



The effect of time left alone on cat behaviour

Effekten av tid lämnad ensam på kattens beteende

Matilda Eriksson

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Matilda Eriksson

Studentarbete 638, Uppsala 2015

**Advanced A2E, 45 ETCS, Master's programme in Animal Science, Examensarbete i
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Handledare: Therese Rehn, SLU, Department of Animal Environment and Health, P.O.B.
234, SE-532 23 SKARA

Examinator: Maria Andersson, SLU, Department of Animal Environment and Health,
P.O.B. 234, 532 23 SKARA

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Fakulteten för veterinärmedicin och husdjursvetenskap

Institutionen för husdjurens miljö och hälsa

Box 234, 532 23 SKARA

E-post: hmh@slu.se, **Hemsida:** www.slu.se/husdjurmiljohalsa

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Summary

There is not much known about the relationship between a cat and its owner. Cats display a variety of behaviours towards their owner, but some of these behaviours are hard to interpret in an ethological context. In this study, the aim was to find out if cats are affected by the duration of time left alone at home. 12 single-housed indoor cats were tested in two treatments, before, during and after 4 h (T_4) and 0.5 h ($T_{0.5}$) separation from their owner. The cats were recorded in their home environment by digital cameras, and their behaviour was observed and recorded through instantaneous sampling, one-zero sampling and continuous sampling. Some households with pair-housed cats were also observed in this study.

The results showed a difference in time spent lying resting during the time left alone. Cats in this study spent more time resting in T_4 , and they also tended to stay in the hallway near the front door before the owner left in this treatment. In the last 5 min of alone time, cats tended to be more attentive towards unidentified sounds and object in T_4 , and during reunion they tended to vocalize (purring), stay close to the owner and stretch more, and the owners tended to take verbal contact more often. The conclusion of this study is therefore that cats are affected by the duration of time left alone at home.

Sammanfattning

Det finns mycket som inte är känt när det kommer till relationen mellan en katt och dess ägare. Katter riktar många av sina beteenden mot sin ägare, men flera av beteendena är svåra att tolka i ett etologiskt sammanhang. I denna studie var målet att se om katter påverkas av att lämnas ensamma i hemmet under olika tidsintervall. 12 innekatter, utan sällskap av en annan katt, testades i två behandlingar; före, under och efter 4 timmars (T_4) och 0.5 timmars ($T_{0.5}$) separation från sin ägare. Katterna filmades med digitalkameror i sin hemmiljö och deras beteenden observerades med hjälp av intervallobservationer, 1/0-registrering, samt kontinuerliga observationer. Några hushåll med två katter observerades också i denna studie.

Resultatet visade en skillnad i tid som spenderades liggande vilande under tiden de var ensamma. Katterna spenderade mer tid vilandes i T_4 , och de tenderade att uppehålla sig i hallen, nära ytterdörren, innan ägaren lämnade hemmet i denna behandling. I de sista 5 minuterna av ensamhet, tenderade de att vara mer uppmärksamma på oidentifierade objekt och ljud i T_4 , och vid återförening tenderade de att vokalisera (kurra), hålla sig nära sin ägare och sträcka på sig mer, och ägarna tenderade att ta mer verbal kontakt. Konklusionen av denna studie är därför att katter påverkas av att lämnas ensamma under olika tidsintervall.

1. Introduction

1.1 The domestication of cats (*Felis Silvestris*)

Today, domestic cats are appreciated companion animals, especially in the western part of the world. In the 1990's it was estimated that there was 35 million cats in the European Union and 59 million cats in the United States (Serpell, 1996). In Sweden, the estimation is around 1.3 million cats and they are the most common pet animal (SCB, 2013). But there is little knowledge of when the relationship between cats and humans started. It is thought that the cat was first domesticated in Egypt about 4000 years ago (Clutton-Brock, 2002; Bradshaw *et al.*, 2012) since remains of them are found in tombs dated from this period.

There are also sculptures and paintings from this time period, depicting cats sharing many activities with humans, such as hunting and eating (Serpell, 2000).

However, new findings in Cyprus, shared by Vigne *et al.* (2004), suggest that the early domestication of cats took place about 9500 years B.C. Scientists found a cat buried in association with a human, which could indicate that a relationship between a human and a cat had taken place. The cat skeleton was found only 40 cm away from the human skeleton, in a purposely dug out hole. Examinations of the cat skeleton showed that the cat was about 8 months old when buried, which suggests that the young cat might have been killed, in order to be buried at the same time as the human. No evidence of any native felid species has been found at the site, so it seems that cats were introduced to the island by humans (Vigne *et al.*, 2004).

The domestication does not seem to have as big effects on the cat as it has had on other domesticated mammals. This is likely because of the fact that the cat was not selected for desired traits and bred by the human population (e.g. Driscoll *et al.*, 2009; Bradshaw *et al.*, 2012). There are three kinds of changes that seems to have taken place. These are reduction in brain size, modifications of the hormone balance, and neoteny, the persistence of some juvenile behaviour characters in the adult (Bradshaw *et al.*, 2012). Behaviours such as purring and treading with the forepaws are both characteristic for kittens that is commonly expressed in adult domestic cats. It is unclear to which degree these behaviours are innate and how much it is due to reinforcement by attention from owners (Bradshaw *et al.*, 2012). Domestic cats have also developed a more “pleasant” meowing than that of African wild cats (*Felis silvestris lybica*) (Nicastro, 2004, cited by Saito and Shinozuka, 2013).

The behaviour patterns of the wild cat have been altered to a lesser degree during domestication. They still retain a functional repertoire of predatory behaviour, as well as mate selection and courting behaviour (Bradshaw *et al.*, 2012).

1.2 The cat-human relationship

The cat is flexible in their dependence of humans, perhaps because of its history living side by side with mankind. This may be because they needed to be flexible in order to survive the changes in the relationship that occurred over time, since they have been both revered and hated during this coexistence (Bradshaw *et al.*, 2012). However, the relationship between man and cat is described as mutually beneficial. The cat receives shelter, food and social interactions from its owner, and the owner may benefit from the companionship as well as from pest control (Bradshaw *et al.*, 2012). Many cats direct species-typical behaviours towards their owners, but it is still much unknown about the social systems, so it is not proven that the behaviour directed to a human has the same implication as when it is directed towards another cat. However, there are some general similarities between these interactions, e.g. there are no consistent patterns of interaction between individuals in a group of cats, which can be seen in the more independent relationship between cats and their owners, as described below (Bradshaw *et al.*, 2012).

Interactions between humans and cats are typically consisting of short bouts. Turner (1991) showed that an interaction initiated by the cat tended to be of longer duration than an interaction initiated by the owner. It was especially apparent when the owner was very active in starting interactions. According to Turner (1991), his data suggests that owners that want to engage in interactions with their cat too often, can end up spending less time with their cat than in a more casual relationship where the cat initiates the interactions.

Martens (1991) performed a study of cats in the home setting together with their owners. Females were found to be more active towards the cat than males, and they were also feeding the cat to a larger extent. The cats showed more frequent approaches and withdrawals towards female than towards male partners, and a preference for adults compared to children and juveniles.

1.3 Usage of environment and enrichment

1.3.1. Territory

Cats are territorial animals, and often build their territory around a food source (Jongman, 2007; Bradshaw *et al.*, 2012). Both sexes will mark their territory through urine spraying and scratching of vertical surfaces, but intact males have a stronger territorial behaviour than females, and will spray with urine more often than females (Bradshaw *et al.*, 2012). Feral cats are flexible in their social structure, ranging from solitary to living in groups. This flexibility is highly dependent on the availability of food resources (Jongman, 2007). Female cats mainly stay within their territory and are considered more social than male cats, who may disappear for periods of time in search of reproductive females (Jongman, 2007; Bradshaw *et al.*, 2012).

The size of territory varies. Studies have indicated that home ranges decrease in size as provision of food increases (Bradshaw *et al.*, 2012). Horn *et al.* (2011) saw that owned cats had smaller territories than feral cats, and comparisons between rural areas and urban areas showed that cats in rural areas had a larger territory than a cat living in a urban setting (Lilith *et al.*, 2008). Since the territory size varies, it is argued that a cat should easily adapt to living in an indoor setting (Jongman, 2007). Within the territory, hiding places will be selected, both at ground level and elevated ones. These serve as places to rest and sleep in, as well as platforms for surveillance of the territory.

1.3.2. Daily activities

Cats, both feral and owned, can spend up to 19 hours a day resting and sleeping, consisting of several short bouts rather than a single session (Bradshaw *et al.*, 2012; Jongman, 2007). They also spend a lot of time grooming, cleaning their fur as they lick and nibble their body (Bradshaw *et al.*, 2012).

Shyan-Norwalt (2005) sent out a survey to owners regarding their indoor cats' daily activities and found that out of 209 owners, 84 % stated that their cats spent their time in windows up to 5 hours a day. Other than watching the world outside, owners stated that their cat spent time playing with toys and cuddling with humans.

1.4 Communication in cats

Cats display a variety of behaviours towards their owners and conspecifics, using vocal, tactile, visual and olfactory signals (Bradshaw *et al.*, 2012).

1.4.1 Vocal communication

The vocal communication of cats can be divided into two major groups; murmur patterns and vowel patterns (Sharma and Ahuja, 2003). The murmur patterns are produced when the mouth of the cat is closed, and the vowel patterns are produced when the mouth is first open, then gradually closed. There are four types of murmur patterns (grunt, purr, call, and acknowledgement) and five types of vowel patterns (demand, bewilderment, complaint, mating cry, and anger wail) suggested. All of the murmurs and vowels have specific distinguishable phonetics.

It is not known if the vocalizations cats use towards humans are of any significance, but some humans say they are able to recognize the meaning and nuances of different calls (Bradshaw *et al.*, 2012). Since the significance is unknown, it is therefore difficult to put the vocal communication between cat and human in an ethological context. However, cats do use vocalizations towards humans to a larger extent than towards other cats, which suggests that cats are able to learn that humans respond to their calls (McComb *et al.*, 2009). Cats who live feral lives are normally much more silent, which implies that individual cats can learn how to use vocal communication, depending on the environment in which they grow up (Bradshaw *et al.*, 2012).

The purr is universal among cats, and along with various meows, the sounds most often directed towards their owners (Turner and Bateson, 2000; Bradshaw *et al.*, 2012). The function of purring is not clearly understood, and until recently, the method of its production was unclear. The sound is produced during both inhalation and exhalation, with a short pause at the transition between the phases of the breathing cycle (Turner and Bateson, 2000). The sound itself is generated by an abrupt separation of the vocal folds, generated by a sudden build-up and release of pressure as the glottis is closed and then opened again (Remmers and Gautier, 1972).

When playing recorded solicitation and non-solicitation purrs, even humans with no experience of owning cats found the food solicitation purr to be more urgent and less pleasant (McComb *et al.*, 2009). They also found that there was a frequency peak in the solicitation purr, indicating activation of the vocal folds via air movement, at a frequency more typical of a cry or a meow. This 'cry' within the low-pitched solicitation purr, was found to be dramatically emphasised by cats in the context of food solicitation. Humans are sensitive to high frequency cries and the cries of healthy human infants is within 300-600 Hz. The cry within the purr was measured to 420 Hz, which is within the interval of a crying infant (McComb *et al.*, 2009).

Saito and Shinozuka (2013) tested domestic cats' abilities to recognize their owners' voice. They recorded the voices of 4 different strangers, all the same gender as the owner, as well as the owner's voice, calling out the name of the cat. First, the voices of strangers 1-3 was played to the cat, then the owners' voice, followed by the voice of the fourth stranger. The response that mainly occurred during this auditory experiment was orienting behaviour, such as ear and head movement, not by communicative behaviour (vocalization and tail movement). They found that the response magnitude of the cat decreased during the call from stranger 1-3, and was then increased when the owners' voice called. With this evidence they concluded that domestic cats are able to recognize individual humans through vocal communication.

1.4.2 Tactile communication

Allorubbing and allogrooming are the two most obvious forms of tactile communication in cats. Allorubbing is defined by either rubbing their heads, flanks or tail on another cat (Bradshaw and Cameron-Beaumont, 2000). Macdonald *et al.* (1987) suggested that rubbing tends to take place between cats of unequal size or status. Mertens (1991) found that cats who are allowed to roam outdoors rub on their owner to a higher frequency than a cat that is confined indoors. Bradshaw *et al.* (2012) discuss the fact that it might be because rubbing often is used as a greeting behaviour pattern, which occurs after a cat has been away from its social group for a period of time. The social meaning of allorubbing is in need to be clarified by further research.

Allogrooming is defined by grooming another cat, and plays an important role in many species (Wilson, 1975, cited by Bradshaw and Cameron-Beaumont, 2000), but is not well

researched in domestic cats. Van den Bos (1998) found that in an indoor colony of 14 neutered males and 11 neutered females, the allogrooming was shown by the more aggressive individuals grooming the less aggressive individuals. The groomers were also aggressive towards the recipient in about one-third of the cases, commonly after the grooming was finished. This was consistent with his idea that allogrooming in the domestic cat is a form of redirected aggression. In his research, he did not find any evidence that there was an effect of relationship on the choice of partners for allogrooming (van den Bos, 1998).

1.4.3 Visual communication using the tail

Cats have a much more limited visual signalling repertoire than that of species derived from cooperative hunters, such as the domestic dog (Bradshaw *et al.*, 2012). It has been speculated that cats maintained a distance from conspecifics that made it unnecessary to develop complex visual signalling suitable for face-to-face encounters. The ability of displaying changes in emotional state and adapting behaviour accordingly was not important in the evolution of the cat.

The tail of a cat, which has an independent movable tip, is a suitable tool for signalling as well as for assisting their balance (Bradshaw and Cameron-Beaumont, 2000). In a submissive or defensive posture, the tail will be tucked between the hind legs. When a cat is lashing its tail from side to side, it is showing off one component of aggressive behaviour, but the full understanding of this signal is unknown (Bradshaw and Cameron-Beaumont, 2000). A vertical tail usually precede friendly interactions. Feral cats use the tail-up expression when they are about to have a friendly interaction with another cat, e.g. before allorubbing (Bradshaw *et al.*, 2012; Bradshaw and Cameron-Beaumont, 2000).

Cameron-Beaumont (1997, cited by Bradshaw and Cameron-Beaumont, 2000) saw that almost every bout of cat-cat rubbing were preceded by the initiating cat approaching with its tail raised. The chance of rubbing was even greater if also the recipient cat raised its tail. The role of tail-up as a signal for friendly behaviour was confirmed by presenting pet cats with different silhouettes identical to each other, except for the tail positioning. The silhouette with a raised tail was significantly more likely to induce tail-up when the responding cat first saw it, and was also approached faster than the silhouette with its tail down. The tail-down silhouette induced some tail-swishing or tail tucked between the hind legs (Cameron-Beaumont, 1997, cited by Bradshaw and Cameron-Beaumont, 2000).

Cafazzo and Natoli (2009) found that in their studied group of cats, low ranked cats raised their tail more often than the high ranked cats, and highly ranked cats also received more tail-up expression from their conspecifics. With this they concluded that tail-up also seem to be a signal of recognition of members which have higher social status in the group.

1.4.4 Olfactory communication

Since most carnivores, such as cats, live mostly solitary lives, it is difficult to know if their visual or acoustic signals can or will be detected by any conspecific (Bradshaw *et al.*, 2012). Instead, odours can be left for days, still providing information about the emitter. Cats have scent glands in skin glands and head glands, and also use scents carried in urine and faeces. Their scents are specific for individuals and can last a while, and are used for marking the environment so that conspecifics later can detect and decode the scent if the emitter is not around. Marking with urine may convey both individual- and group-specific information, and is used more frequently by male cats when consorting with an oestrus female. The specific role of this kind of scent marking in the selection of sexual partners remains unclear (Bradshaw *et al.*, 2012).

Scratching with the front paws is another way for cats to mark within their home range (Bradshaw *et al.*, 2012). Sites such as trees or other vertical wooden surfaces are favoured and can become deeply grooved if used for longer periods. These scratched sites are likely used as combined visual and olfactory signals, since the cat has sebaceous glands of the feet.

1.5 Social needs in cats

Most cats direct species-typical behaviours towards their owners (Bradshaw *et al.*, 2012). The social structure in groups of domestic cats is not just artefacts of the housing conditions in which they are kept, but is also present in groups that are barely tolerant of human company. It seems like the social structure adapts to each population of domestic cats, and groups may form e.g. when food allows two or more individuals to live in close contact with each other.

1.5.1 Group-living cats

Colonies of domestic cats are almost always localized to an environment where the food is available (Bradshaw *et al.*, 2012). These sites may involve e.g. rubbish yards, fishing docks, and industrial sites. Smaller colonies of cats could consist of a single social unit, larger colonies usually are made up of several social groups. Many groups studied have turned out to be related females together with their offspring, immature males and unrelated mature males. Females in a group tend to be more tolerant to each other, but usually attack outsiders, both male and females, on sight. The mature males in a group are just loosely attached and have a larger home range than those of females (Bradshaw *et al.*, 2012).

Cats that live together in the same household do not routinely regard each other as members of the same social group (Bradshaw *et al.*, 2012). Cats that have successfully avoided each other in a home environment may become highly stressed when placed in close confinement together. Therefore, clear signals of social bonds, e.g. allogrooming, should be seen before housing cats together. A tolerance towards conspecifics may also be seen in adult cats that have been housed together for several months or years. This is not accurate in all cases; some cats may never come to accept conspecifics, and may therefore benefit from being housed singly (Bradshaw *et al.*, 2012).

Since cats have limitations in visual signals, it appears to have restricted the types of social groupings they can adapt to (Bradshaw *et al.*, 2012). The members of feral social groups are mainly familial, often developing together since birth. Therefore, they “know” each member well, and can predict how members will react in different circumstances. Encounters with neighbourhood cats or cats from other colonies will generally result in signs of aggression, such as biting and chasing, or total avoidance.

In multi-housed cats, similar problems may occur (Bradshaw *et al.*, 2012). Undesired behaviours from the cats may arise, but depends on the extent to which cats perceive each other to be members of the same social group and the availability of resources. Individuals that are in the same social group will show high levels of affiliative behaviours, such as allogrooming or allorubbing, towards their companion and will stay in close proximity to each other, e.g. sleeping next to each other.

When separate social groups are established within the same home, they will generally establish different central areas and will basically live separate lives (Bradshaw *et al.*, 2012). Generally they establish different routines that minimizes actual encounters with the other cat, or they show aggression or withdrawal towards each other. Owners are often unaware of these avoidance patterns, which is particularly the case where incompatible

cats occupy the same space in order to access essential resources, like food provided in the same room at the same time. In these cases, signs of anxiety may be seen, such as some cats eating very fast or eating excessive amounts to avoid the necessity of going back to the feeding area.

The problems that may occur in a household with separate social groups are often intensified by the owners' tendencies to cluster important resources together (Bradshaw *et al.*, 2012). This is because of the combination between limited resources and avoiding other cats usually leads to a range of undesired behaviour. A cat that has chosen upstairs as a core area will have restricted access to the resources that are downstairs, at the core area of another cat.

Cats do not appear to be motivated to maintain social bonds in the same way as other species (Bradshaw *et al.*, 2012). Therefore, the cessation of an established relationship often result in a permanent split of cats into separate social groups. The recognition of a group member is partially through their odour profiles, which is maintained by affiliative rubbing and grooming, and may be disrupted by situations that alter the scent of a group member. This could cause a breaking of social bonds.

Bernstein and Strack (1996) made a preliminary, descriptive study of the usage of home range in one household with 14 inhabitant cats, with ages varying between 4 months and 13 years. In this study, they saw that each individual had a personal home range, characterized by the number of rooms and the specific rooms each individual used on a regular basis. There was some degree of overlapping in home ranges, and some favoured spots that were time shared (multiple cats used the same spot, but at different times) rather than shared physically (used at the same time). The home ranges of males were larger than those of females in this study. In the summary of the study, the authors said that the peaceful co-existence of multiple individuals in the same household seems to be because of the fact that they are able to stay away from each other.

1.6 Cats' concept of time

Cats are able to tell the difference between a sound that lasts 4 s and a sound that lasts 5 s, which concludes that cats can discriminate between short time-intervals (Bradshaw *et al.*, 2012). They are also able to delay a response to a stimulus by several seconds, to an accuracy of approximately 1 s. These facts indicate that cats have an internal clock that can time the duration of both internal and external events.

1.7 Cats' attachment towards humans

Edwards *et al.* (2007) found that indoor cats were spending more time in locomotor activities, exploring their surroundings and playing more when they had their owner in the same room, whilst if the owner left and a stranger remained in the room, the cat became immobile. As locomotor behaviours and playing in the presence of the owner could indicate that the cat felt more secure, the authors suggested that cats are attached to their owners. Further supporting this, they also found that cat vocalized more when they were left alone in the room, indicating separation distress.

Potter and Mills (2015) however, did not find any indications of attachment in a similar study of outdoor cats. They saw that the cats discriminated between the owner and a stranger, indicating a different relationship with their owner compared to with a stranger. There was some indications of social preference for the owner. The reason for this is unknown, it could be a result of incidental interactions or built upon the fulfilment of psychological social needs.

1.8 Separation anxiety in cats

Separation anxiety, indicated by behaviour expressed only in the absence of the owner (ref), has been observed in cats. Three main categories of unwanted behaviours have been identified; inappropriate elimination, vocalization and destructiveness (Schwartz, 2003). The inappropriate elimination was more common in neutered females, and in 75 % of the cases, the elimination was directed towards the owners bed. Also, excessive or persistent vocalizations have been reported in cats with separation anxiety.

2. Aim, questions of interest and hypotheses

The aim of this master thesis study was to find out if cats are affected by the duration of time left alone at home.

The following questions of interest were analysed:

- Will the behaviour during the separation differ according to the time left alone?
- Will the cats show some indication of distress when the owner leaves?
- Will the greeting behaviour of the cats toward their owners differ according to the time left alone?
- Will behaviour during separation differ according to the number of cats in the household?
- Will the greeting behaviour towards the owner differ according to the number of cats in the household?
- To what extent do cats interact with each other when left alone at home?

My hypothesis is that the cat(s) will show the same behaviours during the time left alone in both treatments (4h vs 0.5h of separation), but the reunion behaviour will differ. I believe that the cat(s) will show more tail-up, vocalize more, and initiate more contact with its owner after the 4h treatment than after 0.5h.

The hypothesis regarding behaviour during separation when comparing between groups (single vs pair-housed cats), is that pair-housed cats will be more active, roaming more, and interacting with the other cat during separation. I also hypothesize that the reunion behaviour will be similar in both groups, but the behaviours presented will be more frequently expressed in pair-housed cats since there may be competition between the cats for the owners' affection.

2.1 Why is this important?

There is not much known about cats' needs when it comes to the social bonds between owners and their cats. This study could possibly give us some indications of how to keep and care for our cats to better fulfill their social needs, and/or their needs when left alone. It could be good to know whether or not it is important for cats to have social company of the owner. This knowledge could help in improving the welfare of domestic cats. It could possibly also be used as a tool when planning future studies, to get even more knowledge of this topic.

3. Materials and methods

3.1 Subjects

The cats in this study were privately owned cats of different breeds and ages. A total of 20 cats in 16 different households were participating in this study (Table 1). In 4 of the

households the cats were housed in pairs. The remaining 12 cats were housed without the company of another cat. 12 of the cats were female, and 8 were male, all neutered, and the ages ranged from 7 months to 15 years. The cats were recruited through advertisement online, posters placed at the Swedish University of Agricultural Sciences (SLU) and Uppsala University (UU), as well as by posters in shops and on community billboards in Uppsala. Except from being healthy, there were two criteria to participate in the study; they should be indoor cats and not younger than 6 months of age. The indoor cat-criterion included that they should live the greater part of their day indoors, not being able to roam outside unsupervised.

3.2 Test environment, equipment and test methods

To investigate the effect of time left alone at home on cat behaviour, cats were left alone on two different occasions on two separate days, and the separation time was altered according to treatment; the cat was left alone during 0.5 h ($T_{0.5}$) and 4 h (T_4). All cats were tested in both treatments. These occurred during the same time of day for each cat, either before noon (07:00-12:00) or after noon (12:00-18:00) equally balanced across cats. Within group (number of cats in the household), treatment order was balanced between the cats with regards to sex of the cat and gender of the owner (Table 1).

Table 1. Participating cats and their owners

<i>Sex</i>	<i>Age (years)</i>	<i>Gender (owner)</i>	<i>No. of cats in household</i>	<i>Ownership length (years)</i>
<i>Male</i>	1,5	Female	1	2
<i>Male</i>	2	Female	1	2
<i>Female</i>	8	Male	1	8
<i>Female</i>	8	Female	1	8
<i>Female</i>	8	Male	1	8
<i>Female</i>	6	Female	1	0,3
<i>Male</i>	4,5	Male	1	5
<i>Male</i>	2	Male	1	2
<i>Female</i>	13	Female	1	12
<i>Female</i>	5	Female	1	5
<i>Female</i>	15	Female	1	5
<i>Female</i>	12	Female	1	5
<i>Female*</i>	9	Female	2	3
<i>Female</i>	7	Female	2	3
<i>Female*</i>	0,7	Female	2	0,3
<i>Male</i>	0,7	Female	2	0,3

<i>Male*</i>	Unknown	Male	2	2
<i>Male</i>	Unknown	Male	2	2
<i>Female*</i>	6	Female	2	6
<i>Male</i>	9	Female	2	9

*Focal animal in this study

The cats were recorded in their home environment using three digital cameras (two SONY Handycam HDR-CX130 and one CANON LEGRIA HF R 68) placed in different locations of the home. One of the cameras covered the entrance area, while the locations of the two other cameras were chosen depending on where the owner believed the cat spent most of the day.

On day 1 of the recording, the test leader (TL) showed up to set up the cameras and to start the recording. The participants were instructed about the study and signed an informed consent. Day 2 of the recordings were in some cases also started by the TL, but in other cases the participants were willing to do this by themselves. In such cases the owners were carefully instructed during the camera set-up in how to handle the recording, and was also given written instructions. When all the cameras were set up, the TL left the household and instructed the owner to stay in the home for at least 10 min before leaving the cat(s) alone in the home. After the owner had entered the home again, either 0.5h or 4 h later, they were instructed to keep the cameras on for at least 10 min more before stopping the recording, or the TL showed up to stop the recording.

3.3 Behavioural analyses

For the analyses, the experiment was divided into five phases (Figure 1); before separation (phase 1), after separation (phase 2), alone time (phase 3), before reunion (phase 4), and after reunion (phase 5). Phase 1, 2, 4 and 5 lasted for 5 min. During phase 3, behaviours were scored for 10 min in total, divided into ten intervals of 1 min each, evenly distributed over the remaining time slot.

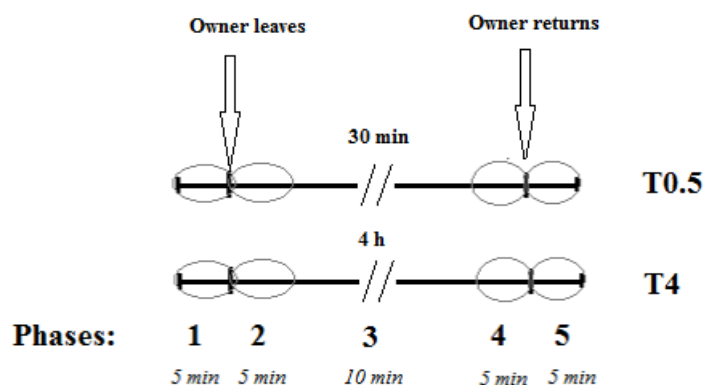


Figure 1. The different phases of the experiment.

T0.5 is the 0.5 h treatment and T4 the 4 hour treatment.

Behaviours of longer duration were recorded using instantaneous sampling every 5s. Behaviours of shorter duration or behaviour often performed in bouts (e.g. clawing, body shake) were recorded using one-zero sampling within every 5 s interval. Lip licking was observed using continuous sampling (frequency). Behaviours recorded are presented in Table 2. The recorded material was observed in a program for behaviour observation (Interact, Mangold) by the TL. From the pair-housed cats, one of the cats was randomly selected and used as a focal animal.

Table 2. Behaviours recorded and their definition

<i>Behaviours</i>	<i>Definition</i>	<i>Recording method</i>
<i>Location: Hallway</i>	Cat is located in the hallway	Instantaneous, 5 s ^a
<i>Location: Window</i>	Cat is located in a window	Instantaneous, 5 s ^a
<i>Other location</i>	Cat is located in another room	Instantaneous, 5s ^a
<i>Walking/trotting</i>	Cat is moving in a walking or trotting pace	Instantaneous, 5s ^a
<i>Running</i>	Cat is moving in a higher pace, galloping	1/0-sampling (5s) ^b
<i>Sitting</i>	Cat is sitting down	Instantaneous, 5s ^a
<i>Lying alert</i>	Cat is lying down, head not in contact with floor/furniture	Instantaneous, 5s ^a
<i>Lying resting</i>	Cat is lying down, head in contact with floor/furniture	Instantaneous, 5s ^a
<i>Lying on side</i>	Cat is lying down on its side, showing greater part of the belly	Instantaneous, 5s ^a
<i>Standing</i>	Cat is standing still on its paws	Instantaneous, 5s ^a
<i>Tail-up</i>	Tail is erect vertically	1/0-sampling (5s) ^b
<i>Tail wag</i>	Tail is wagging	1/0-sampling (5s) ^b
<i>Arch</i>	Cat is arching its back (note if pilo-erection)	1/0-sampling (5s) ^b
<i>Stretch</i>	Cat is extending/stretching a part of or the whole body	1/0-sampling (5s) ^b
<i>Yawn</i>	Cat is yawning	1/0-sampling (5s) ^b
<i>Exploration</i>	Cat is sniffing/licking/biting/manipulating something (not toys)	1/0-sampling (5s) ^b
<i>Body shake</i>	Cat shakes a part of or the whole body	1/0-sampling (5s) ^b
<i>Treading with paws</i>	Cat is treading its paws, similar to the way they tread while suckling at a young age	1/0-sampling (5s) ^b
<i>Play with object</i>	Hunt-like postures, galloping, manipulating objects with paws, directed towards toys or other objects	1/0-sampling (5s) ^b
<i>Solitary play</i>	Hunt-like postures and galloping, not directed towards specific objects	1/0-sampling (5s) ^b
<i>Play with owner</i>	Hunt-like postures, galloping, manipulating objects with paws, directed towards owner, or object manipulated by owner	1/0-sampling (5s) ^b
<i>Groom</i>	Cat is cleaning its body surface by licking,	1/0-sampling (5s) ^b

	nibbling, picking, rubbing, scratching etc.	
<i>Grooming cat*</i>	Cat is cleaning another cats' body surface by licking, nibbling, picking, rubbing, scratching etc., or is recipient of grooming from another cat	1/0-sampling (5s) ^b
<i>Physical contact with object</i>	Cat is rubbing its face or body against objects	1/0-sampling (5s) ^b
<i>Physical contact with owner</i>	Cat is rubbing its face or body against the owner (Cat initiated contact), or is within 5 cm of the owner	1/0-sampling (5s) ^b
<i>Physical contact with other cat*</i>	Cat is within 5cm away from the other cat	1/0-sampling (5s) ^b
<i>Clawing object</i>	Cat is manipulating an object using its claws	1/0-sampling (5s) ^b
<i>Attention towards door</i>	Cat is focused on the door, by gazing/staring at the door (<2 sec)	1/0-sampling (5s) ^b
<i>Attention towards owner</i>	Cat is focused on the owner, by gazing/staring at the owner (<2 sec)	1/0-sampling (5s) ^b
<i>Attention towards cat*</i>	Cat is focused on the other cat, by gazing/staring at it (<2 sec)	1/0-sampling (5s) ^b
<i>Attention towards outdoors</i>	Cat is focused on the outdoors, by gazing/staring at the outdoors through e.g. a window (<2 sec)	1/0-sampling (5s) ^b
<i>Attention towards unidentified</i>	Cat is focused on an unidentified object, by gazing/staring at it (<2 sec)	1/0-sampling (5s) ^b
<i>Vocalising: Meow</i>	Cat is vocalising using a high-pitch meow	1/0-sampling (5s) ^b
<i>Vocalising: purring</i>	Cat is vocalising using a low-pitch purring	1/0-sampling (5s) ^b
<i>Lip licking</i>	Cat is licking its lips	Continuous sampling (frequency) ^c
<i>Near door (ND) <1m</i>	Cat is within 1 m to the front door	1/0-sampling (5s) ^b
<i>Near owner (NO) <1 m</i>	Cat is within 1 m to the owner	1/0-sampling (5s) ^b
<i>Verbal contact owner</i>	Owner initiates verbal contact with cat	1/0-sampling (5s) ^b
<i>Physical contact owner</i>	Owner initiates physical contact with cat	1/0-sampling (5s) ^b

*Additional behaviours for pair-housed cats

a = Instantaneous sampling every 5 s

b = One-zero sampling within each 5s interval

c = Continuous sampling (frequency)

3.3 Statistical analysis

All statistical analyses were performed with Minitab version 17, using 1-sample Wilcoxon rank sum test to analyse differences between treatments in each phase.

Significance limits were set at $p \leq 0.05$ and tendencies were considered when the p-value was between 0.05-0.1. Results are presented in boxplots (proportion of sample points with 95 % confidence interval). Where not significantly different nor tendencies, further exploration of the data is presented as mean proportion of sample points \pm SE. Due to the few number of pair-housed cats (fewer than six, which is the recommended minimum number of subjects when applying non-parametric tests) no statistical tests were performed. However, descriptive statistics is presented regarding pair-housed cats.

4. Results

Out of the 55.2 h of video recorded material, the single cats were out of the cameras range for approx. 34 % of the time, but these occasions were evenly distributed over the phases and treatments (i.e. there were no significant differences between treatments in any phase). Keep in mind that due to the few number of pair-housed cats no statistical tests were performed. However, descriptive statistics is presented regarding pair-housed cats.

4.1. Pre-separation (phase 1)

During the 5 min before the owner left, single-housed cats showed a tendency to spend more time in the hallway ($p=0.1$) near the front door ($p=0.1$), when they were going to be left alone for 4h compared to when left for 30 min (Figure 2). For a descriptive graph showing behaviours performed during this phase, irrespective of treatment, see Appendix 1, Figure 14.

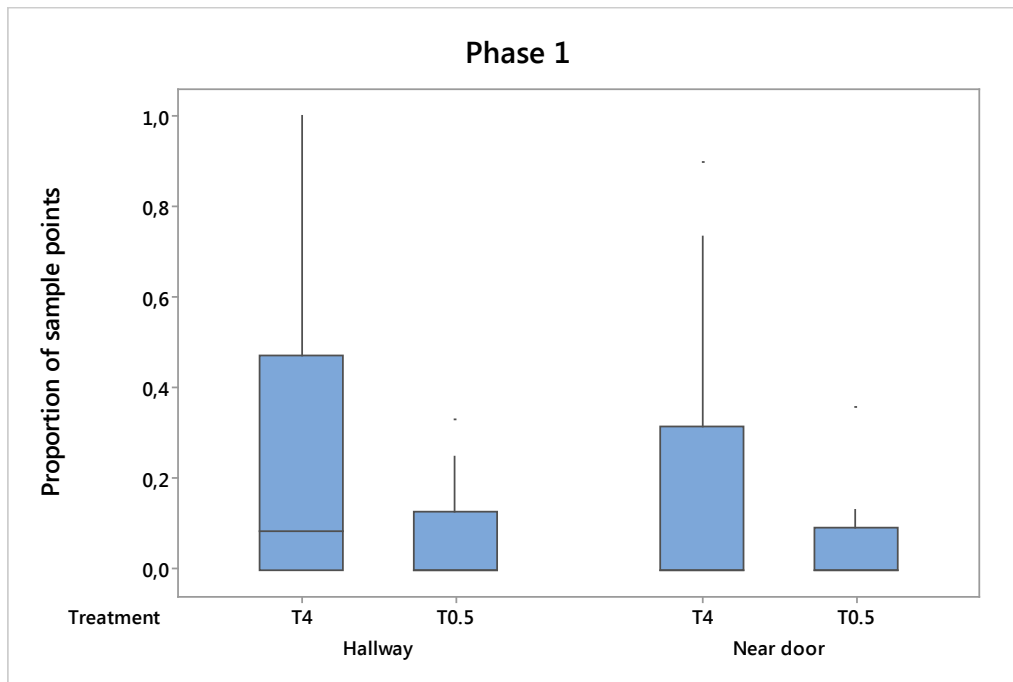


Figure 2. Boxplot (medians with 95% confidence intervals (CI)), showing the time cats spent in hallway (the two boxes on the left hand side) and near the front door (the boxes on the right) before the owners left the home, in T_4 and $T_{0.5}$.

For a descriptive graph showing behaviours in the pair-housed cats, see Appendix 1, Figure 18.

3.2. Separation period (phase 2, 3 and 4)

3.2.1. Phase 2

During the first 5 min after owner departure, no differences were found between treatments.

Although no treatment differences, descriptions of the cats' activities (summarised from both treatments) are presented in Figure 3 (single-housed cats) and Figure 4 (pair-housed cats).

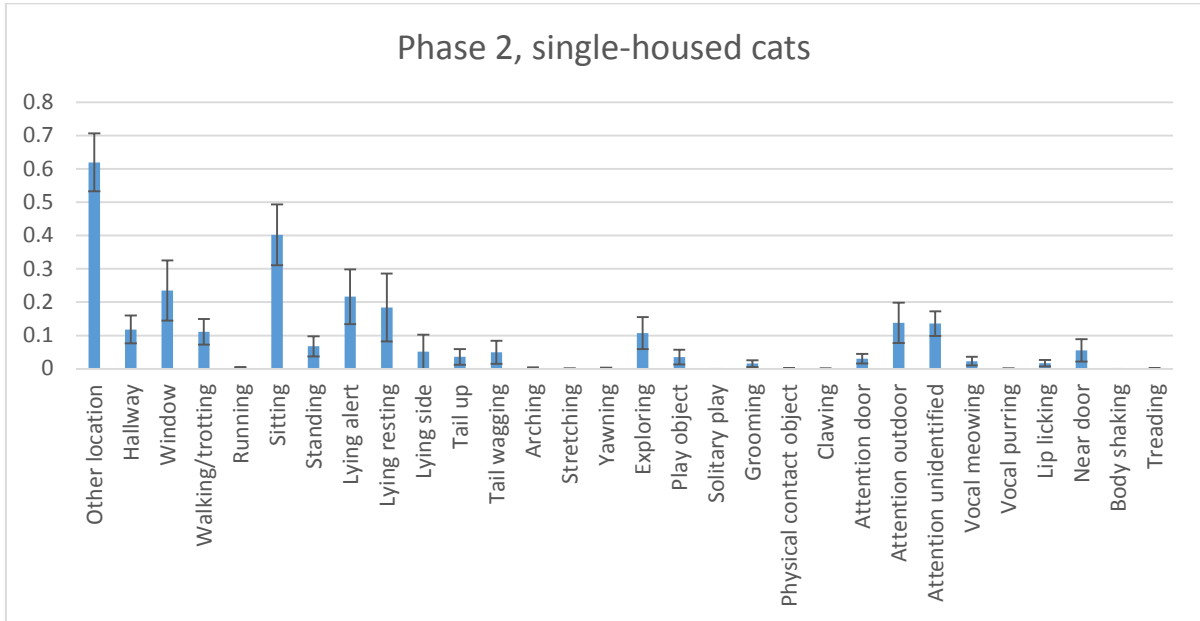


Figure 3. Descriptive statistics (mean proportion of sample points \pm SE) showing behaviours performed during phase 2 in single-housed cats while left alone at home, without consideration to treatment.

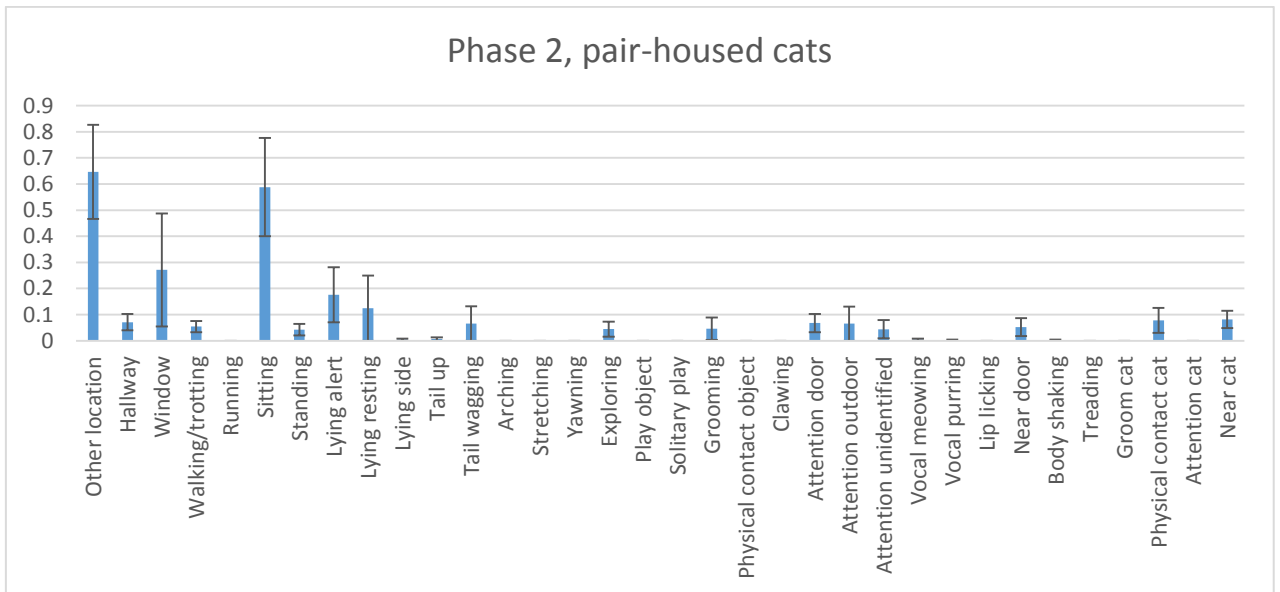


Figure 4. Descriptive statistics (mean proportion of sample points \pm SE) showing behaviours performed during phase 2 in pair-housed cats while left alone at home, without consideration to treatment.

3.2.2. Phase 3

For the rest of the separation time (i.e. the period from 5 min after the owner left until 5 min prior to owner return), cats spent more time lying down resting when left alone for 4h compared to 30 min (Figure 5; $p=0.004$). For a descriptive graph showing behaviours performed during this phase, irrespective of treatment, see Appendix 1, Figure 15.

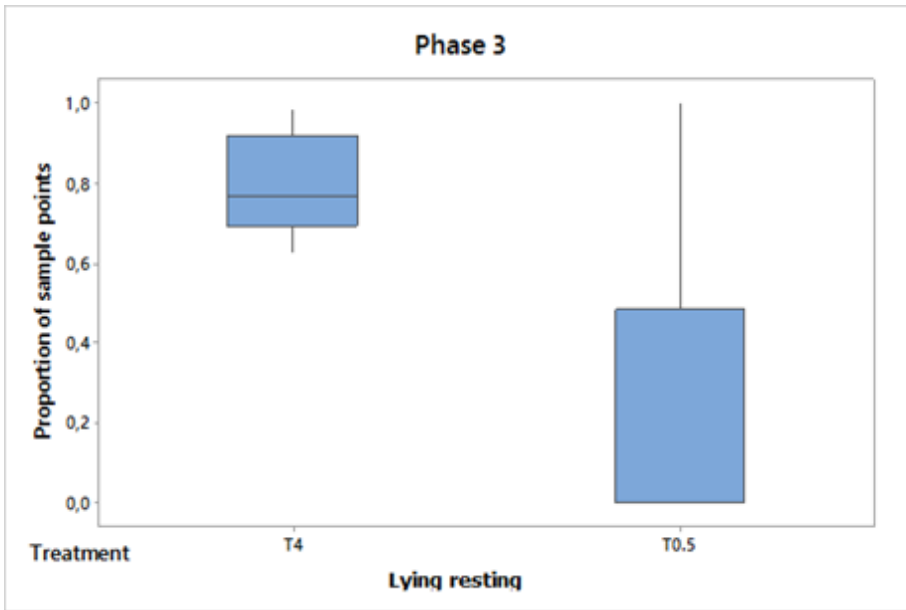


Figure 5. Boxplot (median with 95% CI) showing the time single housed cats spent lying resting in T₄ and T_{0.5} during phase 3 while left home alone.

The pair-housed cats seemed to spend their phase 3 in a similar manner as the single-housed cats, lying resting more during T₄ as indicated by the descriptive statistics presented in Figure 6. They also seemed to spend more time closer to their cat companion during T₄ than T_{0.5}. Possibly cats were more active during T_{0.5}, showing the behaviours lying alert, exploring, stretching and using tail communication.

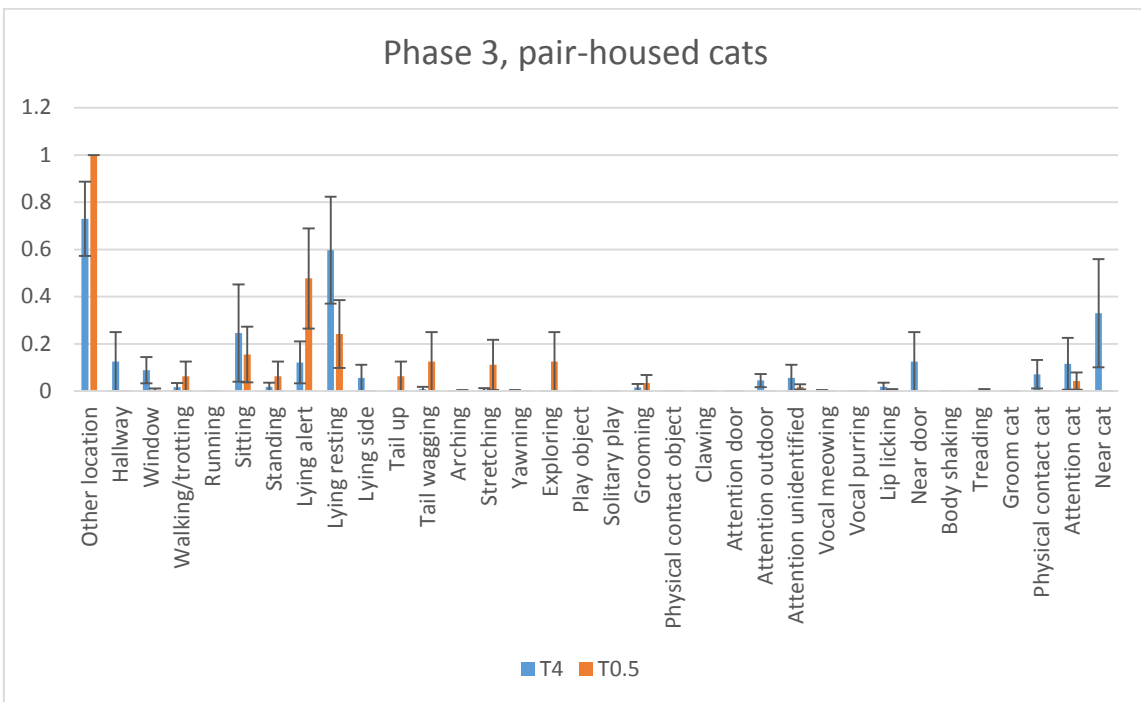


Figure 6. Descriptive statistics (mean proportion of sample points \pm SE) of pair-housed cats left home alone, showing the behaviours performed during phase 3, both treatments.

3.2.3. Phase 4

At the end of the separation time (the 5-min interval preceding the owner's return), cats tended to be more attentive towards unidentified objects/sounds ($p=0.08$) when left alone at home for 4 h compared to 30 min (Figure 7). For a descriptive graph showing behaviours performed during this phase, irrespective of treatment, see Appendix 1, Figure 16. The behaviour of pair-housed cats are presented in Figure 8.

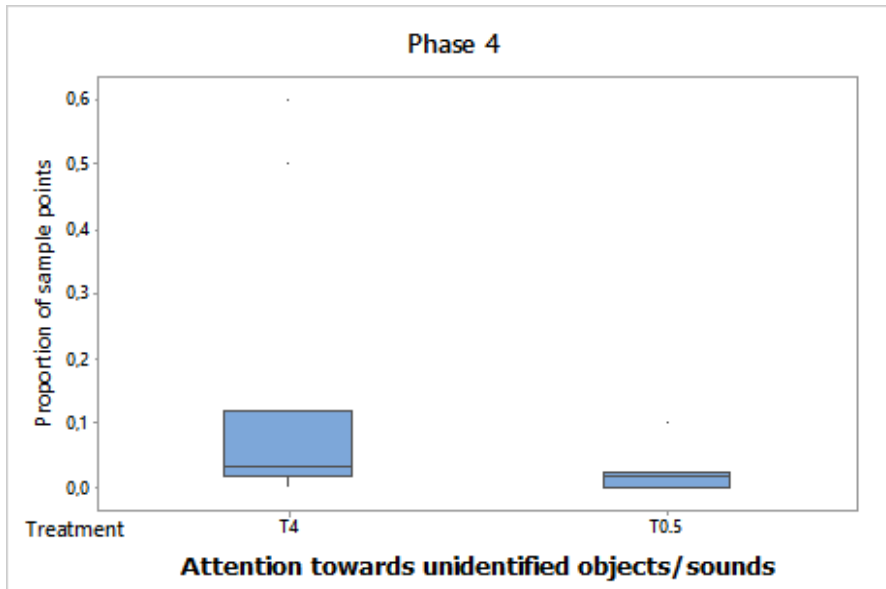


Figure 7. Boxplot (medians with 95% CI) showing time spent by attentiveness towards unidentified objects/sounds in T_4 and $T_{0.5}$ during phase 4 in single housed cats while left alone at home.

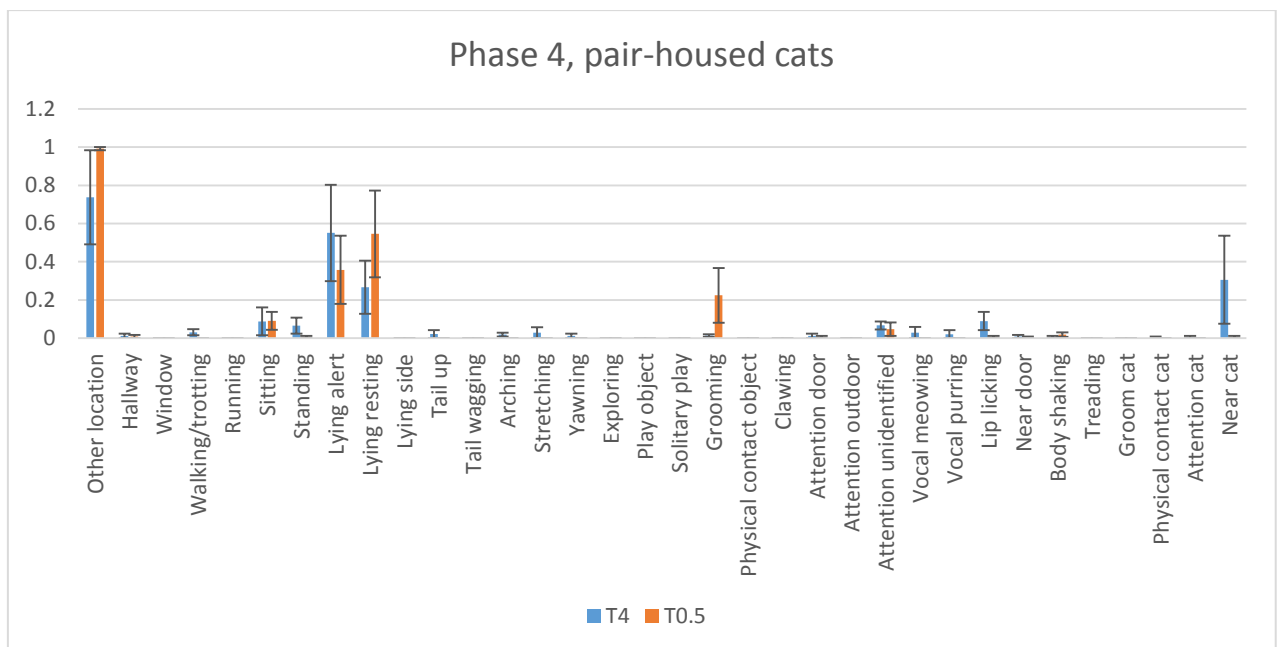


Figure 8. Descriptive statistics (median proportion of sample points \pm SE) showing behaviours performed in pair-housed cats during phase 4, while left home alone, in both treatments.

3.3. Post-separation (phase 5)

At reunion with their owners, cats tended to spend more time near the owner ($p=0.08$) after 4 h of separation. They also tended to stretch ($p=0.09$) and vocalize (purring) more

($p=0.06$) after 4 h of separation compared to 30 min. Moreover, the owner showed a tendency to initiate more verbal contact with the cat ($p=0.07$) in T_4 than in $T_{0.5}$, see Figure 9.

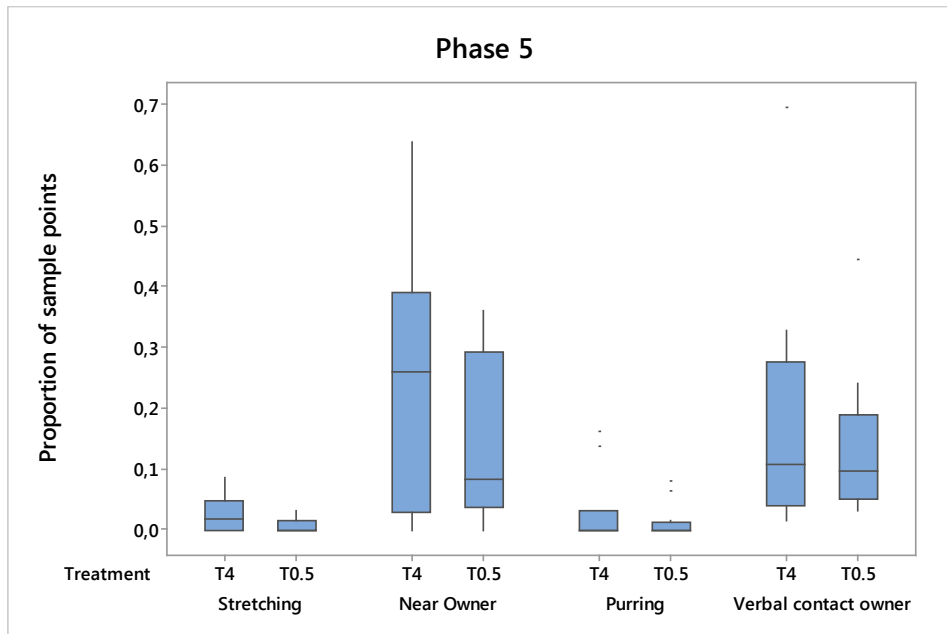


Figure 9. Boxplot (median with 95% CI) of cat (stretching, time spent near owner, purring) and owner (verbal contact) behaviour during phase 5, after the owner had returned.

Looking at the descriptive statistics, it is suggested that the pair-housed cats spent more time in the hallway during phase 5 in T_4 compared to $T_{0.5}$, and they showed tail-up, stretching, staying close to the owner and close to the other cat, and interacting with the other cat using physical contact (Figure 10). The owner seemed, also in this case, to initiate more verbal contact with the cats after 4h of separation. In $T_{0.5}$ it appears as if the cats were not in the hallway as much, but instead were lying alert and attentive.

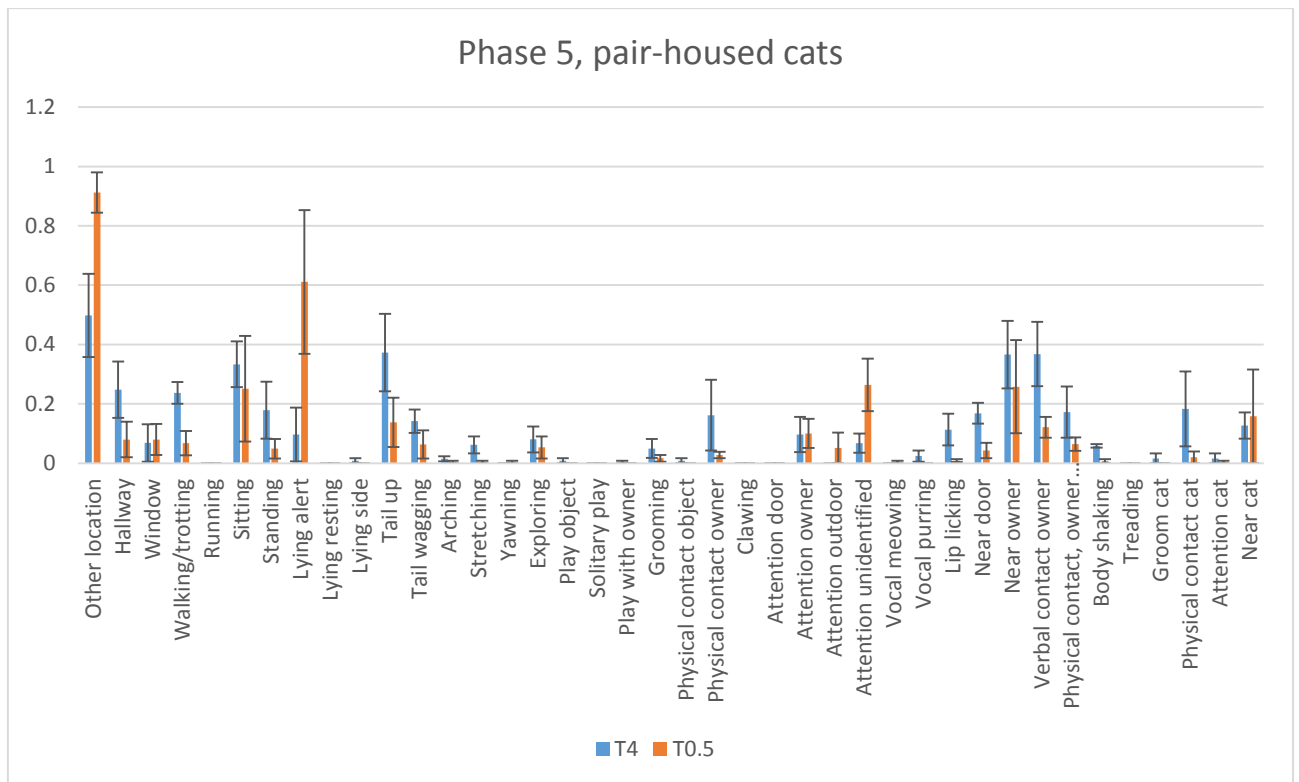


Figure 10. Descriptive statistics (mean proportion of sample points \pm SE) of cat and owner behaviours performed during phase 5, after the owner had returned, in pair-housed cats, in both treatments.

4. Discussion

4.1.1. Pre-separation (Phase 1)

Before separation, cats tended to spend more time at the front door during T₄. This study was designed to control for individual differences between cats, so there should be no differences in this phase, since no treatment has been applied. However, it may be the case that the individual variation is so big that the study requires more cats to overcome such differences.

Nevertheless, the behaviour of the owner may have been a contributing factor to this tendency. When leaving the home for a longer period, he or she might behave differently, e.g. bring out a certain bag or put on a different coat, which the cat associates with the owner leaving for a longer period of time. This could have resulted in the cat spending more time in the hallway, close to the door, to keep an eye on its owner while he or she is preparing to leave.

Phase 1 in the pair-housed cats was not analysed through statistical measures, but when looking at Figure 19 (Appendix 1), there seems to be no differences between treatments.

4.1.2. Separation period

Phase 2

As expected, no differences were found between treatments in phase 2, which is immediately after the owner has left.

When looking at the descriptive graphs, it looked like both the single-housed cats and the pair-housed cats spend it in the same manner (Figure 3 and 4). They mostly spend it in another location, which could be any other room than the hallway, sitting down. The single-housed cats show a bit more attentive behaviours and a bit more motor behaviours

such as walking and exploring than the pair-housed cats. Both of the groups show grooming during this phase, but only the single cats show lip licking. During the observation of the material, lip licking appeared to be associated with grooming. Even though it looks like there is a higher frequency of grooming in the pair-housed cats group, there is no observed lip licking that could be connected to this. Rehn and Keeling (2011) found in their study of dogs left alone at home that dogs expressed more lip licking at reunion after 2 and 4 h than after 30 min. Lip licking in dogs is an indication of arousal, along with body shaking. Since cats are solitary predators, they do not have as great visual signaling repertoire as those found in social predators such as dogs. In this study, there are no records of body shaking for the single-housed cats, but there is a low frequency of this in the pair-housed cats. In cats, there are no studies that look at lip licking as a behaviour indicating stress. However, head shaking has been described as a stereotypy in cats (Bradshaw *et al.*, 2012). Since both body shaking and lip licking are expressed at a very low frequency in both groups during phase 2, there is no way to determine if these are behaviours expressed to show some kind of separation anxiety. Most probably, the behaviours are coupled to the grooming behaviour in this case.

Phase 3

In phase 3 a significant difference was found, which showed that during T_4 cats spent more time lying resting (lying down, head in contact with floor or furniture). It is important to remember that phase 3 in $T_{0.5}$ is much closer to the event where the owner leaves compared to the equivalent phase in T_4 , as the ten 1-min intervals were evenly distributed over the remaining separation time in both treatments. This could be the cause of this difference. When phase 3 is compared through descriptive statistics in a graph, it looks like the cats are more active in $T_{0.5}$ than T_4 (Figure 22 Appendix 1). Therefore, it can be speculated that cats, when left alone, spend a part of their first hour alert, before settling in and beginning to rest. Maybe they have higher expectations of a returning owner during this first hour, since many of the recurring everyday activities, such as fetching mail, going grocery shopping, or taking out the trash, are shorter periods of being left alone. It can be that these short periods when the owner leaves are more likely to be expected to occur since they can happen several times a day, while leaving for work (usually) only happens once every day.

The descriptive statistics for pair-housed cats indicates a similar behavioural pattern to that of the single-housed cats. During phase 3, cats in $T_{0.5}$ seemed to be more active than in T_4 (Figure 6), as they expressed higher frequencies of lying alert, tail wagging, stretching and exploring. This could also be connected to differences in expectations of an owners' return, which was discussed above. However, in T_4 it seems like the cats stay close to each other during this phase. To find out if this is an expression for social needs during many hours of alone time, further studies are required, with a larger number of participants.

Phase 4

The only difference found in phase 4 was that cats tended to be more reactive and attentive towards unidentified sounds and objects in T_4 than in $T_{0.5}$. One may speculate that the cats feel a higher arousal when the owner returns after 4 h than after 0.5 h, and that they show it through attentiveness when they hear or see the owner approaching the door. It could be that cats in $T_{0.5}$ just has settled down and are less prone to respond to the returning owner. This is however impossible to answer since we did not make a more detailed analysis of the behaviour patterns of the cats in this study. Observations throughout the whole separation period in T_4 are needed in that case.

The pair-housed cats (Figure 8) seemed to differ in their behaviour during phase 4 according to the descriptive statistics. Cats in $T_{0.5}$ seemed to show more frequent grooming behaviour during this phase, and more lying alert and lying resting. The grooming and lying alert could be indicating that the cats are still settling in after the owner left, and since they were still quite active in phase 3, this could further support this interpretation. Cats seemed to stay closer to each other in T_4 , express more lip licking and lying alert. In phase 4 of T_4 , they also appeared to show attention to the environment, which could indicate that they reacted in the same manner as single-housed cats during phase 4 in T_4 .

4.1.3. Post-separation

Phase 5

When the owner returned, cats in T_4 tended to show more stretching, purring and staying closer to the owner for a longer time period than in $T_{0.5}$. However, the owners showed a tendency to be more verbal with the cats which could be the cause of the nearness and vocalization of the cats. It might also be that the owner was talking to the cat because the cat was purring and stayed close to them. To find out what behaviour triggers which response, we could have standardized the behaviour of the owners, telling them to either behave in a similar way when returning home in both treatments ($T_{0.5}$ and T_4), or have asked them not to interact at all with the cats when arriving at home. This was not the case in our study, we told the owners to act natural and behave just as they would do in a normal situation. For future studies, standardizing the owner's behaviour would be really interesting to see the response of the cat.

Rehn and Keeling (2011) found that dogs initiated more contact with their owner and showed more greeting behaviour when they had been separated for 2 and 4h, compared to 0.5h, while no differences were observed in owner behaviour. The difference in separation duration did not affect rubbing on owners, which is interesting since rubbing often is used as a greeting behaviour that occurs when a cat has been away from its social group (Bradshaw *et al.*, 2012). This was also indicated by Martens (1991), who found that outdoor cats rub against their owners more when returning home than indoor cats do towards their owners. To speculate in this matter, it could be that an outdoor cat that comes home, feels the need to mark its territory further, since it does not have control over the home range when it is outside. An indoor cat on the other hand, has a well-marked territory already and therefore does not feel the need to rub its owner as frequent, since the owner will stay in the home range. The owner is in that case already 'marked', since it is within the marked territory.

Another tendency found was that cats stretched their body more in T_4 than $T_{0.5}$ when reunited with their owner. To my knowledge it is unknown if stretching might be used in a social context. If it was, it could also explain the low amount of stretching performed during the alone time. But also, it might be a 'comfort behaviour' from spending a longer time lying resting before the owner returned home.

Based on the fact that tail-up expression is used as a greeting behaviour among cats, one of the hypotheses was that cats would show higher frequency of tail-up expression towards their owner when reunited in T_4 . However, the cats showed as much tail-up in T_4 as they did in $T_{0.5}$, and, while not being expressed differently in the two treatments, the frequency of tail-up was much higher around reunion than in any of the other phases (Figure 11, Appendix 1), indicating the friendly greeting pattern. In phase 2 and 4 however, the tail was also used even though there was no owner present. This could be related to the owner leaving and returning to the home and hence suggest a link to communicative behaviour as they might see or hear the owner outside the home.

For the pair-housed cats, the descriptive statistics make it seem as if they show more tail-up in T₄ compared to T_{0.5}. This could be indicating that my hypothesis of exaggerated behaviours due to competition is true. The other behaviours pair-housed cats show during this phase in T₄ is the same as the single-housed cats; stretching and staying close to the owner. They do also stay close to, and initiates physical contact with, the other cat. My hypothesis was that they would show the same behaviours, but to a higher extent. It seems thus that this hypothesis was true, but it is impossible to know for sure since no statistical analysis were performed.

Indications of distress

Some indicators of distress were chosen in this study. These were vocalizations, motor activity, treading and staying close to the front door. Treading is a known comfort behaviour in cats and motor activity is one indicator used in the Cat Stress Score Table (Kessler and Turner, 1997). The indicator of staying close to the door was chosen since it could be logical for a cat with separation anxiety to stay at the place where the owner will show up. Potter and Mills (2015) saw that cats vocalized more frequently when the owner left a room compared to when a stranger left. In our study, according to the patterns observed from the descriptive figures, it seemed as if the cats did vocalize more frequently during phase 2, when the owner had just left, but overall the frequency of indicators of distress were low (Figure 22, Appendix 1). This may be interpreted as cats were not distressed when the owner left the cat.

Interactions between cats

There seemed to be some interactions between the cats in all of the phases (Figure 20, Appendix 1). A quite low frequency of allorubbing was seen, which is a behaviour suggested to be used for recognition of a group member (Bradshaw *et al.*, 2012). Perhaps this was not necessary as the cats were located in the same house on a regular basis. However, no aggressive or withdrawal behaviours were seen in this study, and since the cats did stay within 1 m of each other during almost 20 % in practically every phase, they do seem to use the company of each other during the separation time. In two out of four pair-households the cats were considered siblings and in the other two households the cats had been introduced to each other later in life. Housing in pairs could be beneficial for some cats, however, the individual variation is quite large, so a higher number of participants would be needed in order to further interpret the results.

The study in relation to the Swedish animal welfare law

The results in this study showed that cats are affected by the duration of time left alone. The Swedish Board of Agriculture's prescription and general advice for keeping dogs and cats state in 16 § 1st chapter, that supervision of cats are required twice daily, and more often if the cat is young, sick or hurt (SJVFS 2008:05). The results in this study could therefore indicate that this paragraph is a suitable tool to follow in order to attend to your cat. An owner should always strive to supervise his cat at least twice a day, or see to it that someone else can do it if the owner is away. Not only to make sure that the cat is physically healthy and has access to food and water, but also to fulfill its social needs.

Environmental usage

The two most active phases in the study seem to be phase 2 and phase 5, when summarizing both treatments. During these two phases they walked around, explored, played and utilized the windows, which also was a popular activity according to the survey by Shyan-Norwalt (2005). Especially single-housed cats used the windows to a quite large degree, compared to the pair-housed cats. This could be because the pair-housed cats have

each other to keep an eye on, while, for the single cat, the outside world is much more interesting than an empty house. In the current study, no consideration was taken to how many rooms were visited or specific roaming patterns. When it comes to hiding places, which are chosen in cats' territories (Jongman, 2007), the cats were visible for approx. 65 % of the time, indicating that hiding places may be more popular to use when the owner is at home. That is not entirely impossible, since they then have a reason to go into hiding to get their sleep uninterrupted.

Possible weaknesses that should be addressed in future studies

The main concern with this study is the low number of participants. A lot of people were interested to join the study during the first planning stages, but decided not to once the criteria were specified. When first initiating this study, we planned to record the behaviour of cats while left alone at home during 0.5 h and 8-9 h. However, due to technical limitations this was not possible. Hence, several cat owners that had planned to participate were no longer able to do so due to scheduling issues as the 4 h treatment interfered too much with the owners' routines. Although struggling with finding new participants, the project was also time limited, making it difficult to reach the intended number of participants. With even more participants we could have reached a more secure result in both groups.

As discussed earlier, standardizing the behaviour of the owner at reunion could be a way to make sure that the behaviour of the cat is not depending on the owners' behaviour.

More thorough behavioural observations during separation in T₄ could be beneficial in order to understand the behavioural patterns during the first hour in both treatments. That way, we would have been able to better interpret the found differences in phase 3, where cats in T_{0.5} may not have settled down yet, and this could have been similar for the cats also in T₄. It would also contribute to better understand how cats' activity level declines.

More cameras could probably be of use, considering cats were out of range for a bit over 30% of the time.

5. Conclusion

There was an effect of time on the behaviour lying resting during separation in single-housed cats, and there were several behaviours (vocalize, stretching, staying within 1m of the owner and verbal contact initiated by owner) that tended to be expressed more after a longer duration of separation. With this evidence it can be concluded that the duration of time left alone has an impact on the behaviour of cats, but further investigations are needed to conclude if the reunion behaviour also is affected by the separation time. The participating cats did not show any clear indications of distress when the owner left.

When it comes to pair-housed cats, nothing can be concluded since there were too few participants in this study. However, this study opened up several interesting aspects that may be worthwhile investigating in the future. The descriptive graphs seem to show that cats did spend quite some time close to each other when left alone at home, indicating that they may benefit from each other's company.

The study showed that not all of my hypotheses were supported. Cats did not show the same behaviours when left alone at home for different durations of time, and no *significant* differences in the cats' behaviour were found during reunion. Cats tended to purr more, but did not initiate more physical contact with their owner in T₄. My hypothesis about the group differences could not be answered due to too few participants in the pair-housed group, but the collected data might suggest that the pair-housed cats were more active and

indeed did interact with their companion cat to some extent. According to the graphs, they may also express reunion behaviours at a higher frequency, as hypothesised.

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Appendix 1

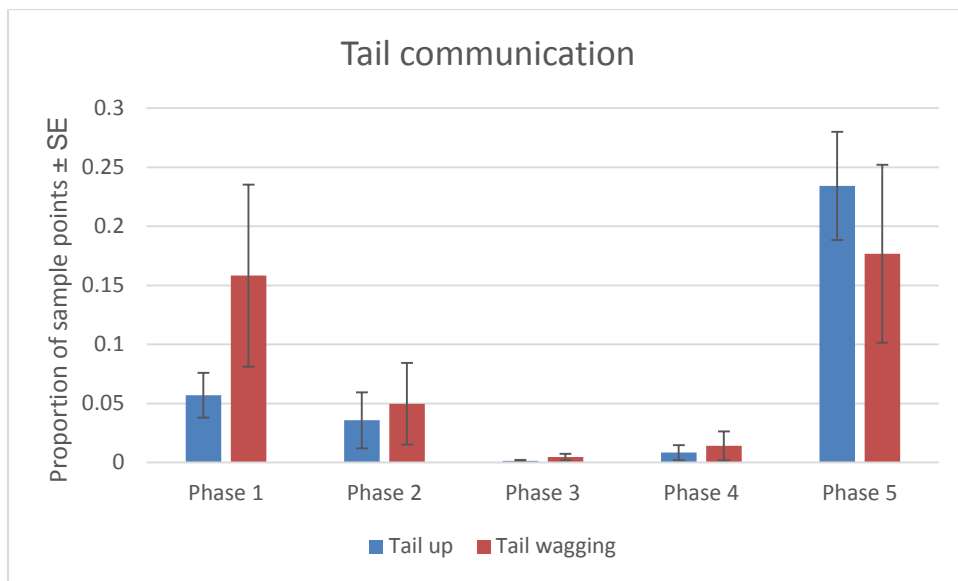


Figure 11. Tail usage during all phases, with no consideration to treatment.

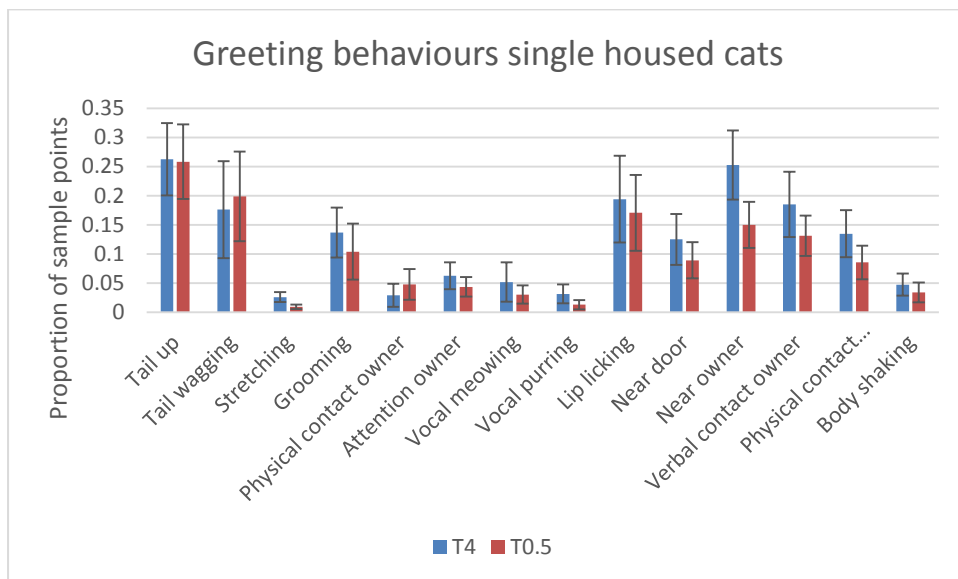


Figure 12. The greeting behaviours presented during both treatments.

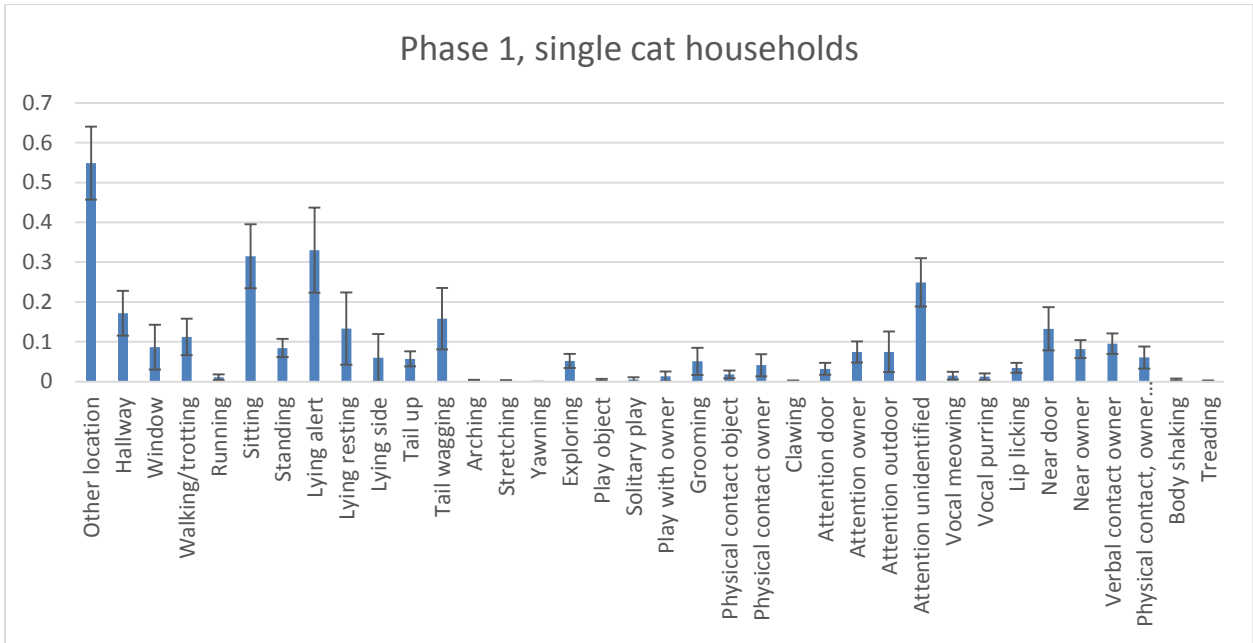


Figure 13. Descriptive statistics showing behaviours performed during phase 1, without consideration to treatment.

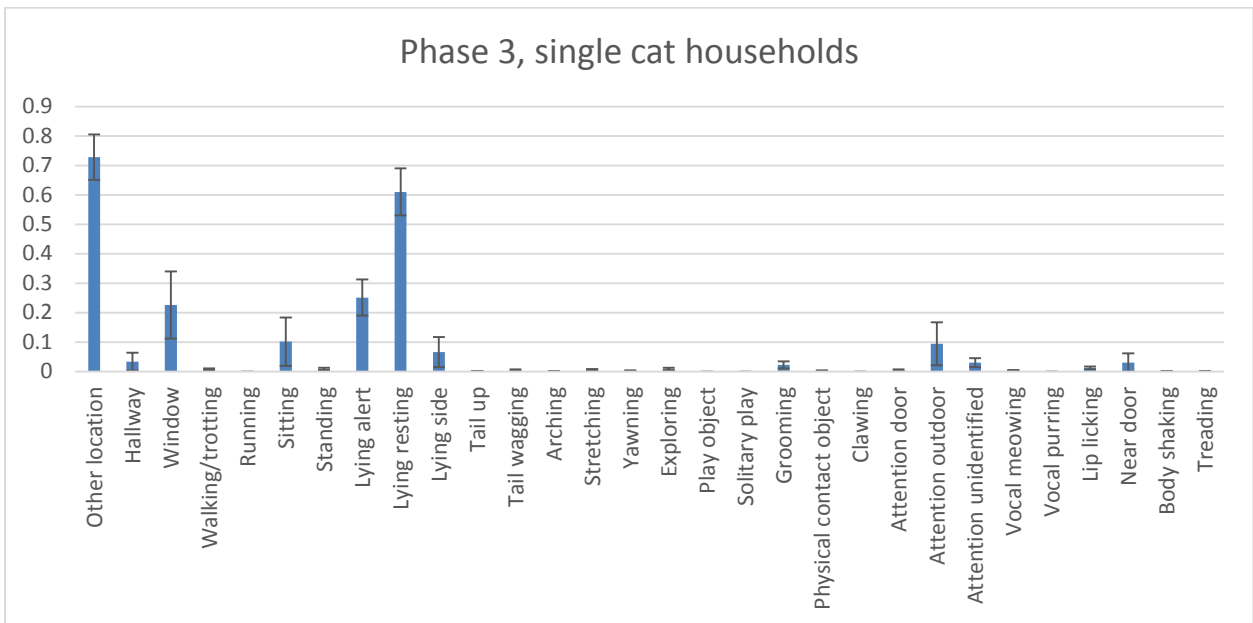


Figure 14. Descriptive statistics showing behaviours performed during phase 3, without consideration to treatment.

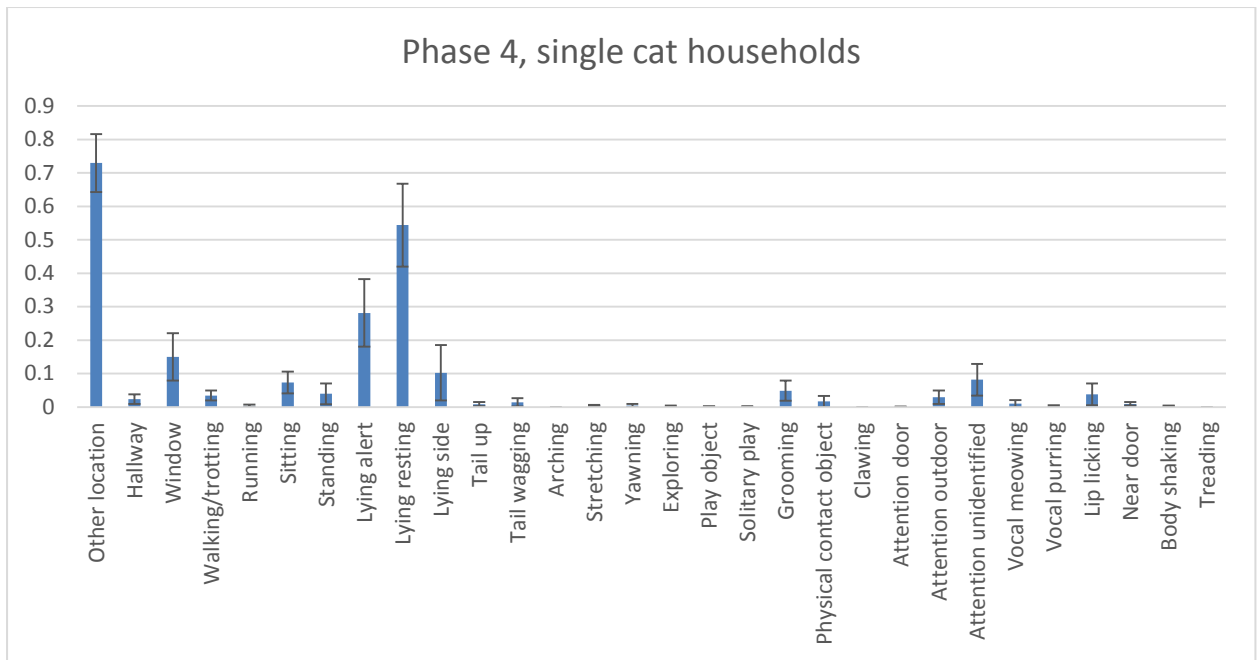


Figure 15. Descriptive statistics showing behaviours performed during phase 4, without consideration to treatment.

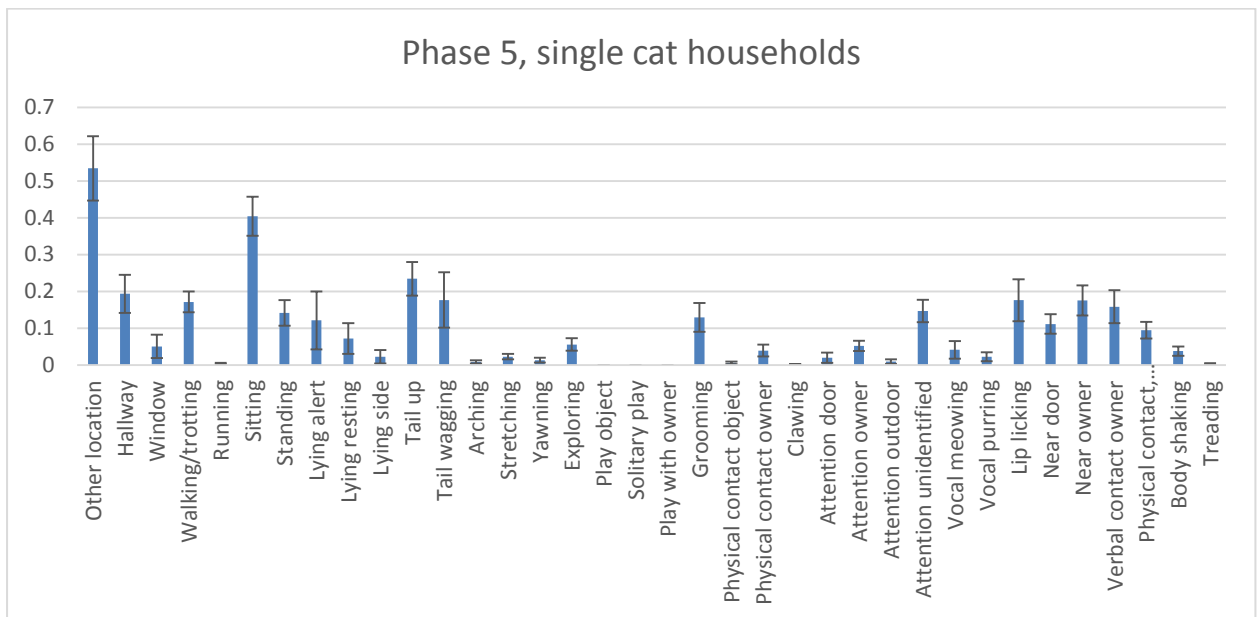


Figure 16. Descriptive statistics showing behaviours performed during phase 5, without consideration to treatment.

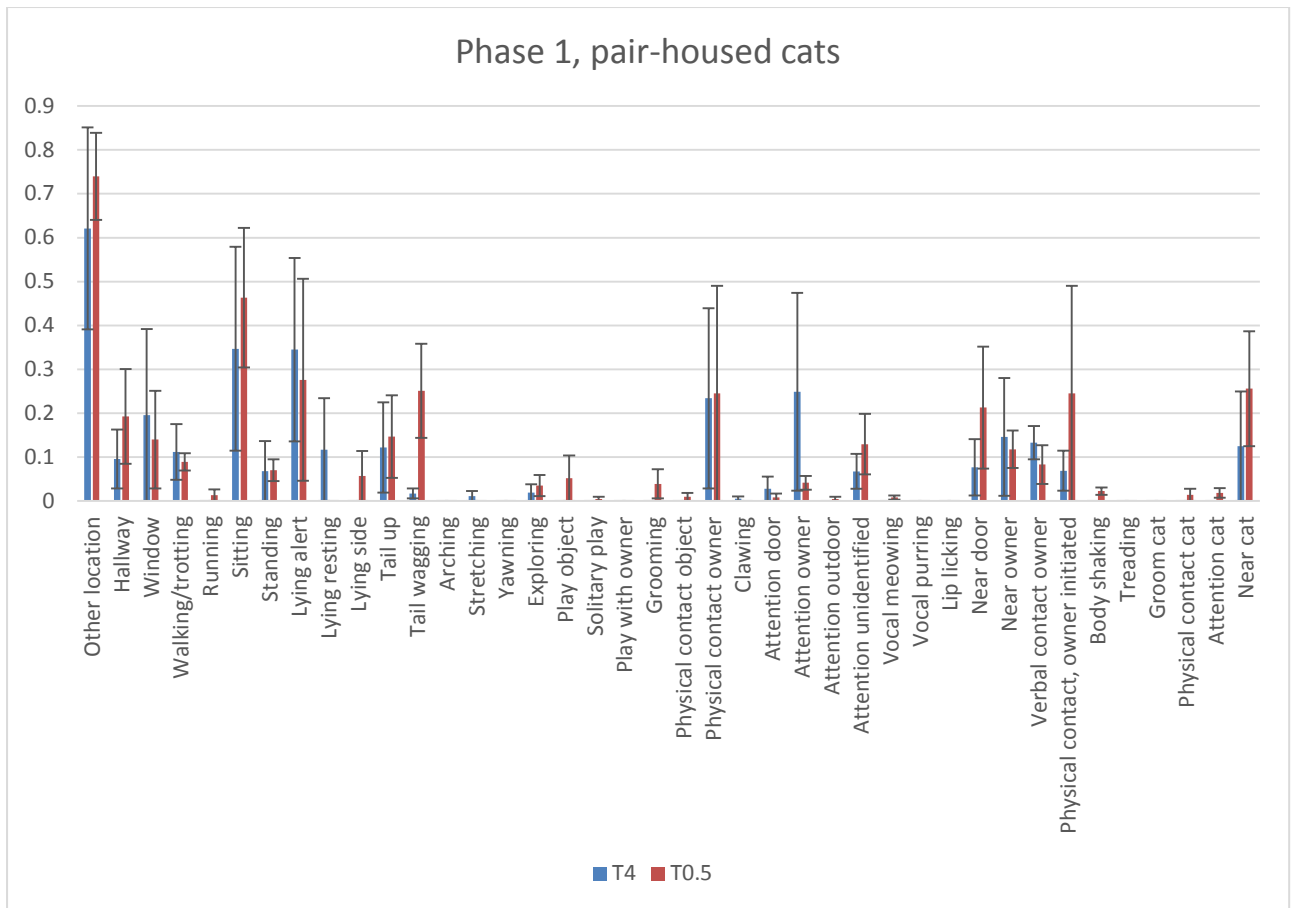


Figure 17. Descriptive statistics showing behaviours performed in pair-housed cats during phase 1, in both treatments.

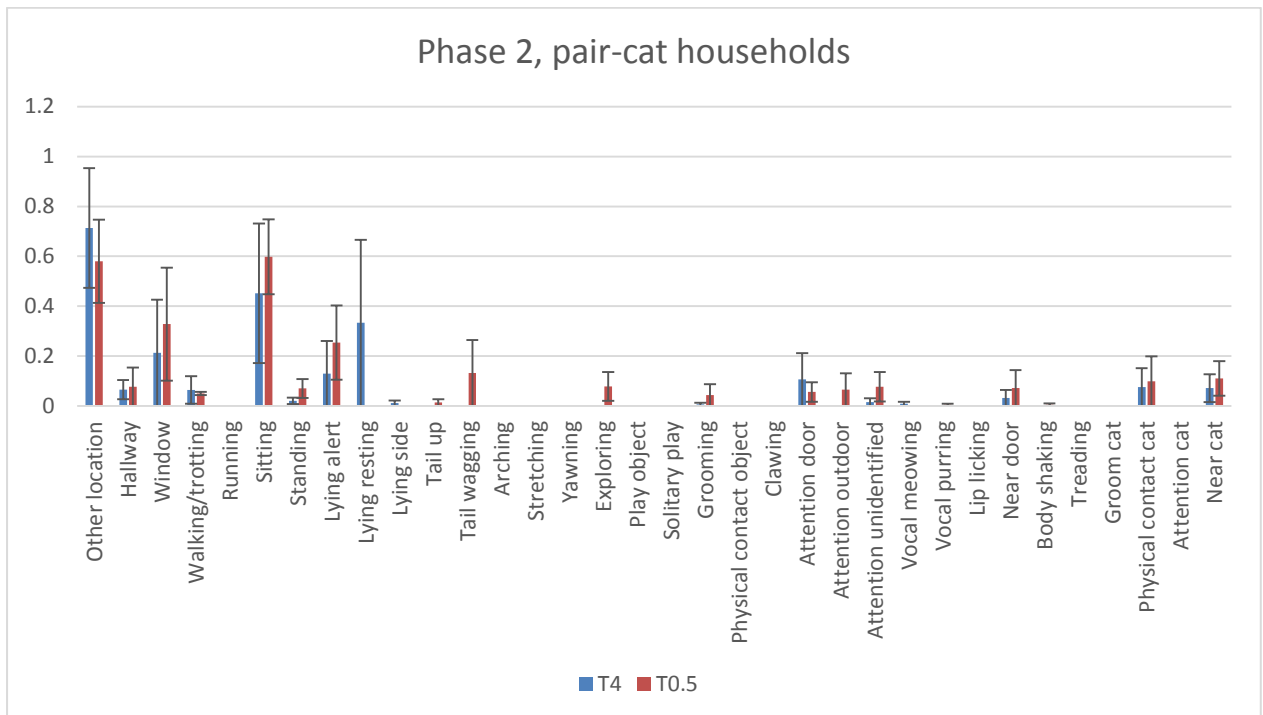


Figure 18. Descriptive statistics showing behaviours performed in pair-cat households during phase 2, in both treatments.

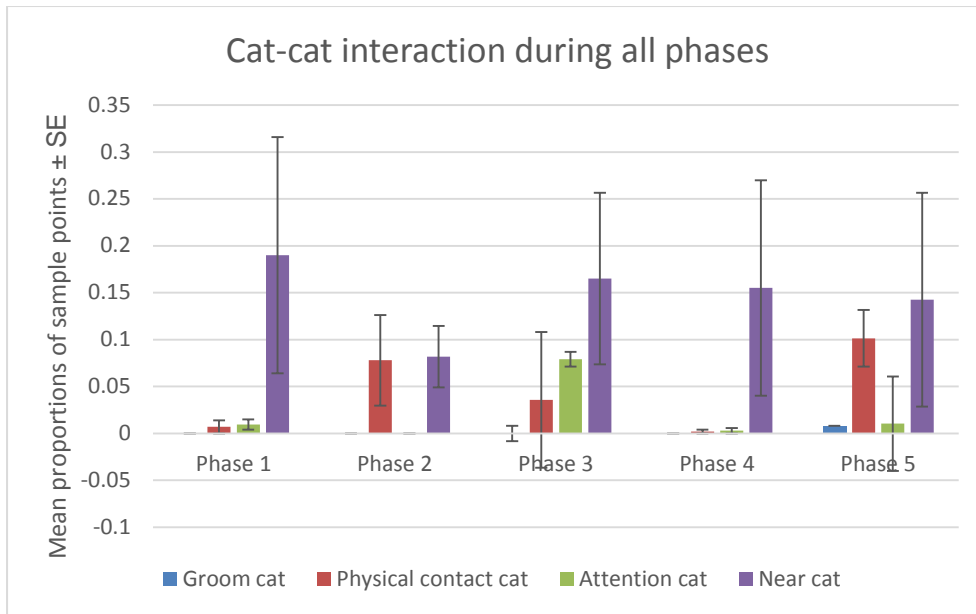


Figure 19. Descriptive statistics showing the amount of cat-cat interaction during all phases, no consideration to treatments.

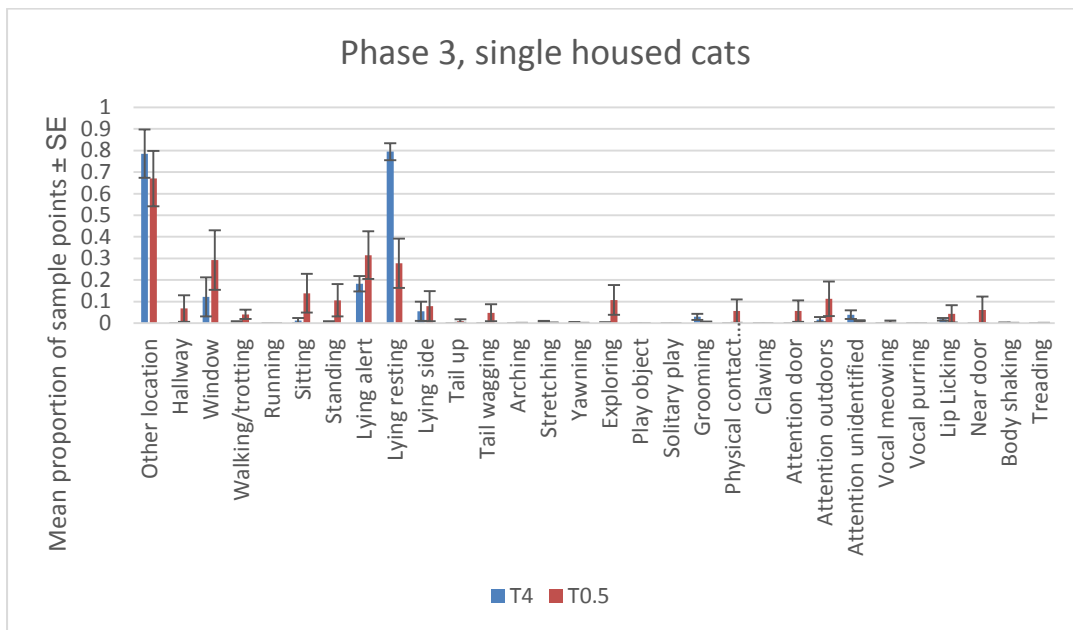


Figure 20. Phase 3 in single housed cats described with mean values and standard error of mean.

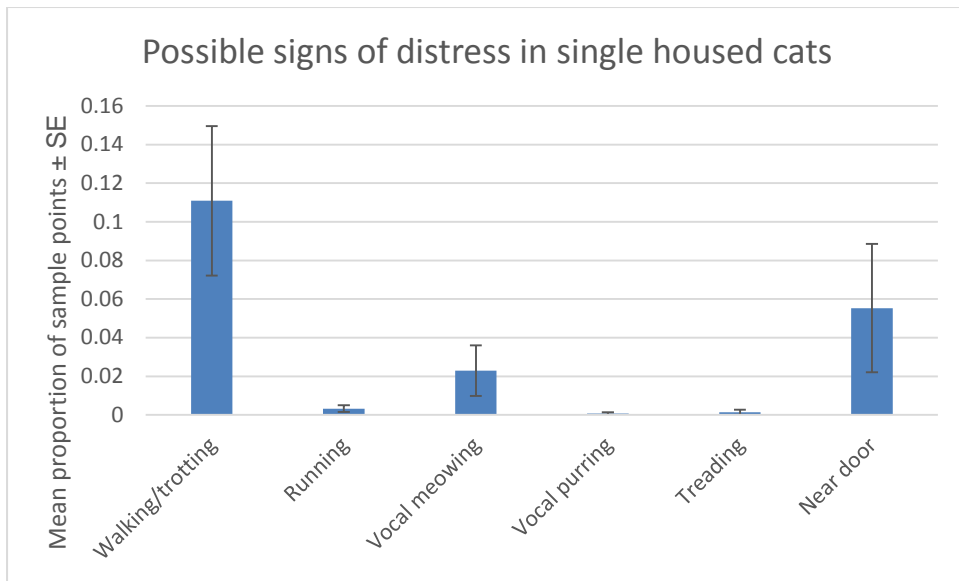


Figure 21. Possible signs of distress performed during phase 2, no consideration to treatment.

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Tel 0511-67000
E-post: hmh@slu.se
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www.slu.se/husdjurmiljohalsa

*Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal
Science
Department of Animal Environment and Health
P.O.B. 234
SE-532 23 Skara, Sweden
Phone: +46 (0)511 67000
E-mail: hmh@slu.se
Homepage:
www.slu.se/animalenvironmenthealth*
