimental group was 19.1 °C (± 0.36 SD) and for the control group it was 19.6 °C (± 0.39 SD). The ambient temperature of the two quarantine rooms did not drop below 15°C during the observation period.

Experimental animals
The experimental group included ten animals; eight females and two males. The age of the animals within this group ranged between 12 and 84 months (mean age: 24.1 month's ± SD 22.2; median 18.0). Nine animals, including five females and four males, formed the control group. The age of the animals within this group ranged between 18 and 72 months (mean age: 39.3 months ± SD 19.9; median 36.0).

Non-normal distribution
A Kolmogorov-Smirnova test was performed on the *mean daily Stress Scores* of the animals in both research groups to control for normal distribution. This statistical test showed that the mean daily Stress Score data of both groups were not normally distributed (experimental group: D (57) = 0.30, $p < 0.01$, N=10 / control group: D (53) = 0.15, $p < 0.01$, N=9).
The *mean Stress Score frequencies* of the animals in both research groups were also controlled for normal distribution with the aid of the Kolmogorov-Smirnova test and also for this data; non-normal distributions were found (experimental group: D (70) = 0.32, $p < 0.01$, N=10 / control group: D (63) = 0.29, $p < 0.01$, N=9).
Due to non-normal distribution of the both data sets and the relative small sample size ($N_{1,2}$=10, 9) non-parametric statistics were used for further analysis.

Correlations
A Spearman's rho test had been carried out to control for correlations between mean daily Stress Scores per cat and age; weight; sex and medical treatment of the animals respectively.
The Spearman's rho test showed no correlations for each of the mentioned independent variables, whereby a Bonferroni correction had been applied considering $p < 0.0083$ as significant.
Consequently, the data of all cats within one group were combined.

The mean Cat Stress Score
In figure 7 the differences in mean Cat Stress Score between the two research groups has been presented on each observation day (day 1-5, and day 14). A Mann Whitney U test was performed to evaluate significant differences in mean Cat Stress Score between the two groups.
The two groups differed significantly on observation day 3 (U = 7.5, z = -3.2, $p < 0.01$, $N_{1,2}$=10, 9) and on observation day 4 (U = 10.0, z = -2.8, $p < 0.01$, $N_{1,2}$=9, 9). These results were Bonferroni corrected whereby $p < 0.0083$ was considered as significant.

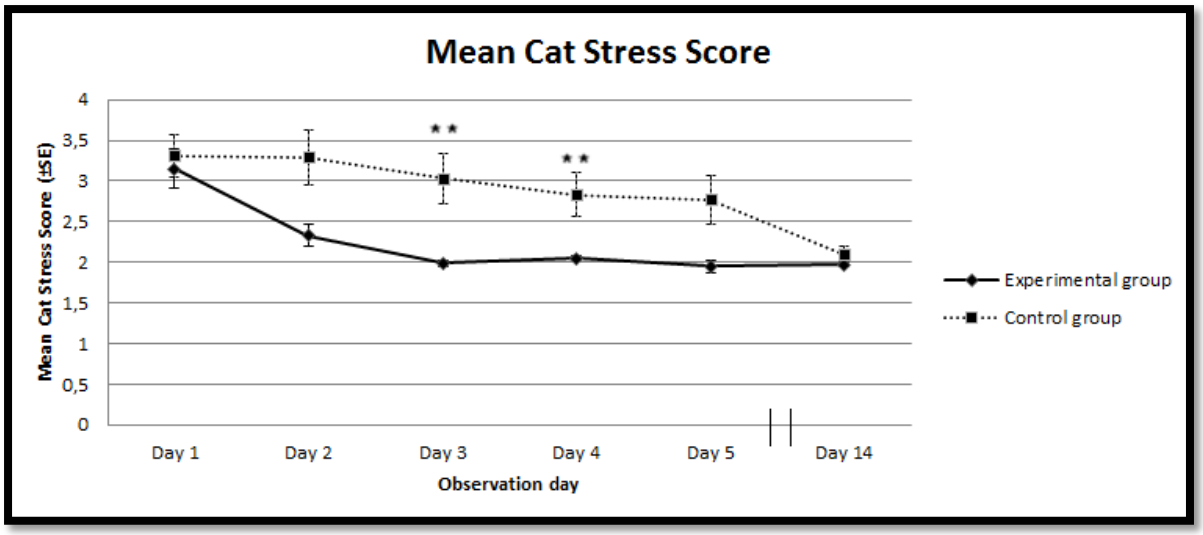

Figure 7: Mean Stress Scores (± SE) of the experimental group and the control group on each observation day (i.e. day 1-5 and day 14) (* *significant $p < 0.01$, Bonferroni corrected).

In figure 7 it can also be seen that there is a difference between the two research groups in extent of the standard error of the mean Cat-Stress-Score. The standard error of the experimental group greatly decreased till almost zero on day 3 (0.04), 4 (0.03) and 5 (0.08), in opposite of the control group where relatively larger standard errors were found (day 1: 0.26, 2: 0.34, 3: 0.31, 4:0.27, resp. 5: 0.30) until observation day 14 (0.09). These trends can also be seen in the boxplot representation of the median with interquartile ranges (figure 8, 9 and 10).
To control for outliers, a graph of the median Cat Stress Score had been made with the corresponding interquartile (see figure 11). This graph also shows the existence of large differences between the two groups in extent of the interquartile and confirms that this result is not being influenced by outliers. From these results can be concluded that the experimental animals; provided with a hiding box, showed less variability around the mean; representing uniformity in their reactions.

An overall decrease in the mean Stress Score for both groups between observation day 1 and day 14 can be seen in figure 7. To detect significant differences in time, the mean Stress Scores of the two research groups over the multiple observation days were tested.
A Friedman test had been used, showing an overall significant difference in the mean Stress Score over the six observation days for both groups (experimental group: $X^2(5) = 31.8$, $p < 0.01$, N=9; control group: $X^2(5) = 27.0$ $p < 0.01$, N=8). Subsequently, a post-hoc analysis was done with Wilcoxon signed-rank tests.
In the experimental group, a significant change in the mean Stress Score had been found between observation day 1 and all of the other observation days; 2($z = -2.8$, $p = 0.005$), 3($z = -2.8$, $p = 0.005$), 4($z = -2.7$, $p = 0.008$), 5($z = -2.7$, $p = 0.008$) and 14($z = -2.7$, $p = 0.008$). A significant change in the mean Stress Score had also been found between observation day 2 and all of the other observation days; 1($z = -2.8$, $p = 0.005$), 3($z = -2.4$, $p = 0.018$), 4($z = -2.0$, $p = 0.043$), 5($z = -2.1$, $p = 0.036$) and 14($z = -2.4$, $p = 0.018$). From observation day 3 on no significant changes could be found in the experimental group.
In the control group, a significant change in mean Stress Score could be found between day 1 and all of the other observation days, except from observation day 2; 3($z = -2.5$, $p = 0.01$), 4($z = -2.5$, $p = 0.01$), 5 ($z = -2.7$, $p = 0.008$) and 14($z = -2.5$, $p = 0.01$). A significant change in the mean Stress Score had also been found between observation day 2 and 14; ($z = -2.5$, $p = 0.01$), between observation day 3 and 5; ($z = -2.4$, $p = 0.02$), between observation day 3 and 14($z = -2.4$, $p = 0.02$) and between observation day 4 and 14($z = -2.5$, $p = 0.01$).
Using the preferred Bonferroni correction for multiple testing, however, no significant changes could be found after correction ($p = (0.05/15)$ 0.003) for both research groups.

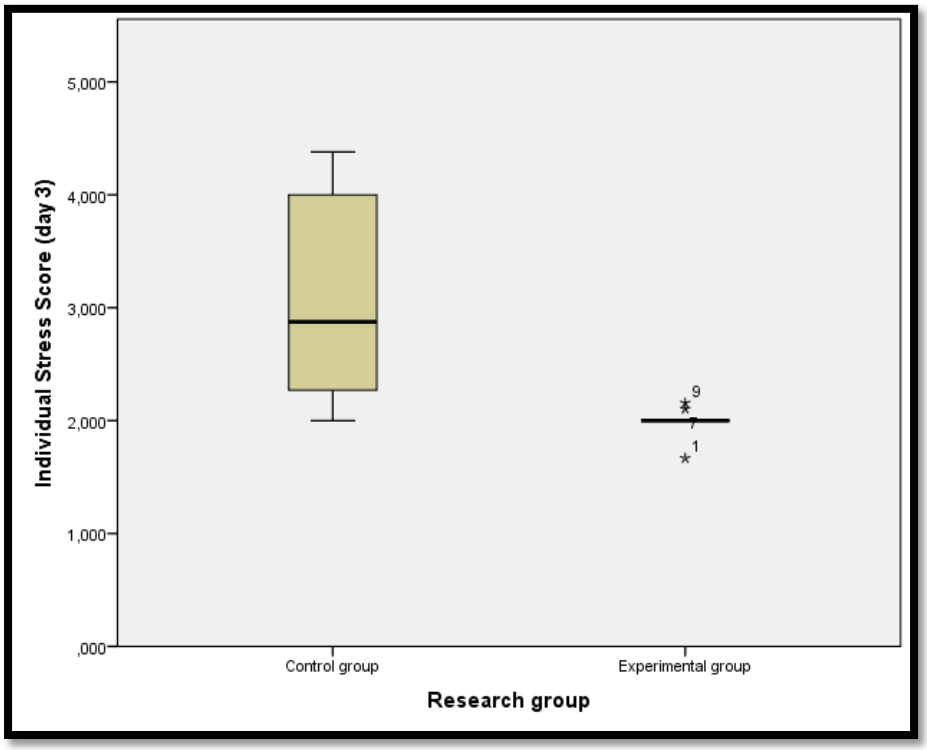

Figure 8: Boxplots with median and interquartile ranges of the individual Stress Scores of the cats in both research groups; the experimental- and the control group, on observation day 3.

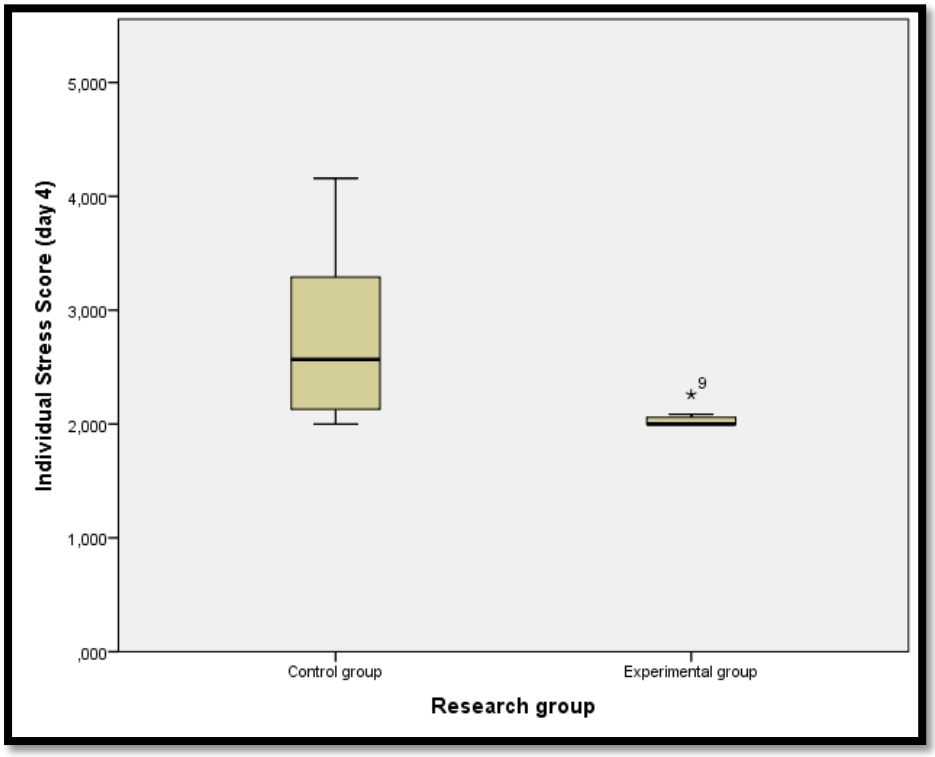

Figure 9: Boxplots with median and interquartile ranges of the individual Stress Scores of the cats in both research groups; the experimental- and the control group, on observation day 4.

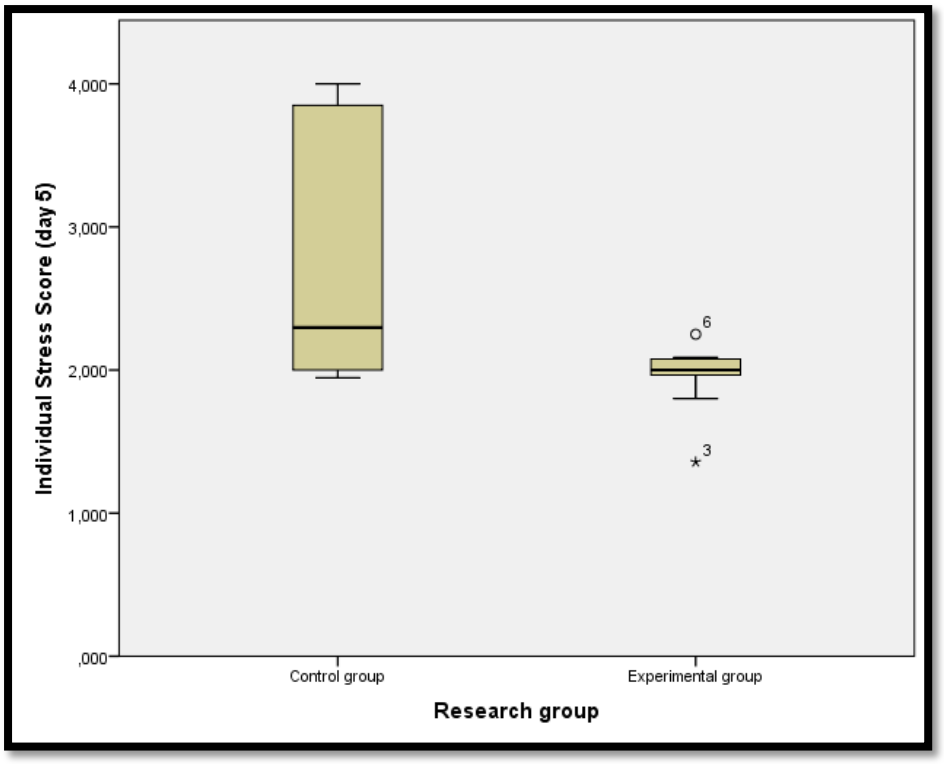

Figure 10: Boxplots with median and interquartile ranges of the individual Stress Scores of the cats in both research groups; the experimental- and the control group, on observation day 5.

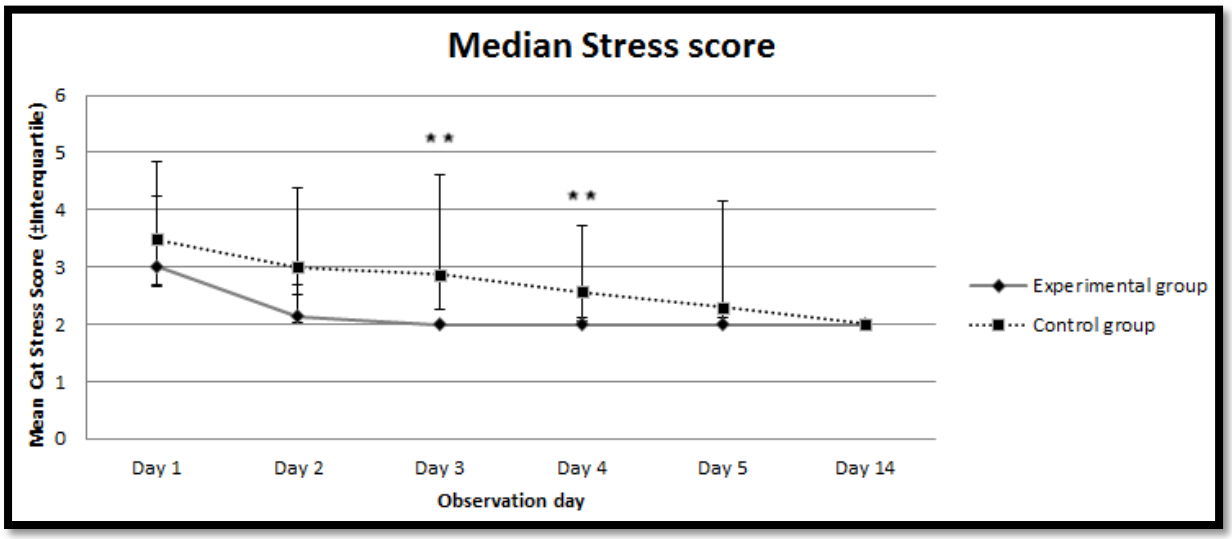

Figure 11: Median Stress Score (± interquartile) of the cats in both research groups; the experimental- and the control group, on each observation day (* *significant: $p < 0.01$; Bonferroni corrected).

Figure 12 shows the distribution of mean occurrence of all individual Stress Score categories (1-7) during the observations expressed in percentages. The Stress Score categories with the highest frequency were the scores 2, 3 and 4; together, they covered 98% of the total scores that were given in the experimental group. For the control group this was 95% of the total scores. Stress Score 6 was found exclusively in the control group, consistent with only 1.5% of the scores given in this group. For both groups, Stress Score 7 has not been scored during the observations.
A Mann-Whitney U test had been applied to look for significant differences in occurrence of Stress Score categories between the two research groups. A significant difference between the groups with

and without a hiding box was found for Stress Score 2 (U = 15.0, z =-2.4, $p < 0.05$, $N_{1,2}$=10, 9). However, after application of the Bonferroni correction, no significant differences could be found anymore (p = (0.05/7) 0.007).

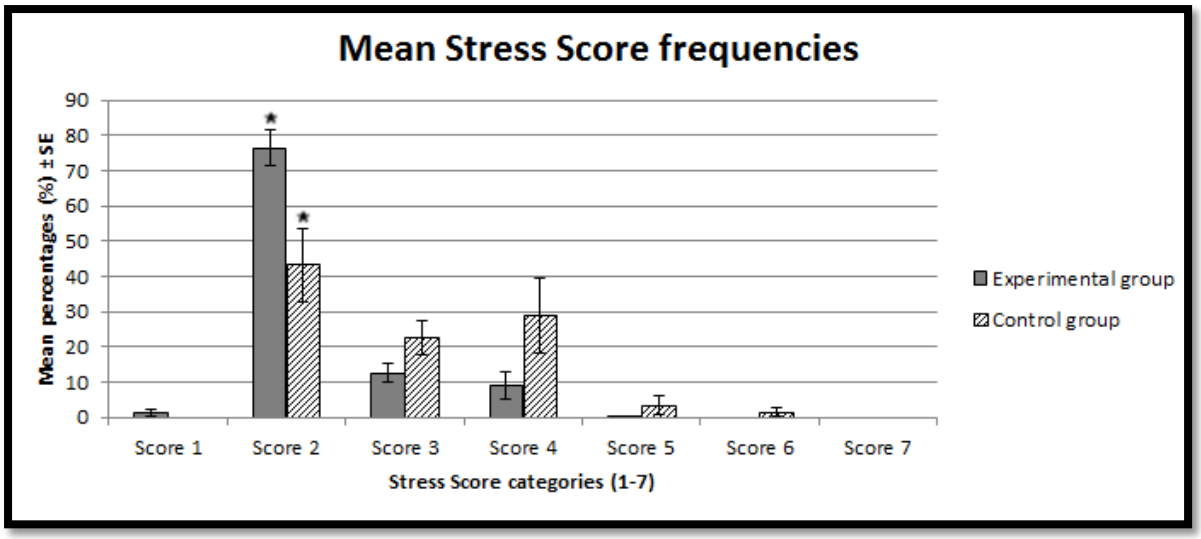

Figure 12: The mean frequencies of each Stress Score category (in percentages ± SE) for the two research groups; the experimental- and the control group (* significant: $p < 0.05$).

The time budget

In figure 13 the time budgets of the animals in the control group is depicted. Cats within this group spend most of their time (45% of the total observation time) *behind their litter box*, whereas the cats in the experimental group, spent most of their time (55% of the total observation time) *in their hiding box* (see figure 14). The amount of time spend *elsewhere* is comparable between the two groups, with the control group spending 30% and the experimental group spending 32% of their time *elsewhere*. The duration of time spent *on the shelf* varies between the groups (experimental group: 13%, control group: 25%).

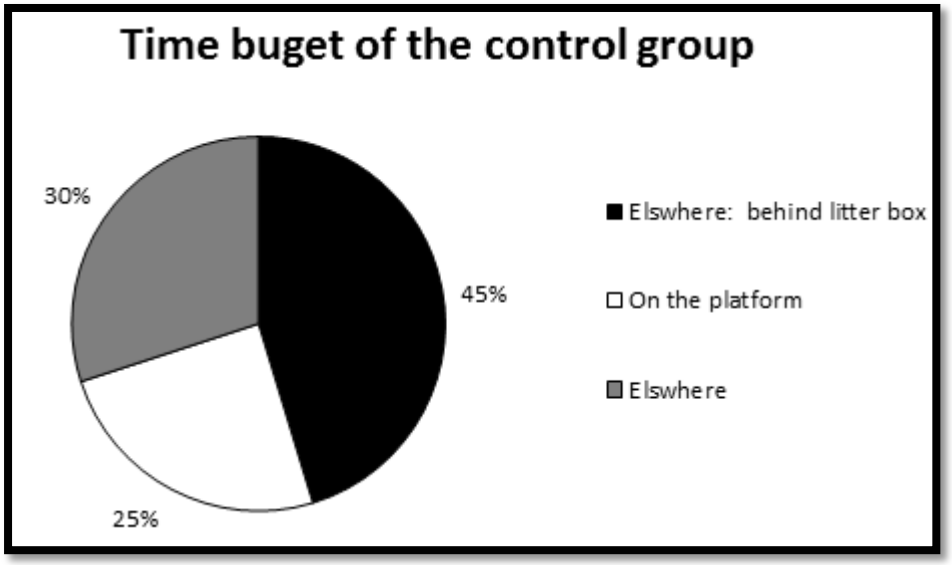

Figure 13: Time budget of the control group expressed as percentages of the total observation period (120 minutes).

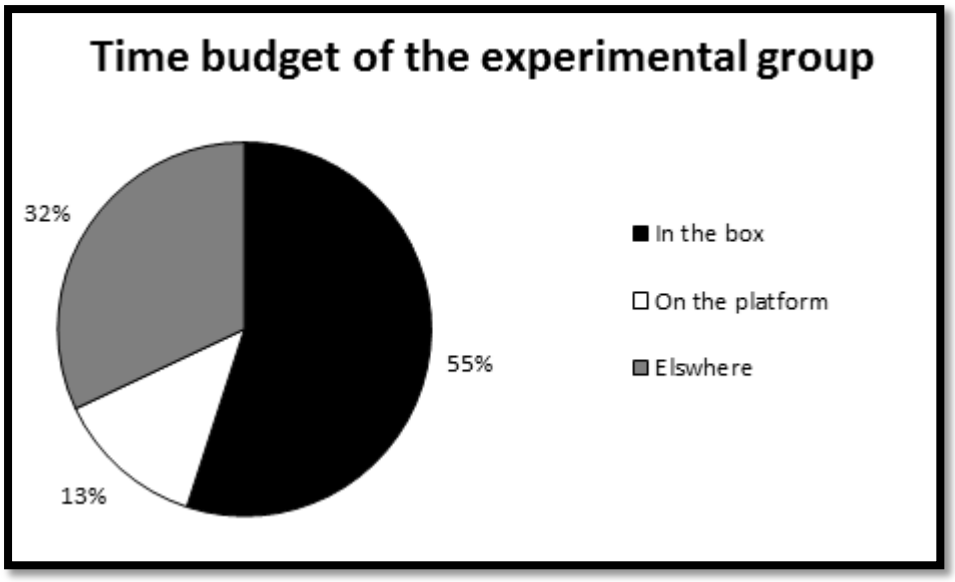

Figure 14: Time budget of the experimental group expressed as percentages of the total observation period (120 minutes).

Figures 15 and 16 show the individual time budgets of each cat in the two research groups. Some animals in both groups deviated from the mean time budget of the research group, the so-called 'outliers'. This can be seen in the figures below: cats number 6 and 9 of the control group showed a preference for the platform (figure 15). In the experimental group cat number 4 showed a slight preference for the platform instead of the hiding box, or elsewhere (see figure 16).

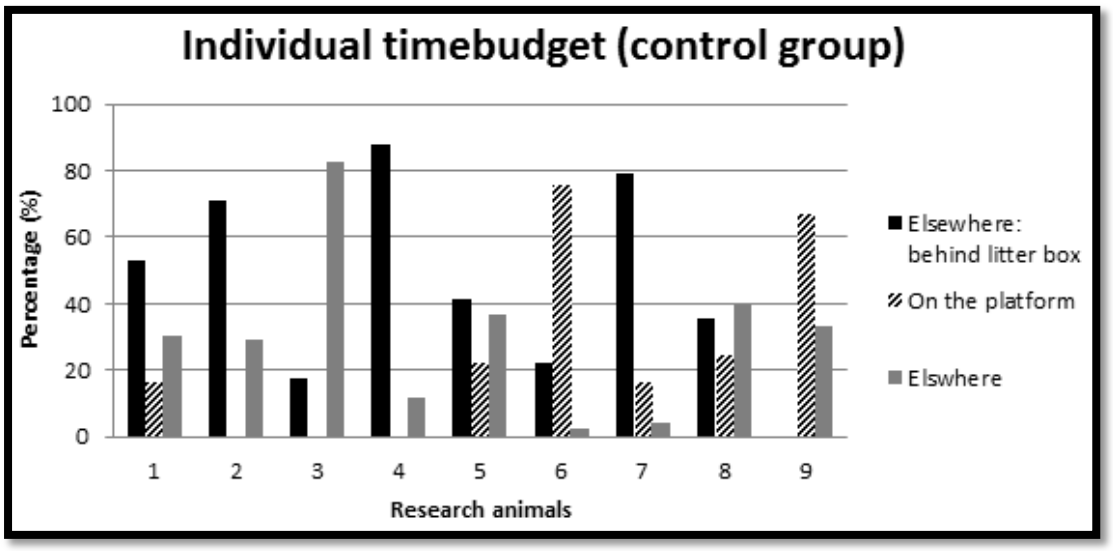

Figure 15: Time budget of the individual research animals within the control group (N=9).

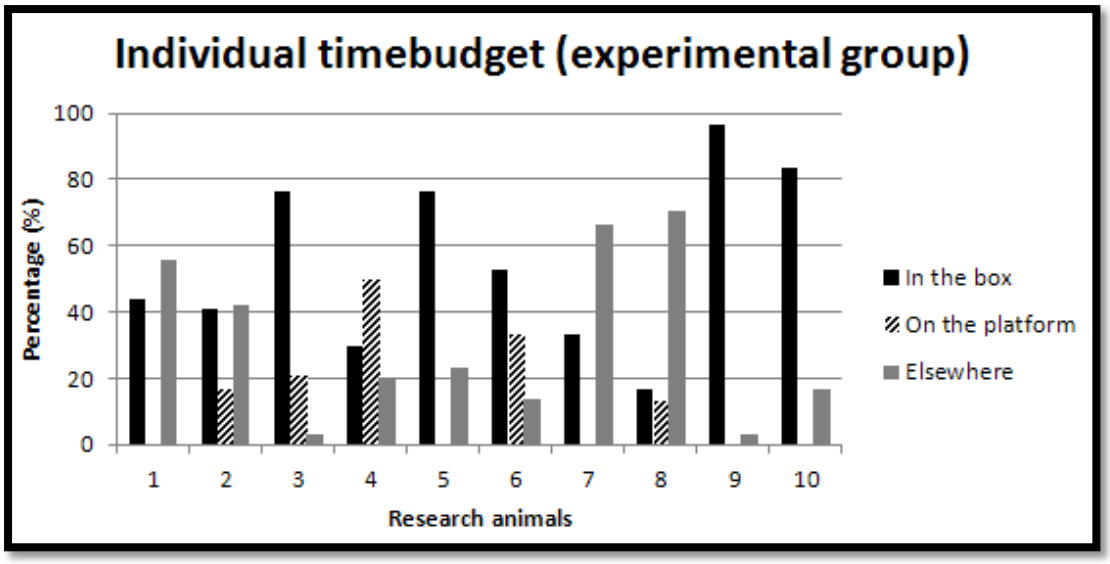

Figure 16: Time budget of the individual research animals within the experimental group (N=10).

Discussion

The main purpose of the present study was to determine the potential effects of a hiding box on the stress levels of newly arrived cats housed in a Dutch animal shelter. It was hypothesized that newly arrived cats which were provided with a hiding box and thereby were able to hide, would have significantly lower stress levels in comparison to cats that did not have the ability to hide.
This hypothesis was based on previous research on hiding behavior (Carlstead et al., 1993; Gourkow & Fraser, 2006; Kry & Casey, 2007, Rochlitz et al., 1998) and can also be substantiated by the study of Overall and Dyer (2005) who estimated that hiding behavior is exactly the way how the cat would cope with stressors in a natural environment. Therefore, 19 newly arrived shelter cats were observed over a 14 days period with the help of a Cat-Stress-Score ethogram (Kessler & Turner, 1997) in the presence or absence of a hiding box.

The most important results of the present study are, that: *1) The experimental group provided with a hiding box, showed lower mean Stress Scores in time compared to the control group, which did not had a hiding box; significant differences between the two research groups could be found on observation days 3 and 4; 2) The mean Stress Score of the experimental group decreased much faster over a 14 days observation period. This group already appeared to be recovered at observation day 3, whereas the control group recovered more gradually and needed more than 5 observation days for this; on observation day 14 a stress level comparable to the experimental group was seen; 3) The cats within the experimental group showed less variability in their scores compared to the individual mean Stress Scores of the cats within the control group, meaning that the cats within the experimental group showed a similar reaction to the novel environment; 4) The cats within the control group showed a kind of "replacement hiding" behavior within the possibilities they were provided, hence, they chose to hide behind their litter box. This alternative, however, appeared inadequate and less effective as was shown by the results of the mean Stress Scores; 5) The present study demonstrates that the use of a hiding box has an important stress reducing function for cats in a novel situation, like an animal shelter.* Some of these findings will be discussed in further detail below.

Experimental animals
Comparing to the 43 animals that have been observed in the study of Kry and Casey (2007), the number of animals in the present study (N=19) was much lower. Obviously, the power of present study would have been increased when more animals would have been observed. This, however, was not possible due to the time span of the study, a sudden alert of a dermatophytosis outbreak (resulting in a two week stagnation period of the observations wherein a fungal culture was performed, which luckily turned out to be negative) and the fact that not enough new cats were taken in by the shelter during the observation period.
The finding that minimal variation in mean Stress Score was seen between the animals of the experimental group supports the power of present study. This finding implies that this research group represents for the whole cat population (Lehner, 1998). However, the control animals showed less uniformity; possibly to a (unknown) difference in individual life history, which partly determined the adaptability of the animals to the novel situation. A suggestion for further research would be to include more animals into this research (control) group.

The Cat Stress Score ethogram
The behavioral observations had been done with the aid of the Cat-Stress-Score ethogram developed by Kessler and Turner (1997). Criticism of using this ethogram as a method of measuring behavior and as an indicator of stress is that this ethogram has not been validated yet. A suggestion for further research, which also has been suggested in the research of Ottway and Hawkins (2003), would be to include physiological parameters to the ethogram. However, a disadvantage to this suggestion is that the collection of physiological parameters, like heart rate or plasma cortisol levels are mostly invasive or at least ask for a short handling procedure of the experimental animal. This can possibly influence

the stress level of the animal in addition to the ethical considerations. In a recent study (Tanaka et al., 2012) has been suggested that there is a relation between reduction in body weight and stress level in cats. Measurement of the cats' body weight could therefore be an alternative physiological parameter to edit to the ethogram, wherefore minimal handling procedures are needed and which is non-invasive for the animal.
For the present research it was decided to use the Cat-Stress-Score ethogram in its present form, without inclusion of physiological parameters, because of the following reasons: the non-invasive way of collecting data, no handling of the animals, the ethogram is easy (Dybdall, 2007) and quick to use and it's an inexpensive method (Dybdall, 2007) for the assessment of the stress level of the individual cat, which all are important criteria for research in shelters. The fact that Kessler and Turner (1997) had found minimal inconsistencies between different components (e.g. a cat with exposed belly but diluted eyes was not found) also advocates for the robustness and reliability of the ethogram as a measuring instrument (Dr. Kessler, personal communication, 26 February 2013).

Overall conclusions of the present research

The mean Cat Stress Score

A major result of present study is that the experimental group showed lower mean Stress Scores compared to the control group: significant differences between the two research groups could be found on two of the six observation days (namely on observation day 3 and 4). These findings support the hypothesis of the present study, that hiding boxes would provide significant lower stress levels in cats, which is conform the results of Kry and Casey (2007) wherein the enriched group (cats provided with a hiding box) also showed lower Stress Score levels compared to the control group (cats without a hiding box) in this study.

The results of the present study show that the mean Stress Score of the experimental group decreased much faster than the mean Stress Score of the control group; a mean Stress Score around 2 had already been reached on observation day 3 in the experimental group.
Due to the observation schedule (behavioral observations on day 1, 2, 3, 4, 5 and 14) it is unknown at which exact day between observation day 5 and 14, the mean Stress Score level was around 2 for the control group. Nevertheless, some conclusions can be drawn based on the study of Gourkow and Fraser (2006). Gourkow and Fraser (2006) estimated the stress levels of individual cats for ten consecutive days. This estimation had been done with the same Cat-Stress-Score ethogram (Kessler & Turner, 1997) that had been used in the present study. The cats were divided into four research groups with different housing conditions; with and without enrichment (used enrichment types; a platform, hiding areas and different toys). Until observation day 9, a clear difference was seen between the groups; the group that was not provided with any enrichment, allowing hiding behavior or evading of the situation possible, showed much higher mean stress scores compared to the enriched groups.
On the basis of these findings one can speculate that the mean stress level of the control group in the present study most likely reached Stress Score 2 before observation day 14.

Cats of the experimental group showed more uniformity in their behavior, shown by the minimal standard error of the mean Stress Score; an intergroup difference of the mean Stress Score was also represented by the outcome of the Friedman test. In the experimental group, the first significant difference in the mean Stress Score (within one group between two observation days) with the aid of the Friedman test was already found between observation day 1 and 2. No significant differences could be found from observation day 3, which means that the reduction in stress level of this group was mainly achieved during the first three observation days. For the control group, however, recovery appeared to start later and took up much more time than the experimental group needed.

Concluding does these finding suggest that the experimental group showed a faster recovery due to the provision of a hiding box; which has significant positive implications for the welfare of these animals. The cats within the experimental group all showed to be more capable to adapt to their novel environment, implying that the hiding box is an important type of enrichment for cats to cope effectively with stressors. This conclusion is in line with the suggestions that were made in the studies of Carlstead et al. (1993), Gourkow and Fraser (2006), Kry and Casey (2007) and Rochlitz et al. (1998).

Kessler and Turner (1999) considered that a Stress Score less than three should be interpreted as an "acceptable stress level", whereby following Ottway and Hawkins (table 2; 2003) the animal welfare is not being influenced. Ottway and Hawkins (table 2; 2003, see appendix 3) developed a table wherein the Stress Scores categories of Kessler and Turner (1997) are correlated with animal welfare. This table has been based on the literature of Broom and Johnson (1993), who described the potential consequences of stress and the corresponding influence on animal welfare.
Following this table of Ottway and Hawkins (table 2; 2003), Stress Scores 5 ("fearful, stiff"), 6 ("very fearful") and 7 ("terrorized") (Kessler & Turner, 1997) present for a situation in which the animal experiences stress due to the fact that the animal is not able to adapt to its environment, resulting in a degradation of the animal welfare. These higher scores (>4) were rarely scored in both research groups. The fact that the Animal Rescue Centre-Tilburg (DOC-T) only takes in stray animals, which are supposedly socialized (based on their behavior and approachability by people) may explain this finding. Despite this selection of (social) animals, the research groups within the present study still represent shelter cats in general, since this selection resembles the procedure in most Dutch animal shelters. As a standard procedure, non-socialized, feral cats are being brought to a TNR project ("Trap, Neuter and Return") and thereafter returned to the place where they were captured, to control the feral cat population (Dierenbescherming Nederland, 2012c). These feral cats, being unadoptable, were not included in this research.
The incidence of Stress Score 4 (activity: "defensive sleep") (Kessler & Turner, 1997), demonstrates the effect of the hiding box on the animal welfare. According to Ottway and Hawkins (2003) Stress Score 4 represents "compromised welfare" (p184), since the animals have "difficulty to cope with their environment" (p184). The frequency of Stress Score 4 was highest in the control group (29%, compared with 9% in the experimental group), which was also seen in the study of Rochlitz et al. (1998). This implies that the animals within this group experienced a longer period of affected welfare; however, this intergroup difference in frequency of Stress Score 4 was not significant.
The opposite effect, in which welfare was not affected (Ottway and Hawkins, table 2; 2003), also differed between the two research groups: the incidence of Stress Score 2 ("weakly relaxed") (Kessler & Turner, 1997) was significantly different (experimental group: 77%, control group: 43% of the total scores that were given). Since this score implies that the welfare of the animals is not affected (Ottway & Hawkins, table 2; 2003) it can be concluded that the animals of the experimental group experienced an overall better welfare during the observation period, compared to the control group.

Time budget
In a previous research, Roy (1992; cited in Rochlitz, 1999, p 8) showed that "cats prefer material that maintains the same temperature" (e.g. a towel). Consequently, it was decided to provide the animals of both groups (experimental and control) with three towels in their cage to equalize the living conditions and creating a comfortable place. One towel was placed on the shelf, one on the lasting free part of the cage and for the enriched group the third towel was placed insight the hiding box. Moreover, this provision controlled for the influence of the additional incentive value of the towel in

the box. In this way the effect of the hiding box *per se* could be seen more exclusively. Consequently, a more pure conclusion can be drawn that the meaning of the hiding box is not just an attractive or pleasant place to sleep or to lie, but has a mainly concealing function for the cat. The hiding box was used by the experimental group for the majority of the observation period (55% of the total observation time).
In the study of Carlstead et al. (1993) as well as in the study of Gourkow and Fraser (2006) and Kry and Casey (2007) it has been seen that cats which were deprived from resources whereby they are able to hide themselves, showed a behavior that was described by Carlstead et al. (1993, p1) as "an attempt to hide". The animals tried to hide for the stressors in its environment by "crouching behind their beds" (Kry & Casey, 2007, p380) or litter pan (Gourkow & Fraser, 2006) in absence of a proper hiding place. This behavior has also been seen in the control group in the present study: the animals within this research group spent 45% of the total observation time *behind their litter box*. The fact that cats try to perform this kind of alternative hiding behavior means that they were highly motivated to perform this behavior, although there was no adequate opportunity. This finding supports the previous conclusion in this study that *hiding* seems to be an important behavior for cats, whereby they effectively can cope with stressors, but also imply that this behavior may even be classified as *a behavioral need* for the cat (*Felis silvestris catus*).

Implications for the welfare of cats
The present study shows that *hiding* is indeed an important coping strategy for cats to adapt to new stressful environments and/or situations and contexts (*coping strategy*). Subsequently do the results imply that *hiding* may even be classified as *a behavioral need* for the cat (*Felis silvestris catus*). Since the hiding box is a relative cheap environmental enrichment type, which can be applied in a relative small cage, it would be well applicable in a shelter situation. The provision of these hiding boxes is believed to be of great importance improving the welfare of cats in shelter practices.

Suggestions for further research
The present research addressed the effect of hiding boxes on the stress level of solitary housed animals in the quarantine room of a Dutch animal shelter, the first two weeks after arrival. Normally, most Dutch animal shelters relocate their cats after these 14 days quarantine room to a group housing room, from where they can be adopted by new owners. So far, no research is available on the stress reducing effects of hiding boxes in group housing systems of cats. As group housing appears to become a standard and most unrelated cats in a captive situation will not harmonize without stress (Monk, 2008; Ottway & Hawkins, 2003), it is expected that the hiding box would have beneficial effects as well in group housing systems.
Previously, Kry and Casey (2007) also mentioned to be interested into further research about this subject. They suggested that the provision of hiding boxes could also prevent stress evoked in situations of limited resources or due to high animal density on a limited space (Kry & Casey, 2007). This will then be in result of expansion of the complexity of the room and the amount of living space, since the animals can sit on top of the hiding box as well as in the hiding box (Kry & Casey, 2007). Future research must give more insight in this topic.

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Appendixes

Appendix 1: Seven Level Cat-Stress-Score Ethogram (Kessler & Turner, 1997).

Table 2 **Seven-level Cat-Stress-Score (a further development of the Cat-Assessment-Score by McCune 1994).**

Score	Body	Belly	Legs	Tail	Head
1 Fully relaxed	*i:* laid out on side or on back *a:* not applicable	exposed, slow ventilation	*i:* fully extended *a:* not applicable	*i:* extended or loosely wrapped *a:* not applicable	laid on the surface with chin upwards or on the surface
2 Weakly relaxed	*i:* laid ventrally or half on side or sitting *a:* standing or moving, back horizontal	exposed or not exposed, slow or normal ventilation	*i:* bent, hind legs may be laid out *a:* when standing extended	*i:* extended or loosely wrapped *a:* tail up or loosely downwards	laid on the surface or over the body, some movement
3 Weakly tense	*i:* laid ventrally or sitting *a:* standing or moving, back horizontal	not exposed, normal ventilation	*i:* bent *a:* when standing extended	*i:* on the body or curved backwards, may be twitching *a:* up or tense downwards, may be twitching	over the body, some movement
4 Very tense	*i:* laid ventral, rolled or sitting *a:* standing or moving, body behind lower than in front	not exposed, normal ventilation	*i:* bent *a:* when standing hind legs bent, in front extended	*i:* close to the body *a:* tense downwards or curled forward, may be twitching	over the body or pressed to body, little or no movement
5 Fearful, stiff	*i:* laid ventrally or sitting *a:* standing or moving, body behind lower than in front	not exposed, normal or fast ventilation	*i:* bent *a:* bent near to surface	*i:* close to the body *a:* curled forward close to the body	on the plane of the body, less or no movement
6 Very fearful	*i:* laid ventrally or crouched directly on top of all paws, may be shaking *a:* whole body near to ground, crawling, may be shaking	not exposed, fast ventilation	*i:* bent *a:* bent near to surface	*i:* close to the body *a:* curled forward close to the body	near to surface, motionless
7 Terrorized	*i:* crouched directly on top of all fours, shaking *a:* not applicable	not exposed, fast ventilation	*i:* bent *a:* not applicable	*i:* close to the body *a:* not applicable	lower than the body, motionless

i = inactive, *a* = active

Score	Eyes	Pupils	Ears	Whiskers	Vocalization	Activity
1 Fully relaxed	closed or half opened, may be blinking slowly	normal	half back (normal)	lateral (normal)	none	sleeping or resting
2 Weakly relaxed	closed, half opened or normal opened	normal	half back (normal) or erected to front	lateral (normal) or forward (normal)	none	sleeping, resting, alert or active, may be playing
3 Weakly tense	normal opened	normal	half back (normal) or erected to front or back and forward on head	lateral (normal) or forward	meow or quiet	resting, awake or actively exploring
4 Very tense	widely opened or pressed together	normal or partially dilated	erected to front or back, or back and forward on head	lateral (normal) or forward	meow, plaintive meow or quiet	cramped sleeping, resting or alert, may be actively exploring, trying to escape
5 Fearful, stiff	widely opened	dilated	partially flattened	lateral (normal), forward or back	plaintive meow, yowling, growling or quiet	alert, may be actively trying to escape
6 Very fearful	fully opened	fully dilated	fully flattened	back	plaintive meow, yowling, growling or quiet	motionless alert or actively prowling
7 Terrorized	fully opened	fully dilated	fully flattened back on head	back	plaintive meow, yowling, growling or quiet	motionless alert

Appendix 2: Ethogram UK Cat Behavior Working Group (1995).
Definitions developed by the UK Cat Behavior Working Group in 1995 of posture elements, tail- and ear positions and activity, that are used in the Cat-Stress-Score ethogram of Kessler and Turner (1997).

Posture elements
Lie on side: Positioned fully on side, one side of the cat in complete contact with the ground. Head on side or extended. Paws extended.
Lie half side: Positioned on side with body but not head in complete contact with the ground.
Crouch: Positioned with ventrum and legs in contact with the ground, paws unfolded.
Lie ventral: Positioned with ventrum and legs in contact with the ground, paws folded.
Lie dorsal: Positioned flat with back in contact with the ground.
Sit: The pads of the front paws are on the ground with the front legs straight and the rump squarely on the ground.
Stand: Positioned with just four paws in contact with the ground.

Tail
Twitch: A cat abruptly moves part of its tail from side to side or up and down.
Tail up: A cat raises its tail to a vertical position.

Ear positions
Back: Ears are held at the rear of the head.
Forward: Ears are held at the front of the head.
Flat: A cat flattens its ears to its head, such that they tend to lie flush with the top of the head.
Erect: A cat points its ears upward.

Activity
Sleep: Cat immobile, eyes closed and not easily disturbed.
Rest: Cat remains generally inactive with eyes closed but occasionally opens them to scan the area: ears flicking regularly.
Alert: Cat remains generally inactive with eyes fully open and flicks its ears occasionally as it scans its surroundings.
Explore: Cat travels slowly, sniffing at objects and investigating its surroundings.
Crawl: Cat moves with body in a crouched position.

Appendix 3: The Cat-Stress-Score related to welfare by Ottway and Hawkins (2003).

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

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