WHICH CAT TO CHOOSE: AN ANALYSIS OF MATE PREFERENCE, AND RECOMMENDATIONS FOR CHOOSING AN ADDITIONAL CAT.

Thesis Behavioural ecology
Faculteit: Bètawetenschappen
Departement: Biology; Environmental biology &
Dier in Wetenschap en Maatschappij

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Utrecht, August 2014

August 2014 UNIVERSITY UTRECHT

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Utrecht, Aug 8th 2014

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Abstract

The domestic cat kept in multi-cat households often shows aggression. According to a survey of 90 households almost 50% of the owners have problems with cat-cat aggression in their household. This cat-cat aggression or intercat aggression is a big problem for cat owners. In order to get a better understanding of this problem, an analysis of cat preference was performed and recommendations are given with regards to choosing a new cat in addition to the one you have. The domestic cat may live in social groups if their food resource is concentrated and stable. These social groups can consist of related females and a larger group consists of related females and unrelated males. Studies in shelters and households show that related females are the best combination for a positive quality of the relationship. However, the most important factors predicting a good quality of a relationship are that cats are related, that the difference between the cats' age is small or that they have grown up together. Social ties established early in life could be an explanation for more affiliative behaviour between cats and for prevention of territorial aggression. Besides these main factors, density, the method of introduction of a new cat and housing conditions are important for a good quality of the relationship between the cats.

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1. Introduction

During the first decade of the 21st century, the cat became the preferred pet of many owners, valued because it combines an affectionate nature with a degree of independency, as well as more prosaic qualities such as convenience and cleanliness (Bradshaw *et al.*, 2013). However two-cat households and multi-cat households turned out to be potentially problematic. According to a survey of 90 multi-cat households almost 50% of the owners have problems with cat-cat aggression in their household (Bradshaw *et al.*, 2000), where other behaviour problems occurred in less than 10%. Cat-cat aggression can lead to stress behaviour, inflict wounds etc., making cat-cat aggression a big problem for cat owners. In this thesis, I investigate the natural social behaviour of the domestic cat and provide recommendations about the best combination of cats in two-cat households with regards to gender, relatedness (a.k.a. coefficient of relationship) and age. In addition I will discuss effects of castration, density and environmental enrichment on aggression.

1.1 The natural behaviour of the cat, *Felis*.

The domestic cat, formally classified as *Felis Silvestris catus*, descends from the wild cat *Felis Silvestris Lybica* (Bradshaw *et al.*, 2012). The *Felis S. Lybica* is an African/Arabian wild cat, which is the easiest to domesticate, compared to other wild cats (Leyhausen, 1987). The domestication process of cats was unique, having been described as 'self-domestication' (Beaver, 1992). That is to say that humans played little or no role in the changes except by allowing cats near them, giving the cat a better chance of survival and reproductive success (Beaver, 1992).

1.1.1 Wild cat

In order to understand the social structure of the domestic cat is it important to understand the social structure of the ancestors and other related *Felis* species. Unfortunately not much is known about the social behaviour and organization of the *Felis S. Lybica*. A wild species that is frequently observed and that has the same size as the domestic cat is the Iriomotecat, *Prionailurus iriomotensis* (Leyhausen, 1987). This cat lives in South and East Asia and is related to the panther, *Prionailurus bengalensis*. The Iriomotecat has a strict territory with an average of two square kilometers. The cats are strictly solitary and have no contact with cats living in adjacent territories, except during mating season. The European wild cat, *Felis Silvestris* also shows the same solitary pattern as the Iriomotecat (Leyhausen, 1987). In addition to this solitary cat species, there are some more social species, such as the red lynx *Lynx rufus*. The lynx males form bonds with females and their related kittens for a few hours to a few weeks. There are also some feline species where adults live together for a longer period. For instance, cheetahs *Acinonyx jubatus* and lions *Panthera leo* adult males live in groups, and females live communally only in lions. However, in the lion and other Felis species, such as the

puma *Profelis concolor* and the tiger *Panthera tigris* the social organization depends on the environment (Leyhausen, 1987). For example in the Amur area of Russia, tiger ranges extend over several hundred, even thousands of square kilometers. Under these circumstances it is impossible for a male to control more than one female. In comparison with tigers in Sunderbans of Bengal, an area with enough food, females have smaller territories, which results in the fact that male tigers can monopolize several females (Leyhausen, 1987). The latter is a basal form of social organization. Unfortunately, researchers have no certain knowledge of the social organization of tigers, because of inadequate data and too few and only incomplete studies.

Research on the home range of the black-footed cats (*Felis nigripes*) showed that the home range of females and males overlap each other (Sliwa, 2004). Nothing was described about the social behaviour between the cats, but they observed that the black-footed cats hunted solitary. Where lions are know to hunt in groups. The lions in Tanzania and Uganda live in multi-male and multi-female groups. These two countries are rich in water and prey so there is enough food to share. North Africa is very dry and has a lower availability of prey, so for the lion it is more difficult to find a prey. In consequence, in Northern Africa the lions live a more solitary life without a group. This difference indicates that the fact that cats live together probably depends on environmental factors (Leyhausen, 1987). So, in an environment with less prey the group of animals is smaller compared to a prey rich environment.

1.1.2 Domestic cat

The social behaviour and organization of the domestic cat can vary considerably. Their behaviour has been studied in free-roaming and indoor cats. Domestic cats were considered to be a solitary species that had no need for companionship and preferred to be alone. However, recent findings suggest that free-roaming domestic cats might choose to live in groups, commonly called a colony. Whether cats live solitary or in a group depend on the environmental conditions under which they live. Research has shown that this flexibility depends on the abundance and distribution of food resources (Yamane *et al.*, 1997), as has been demonstrated in some wild species. If the food is concentrated and if it is a stable resource, which is large enough, group formation may occur (Izawi, 1984). The group formation can develop because the food resource provides a lower cost for hunting and higher benefit, because the group is able to defend its resources and kittens against other cats.

Cats that live without human intervention are mostly solitary, because a cat mainly hunts mice, which is a single meal for a hunter without any to share (Beaver, 1992), when the food resource is stable and concentrated, cats may hunt and live in groups (Corbett, 1979; Bos, 1995). There is a variety in these groups qua size and composition; this variety will be described in the following part.

1.1.2.1 Colony size

Colonies vary in size, and can be organized in three main categories. The most common colony size is the smallest colony (Crowell-Davis, 2007). This colony consists of a queen with her kittens that are not yet mature enough to survive independently. The sexual partner does not form a bond with the queen. A larger colony is composed of several queens, mostly related, and their kittens. These queens work together to raise their kittens, by cleaning the perineum of the birthing queen and cleaning the newborn kittens. Queens can also bring food to nursing queens and groom them. Moreover they guard and groom each other's kittens. In many cases the queens are related, for example mother-daughter or sisters. This is an example of kin selection; by helping related cats, they also pass on their own genes. Every time they show this 'helping' behaviour they will increase the probability of survival of their grandchildren, siblings, nephews or nieces. Even if the queens are not related, the cooperation is ideal for the phenomenon of reciprocal altruism to function effectively (Crowell-Davis, 2007). So when there is enough concentrated food, females stay in their birth-group. However, there is one example of females that leave their home range. When the density of females is too high, it is possible that there are not enough nest places (Devillard *et al.*, 2003). The smaller and lower ranking females then show a reduction of reproductive success. These females mostly leave their original group to find other nest places. The colony sizes therefore depend on the amount and concentration of resources.

The largest colony consists of several related and unrelated females with some males. These groups may consist of between 24 and 39 individuals (Natoli *et al.*, 1985). The researchers monitored the cats in the historic monuments and public gardens in Rome, where the cats found food and shelter. The study showed that individuals of both sexes differed in their attendance records and in the particular site they frequented. Females stay most of their time at a particularly territory, while males roam around different female-territories. Based on studies it is difficult to determine the dominance hierarchy of multi-sex colonies in cats (Natoli *et al.*, 2001; Knowles *et al.*, 2004). A study suggested that rank maybe determined by weight rather than sex (Knowles *et al.*, 2004). Female cats seems to be more dominant, but in an environment in which food is scarce and female cats expend energy nursing, sexually intact male cats may weigh more and be more capable of reaching a higher ranking than sexually intact female cats (Knowles *et al.*, 2004).

The females copulated with multiple males and males mated with multiple females (Turner and Bateson, 1994). This type of sexual reproduction strategy is possibly adopted to prevent infanticide because for the males in the group it was unknown which kittens were related to them. The males have a role in raising the kittens as well. Adult males have been observed to use a forelimb to separate intensely wrestling juveniles without any display of aggression, groom kittens, curl up around kittens and to defend them (Turner and Bateson, 1994). This means that besides female cats, male cats can live with kittens together in a friendly manner. As described earlier, female kittens often remain at their place of birth, provided that there are

enough resources. Whether male kittens leave their place of birth depends on several factors, which will be discussed below.

1.1.2.2 Male dispersal

It has been shown that there are four different categories of males, 'breeders', 'challengers', 'outcasts' and 'novices' (Lieberg, 1980). The 'breeders' are reproductive males that live with unrelated females, which they monopolize. 'Challengers' are males of 2 to 3 years that try to challenge the 'breeders'. The 'outcast' males are young males that just left their birthplace. They avoid contact with other cats. The last category is the 'novices'; one-year-old males that still live in their birthplace. The 'novices' leave their mother's home range within 1 to 3 years of age in response to high levels of aggression received from dominant territorial males. This level of aggression displayed by males depends on the social density, and the amount of females (Devillard *et al.*, 2003). There is a difference in male dispersion between a situation with a low social density and a high social density. The difference will be explained below.

If the social density is low, the aggression of males against other males is high. This can probably be explained by the fact that if the group is small, the males can easily monopolize the females. There are two main types of males that leave the natal group (Macdonald, *et al.*, 1987). Some males spend most of their time within another group of females and develop strong social bonds with them. The males become familiar to the females. The other group of males does not form strong affiliations with groups or individual females. They have a large home range encompassing a number of different female groups. It is quite uncommon for these individual males to form coalitions (Dards, 1983). Females are not aggressive towards familiar males that live in the same group for a long time, but are often aggressive against unfamiliar males.

A high social density results into low aggression of males against other males. Devillard *et al.* (2003) demonstrates that if the aggression is low, the males stay at their birth site. These multi-male and multi-female groups often consist of related cats. So, because of overlapping generations, they could potentially mate with close relatives. That means that it is possible that mothers mate with sons and fathers with daughters. It has been observed that highly inbred mating occurred in populations without any decrease of litter size, survival probabilities or body weight of the off-spring (Devillard *et al.* 2003). However, females do not accept mounting or copulation attempts by all males during their oestrous period. Ishida (2000), for example, reports that females avoided copulation with their close kin, but not with distant relatives.

So, in general, male dispersal occurs in two different types. Low-density results in aggression and males leave their natal group or the social density is high and males stay in their natal group. This means that males can live together when the social density is high.

1.1.2.3 Interactions

In addition to group formation, social behaviour of the domestic cat is examined. Cats form close relationships with particular conspecifics and engage in a variety of affinitive behaviour, thus producing a socially complex society (Crowell-Davis *et al.*, 2004; Crowell-Davis, 2007). Individual members of the colony can recognize other colony members. It is difficult to study social behaviour, because domestic cats are seen in different group formations, which can result in a large variation in social behaviour. However, there are some main factors that are the same for all groups.

The size of a group influences the frequency of interactions between cats (Table 1, Kerby and Macdonald, 2000). In a small colony of cats (4 to 9 individuals) interactions are most frequent (average 0,760 times per hour), in a medium colony (5 to 15 individuals) interactions occur less often (average 0,520 times per hour), while in a large colony (25 to 30 individuals) interactions are even less frequent (average 0,203 times per hour). In medium and large colonies most of the interactions are male-female, followed by male-male interactions and least often female-female interactions. However, Kerby and Macdonald (2000) did not describe if the nature of the interactions was positive or negative.

Table 1. Hourly rates of interaction observed between pairs of average representatives of each adult for three types of colonies (Kerby and Macdonald, 2000).

	Small (n=4-9)	Medium (n=5-15)	Large (n=25-30)
Male-Female	0,37	0,228	0,100
Female-Female	0,39	0,114	0,046
Male-Male	-	0,178	0,057
Total	0,760	0,520	0,203

In other studies the difference in affiliative and aggressive behaviour performed by males and females is investigated. The social relationships within males and females are different. Females within a group are friendly to each other. They spend a lot of time in close proximity and perform a lot of amicable behaviour (Turner en Bateson, 1994). For males it is rare to live together or give each other a lot of affection. Dards (1983) never observed amicable behaviour between any of the mature males. Generally, when two unfamiliar males meet each other for the first time, without a female in the area, they will sniff, but this will quickly give way to aggression, including growling and yowling.

Besides gender differences in interactions, there are also an age differences in the amount of interactions (Kerby and Macdonald, 2000). Male juveniles show significantly more social affinity towards their male littermates than towards their maternal half-brothers of different ages. This is based on patterns of

proximity. They also preferred their related male juveniles in comparison to related male kittens. Similarly, the male kittens preferred their male littermates to their older brothers. This pattern can also be found in females. The strong ties are remarkable for young males of similar age that disperse separately (Macdonald, *et al.*, 1987). In lion society males form coalitions when they are old enough to leave their birthplace. These juvenile males need to form strong ties because of this coalition later in life. The apparent strong tie formations in the domestic male cats are probably rudiments of a lion like society. The fact that male coalitions have apparently not arisen amongst farm cats, may be attributable to differences between the ecology of cats and lions in such factors as prey size and dispersion of and dependability on females and prey. Another reason could be that the domestication of cats influenced the disappearance of male coalitions.

In addition to the natural behaviour of the domestic cat, it can be concluded that the domestic cat can live in a group when the food resource is concentrated and stable. Usually related females live together, while males live with unrelated males and females. Only when the social density is high, related males are seen to live together. Females performed more affiliative behaviour to each other, while males performed more aggressive behaviour against each other. However, what is the quality of the relationship between cats in households and shelters? The effect of group housing and solitary housing in households and shelters will be discussed below.

1.2 Social behaviour of domestic cats in Household and shelters

The natural social structure and behaviour of the domestic cat provide a good indication about the influences of gender, age and genetic relatedness in cat groups. In order to provide recommendations concerning the composition of two-cat and multi-cat households it is not only important to understand natural social behaviour of the domestic cat, but also to observe the behaviour in households and shelters. Differences in social behaviour between cats regarding gender, relatedness and age will be discussed. First the differences between singly housed cats and multiple-housed cats will be described to investigate the impact on the welfare status of the cats involved.

1.2.1 Solitary-housed or multiple-housed cats

Based on studies on free-roaming cats, it is difficult to decide if a cat is principally a solitary or a social animal, because both variations occur. Years ago, people thought that cats were basically solitary animals, thus cats were housed mostly solitary. However, resent research suggests that cats are social animals (Kessler and Turner, 1996; Monk, 2008; Ramos *et al*., 2012). This resulted in more group-housed cats, because owners thought it was more natural and a form of enrichment. Nevertheless, for some cats group housing is perhaps more stressful than enriching (Monk, 2008). When people place a second cat in the house, they assume that they have one colony of cats. Unfortunately, many owners have two separate colonies in one house. For example, the Free-roaming cats form bonds based on relatedness and are early socialized (Crowell-Davis *et al*., 2004), while in households and shelters group housing is forced by humans sometimes involving non-related and poorly socialized animals. To measure the effect of group housing on the behaviour of cats, some researchers investigated the difference in behaviour of solitary and group-housed cats.

When cats were placed in a boarding cattery, there was no difference in stress level between singly- and group-housed cats (Kessler and Turner, 1996). Only animals familiar to each other were housed together in this pair-housing situation. Familiarity is important for group housing: Ottway and Hawkins (2003) did show a difference between singly- and group-housed cats. The cats they studied were unfamiliar to each other and group-housing lead to a significant higher stress level compared to singly housed cats. Apart from familiarity, the effectiveness of group housing is based on the duration of being together. The study of Monk (2008) showed that group housing was effective for the cat's welfare when they were placed together for longer than eight months. In the first eight months of group housing the stress level of the cats was higher compared to singly housed cats. There was also a correlation between negative interactions and time spent in the shelter. The cats' aggression level decreased over time. In the studies of Ottway (2003) and Monk (2008), cats' owners had to fill out a checklist to investigate stress. However, physiological measures should have been taken into account to support their results. These measurements have been done in another study, which showed that singly housed cats in shelters have a higher urine cortisol-to-creatinine ratio, a stress indicator, compared to group housed cats (Uetake *et al*., 2013). The cats in social groups also showed more locomotion and

social/solitary play, which is in contrast to the results of Ottway. However, there was a difference between the studies; the stress levels of the cats in Ottway's study were measured immediately after placing the cats together, while in Uetake's study the cats had already been together for seven months. So based on the results of Uetake and Monk it can be concluded that, after half a year, cats placed together showed less stress than singly housed cats. Barry and Crowell-Davis (1999) also showed that the amount of aggression was negatively correlated with the amount of time the cats had lived together.

Besides the studies on cats in animal shelters, there are also studies on cats in households. There was no difference in the faecal glucocorticoid level between singly- and group-housed cats in households (Ramos *et al.*, 2012). A study on urinary cortisol neither showed a difference between singly- and group-housed cats in households (Lichtsteiner and Turner, 2008). Thus, there is a difference between households and animal shelters, as cats in animal shelters showed more stress in group-housing compared to solitary housing, where no difference was found in private households. This difference could occur because in a household the social density is generally lower than in an animal shelter. Furthermore, stress levels might be lower, because the group in a household is usually also more stable. It seems that households provide more adequate conditions for both singly housed and group housed cats.

Whether group housing will be successful depends on the degree of socialization of the cats. It has been shown that, in group-enclosures, cats that were non-socialized towards conspecifics were more stressed than cats that were socialized towards conspecifics (Kessler and Turner, 1999). Moreover, non-socialized cats had a short-term negative effect on the other group members; namely, their stress levels increased in the first few days after admission.

In addition to stress, there are other differences between singly housed cats and pair-housed cats. Singly housed cats interact more with objects and with their owners and self-groom less (Bradshaw and Smart, 1993). The same differences were also found in adult cats living in single- and multi-cat households. These findings suggest that cat-cat social behaviour interacts substantially with cat-human behaviour (Bradshaw and Smart, 1993).

All these studies together suggest that for a short stay in a shelter, singly housing is probably a better option. However, after several months group housing could be more effective. Group housing increases the cat's welfare when the cat is well socialized towards conspecifics, when the group is stable and when there is sufficient space provided. When these criteria are met a multi-cat household is probably better for the welfare of a cat than solitary housing. An additional question is what combination of cats is best in a two- or multi-cat household. In the following paragraphs this question will be answered, using gender, relatedness and age as parameters.

1.2.2 Gender

When people want to add a new cat to an existing cat household, it is important to find out what the best combination of genders can be. Several studies have investigated the relationship between gender and intercat aggression. Based on the natural behaviour of domestic cats living in social groups, females show more proximity and affiliative behaviour and less aggression compared to males (Dards, 1983; Macdonald *et al.*, 1987 and Natoli 2000). This difference is reflected in that females are used to living together in social groups. In order to understand the difference in behaviour between males and females some researchers have done more detailed analyses of these gender behaviour differences (Dards, 1983; Macdonald *et al.*, 1987). Females allogroom and allorub with both males and females, but they allorub males more often than females. Males are reported to allogroom and allorub only with females (Dards 1983; Macdonald *et al.*, 1987). Allorubbing is a form of scan marking and it is used by the cat to become familiar with objects and conspecifics. As males are transitory members of female groups, the males and females allorub more with each other than they do with the same sex. When males come back to the female group they need to become familiar with the females and vice versa. This creates the need for more frequent and elaborate allorub behaviour between males and females (Macdonald *et al.*, 1987; Barry and Crowell-Davis, 1999). Females are already familiar to each other, thus allorubbing is not as necessary between females.

The previous results of allogrooming and allorubbing are based on studies of free-roaming cat-groups. However, is this behavioural pattern the same in households? Barry and Crowell-Davis compared 60 households with two males, two females or a male and female cat. All the cats were neutered and they were exclusively kept indoors. There was no significant difference in affiliative behaviour between the three different gender pairs (Barry and Crowell-Davis, 1999). The different results between free-roaming cats and cats in households occurs probably because household cats are already familiar to each other and they never move a considerable distance away from each other (Barry and Crowell-Davis, 1999). Therefore it can be concluded that when cats live indoors with each other they have no preference for a certain gender. However, when looking at proximity, neutered male pairs spend more time in close proximity to each other (0 to 1m) than neutered male-female pairs and neutered female-female pairs (Barry and Crowell-Davis, 1999; Natoli, 2000). Based on these results females perform more affiliative behaviour than males, where males are more tolerant towards each other.

Besides affiliative behaviour and proximity, aggressive behaviour is also important in understanding the quality of the relationships between genders. Studies on free-roaming cats have reported aggression between males, between females and between females and males (Laundre, 1977). Aggression was equally directed towards same sex as towards opposite sex victims. Males may show aggressive behaviour against a male juvenile that is old enough to leave his birthplace. So, aggressive behaviour is performed by both sexes, but is there a significant difference in the amount of aggressive behaviour between the genders? Lindell *et al.* (1997) found such a difference in the amount of aggressive behaviour between genders. Male cats initiated aggression

in more cases than female cats. Males being more aggressive than females, is a typical mammalian pattern. Nevertheless, Barry and Crowell-Davis (1999) and Levine *et al*. (2005) found no difference in the amount of aggressive behaviour between cat genders. How come the cats in these studies did not follow the typical mammalian pattern of males as the more aggressive gender? It is possible that there was no difference in aggressive behaviour between the genders because of neutering. Neutering decreases the testosterone level and territorial behaviour, which results in less aggression (Barry and Crowell-Davis, 1999). The effects of neutering males and females will be discussed next, because it has an important influence on the interaction between cat genders.

1.2.2.1 Castration

There is a recent trend in households to neuter most cats at an early age. Problem behaviour is one of the main reasons for people to neuter their cat (Bradshaw *et al*., 2012). In male cats spraying is the biggest behaviour problem and in female cats it is inappropriate urination. Addressing the problem of ever-increasing numbers of unwanted kittens is also a reason for neutering. One of the most notable effects of neutering in male cats is the reduction of aggressive behaviour (Bradshaw *et al*., 2012). If neutering is done within the first year of life, urine spraying, aggression towards other cats and roaming are all partially or even totally suppressed. Even after a male has had aggressive and sexual experiences, castration can reduce aggression and increase the frequency of affiliative behaviour (Bradshaw *et al*., 2012).

Within females, reproduction is inhibited by the removal of the uterus. The effect of neutering on aggressive behaviour in females is less clear. Some studies conclude that neutering has no effect (Bradshaw *et al*., 2012), while other studies suggest a decreased aggression level in neutered females compared to intact females (Amat *et al*., 2009; Finkler *et al*., 2011). This result of decreased aggression in female cats is in contrast with the effect in dogs. Studies on dogs show that neutering may increase aggressive behaviour in females due to the elimination of progesterone, as progesterone normally has a calming effect (Amat *et al*., 2009). However, in the studies of Amat and Finkler intact females with kittens were used for the comparison to neutered females. Thus, the intact females may have been aggressive towards other cats to protect their offspring. The pregnancy and lactation of the cat also increased energy demands during these periods. This means that the intact females have to increase their food intake, which results in more aggressive behaviour directed towards other cats around the food resource. A study that compares neutered females with intact females without kittens is necessary to understand the effect of neutering.

Another effect of the neutering of females is an increase of behavioural problems. Neutered females exhibit significantly more problems than intact females (Heidenberger, 1997). Castrated females are more anxious than other cats and on average castrated females are heavier than intact cats. The anxiety problems

are correlated with body weight and it may also have a negative effect on the success of an introduction (Heidenberger, 1997). These factors need to be taken into account when a female is neutered.

Castration also influences the social behaviour of cats in a group. Studies examined the effects of castration on social behaviour in cats. A difference in agonistic interactions was found when a group of neutered free-roaming cats is compared with an group of intact free-roaming cats (Finkler *et al.*, 2011; Bradshaw *et al.*, 2012). There was less aggression in neutered groups and fewer agonistic encounters between neutered males. In the neutered group more immigration of new cats and a reduction of aggression towards members of neighboring groups was observed. Relationships between neutered males were found to be more similar to those between adult females than to those of uncastrated males. The individuals often spent several hours in association with other neutered males or females (Robinson, 1992).

1.2.3 Relatedness

In addition to gender, an important factor for the relationship between free-roaming cats is relatedness. It has been shown that females live with related females and sometimes with males, while males usually live with unrelated females. In order to understand if this preference is also present in households, a study was done on a colony of 28 cats in one household (Curtis *et al.*, 2003). This study indicated that cats have a preference for demonstrating affiliative behaviour to related cats (Curtis *et al.*, 2003). Cats showed more allogrooming and were in closer proximity to related cats than unrelated cats. Bradshaw and Hall (1998) found the same results, but unrelated and related pairs in different households were compared. The results showed that related pairs spent more time in physical contact with each other, groomed one another more often and were more likely to feed close to one another than unrelated cats (Bradshaw and Hall, 1998). In this study, apart from the difference in relatedness, some other factors that could differ were different between related and unrelated pairs. For instance, related kittens that grew up together formed stronger social ties than unrelated kittens that were placed together after the youngest was four months old (Bradshaw and Hall, 1998). This difference is probably caused by social ties between cats being established during the socialization period of kittens (3-8 weeks), thus earlier than four months. Social ties established early in life may be the reason for more affiliative behaviour between cats. When unrelated cats are raised together during the socialization period, they probably have the same strong social bonding (Bradshaw and Hall, 1998; Curtis *et al.*, 2003). Unfortunately no study has been done with unrelated cats that are placed together during the socialization period. Based on the results of the free-roaming colonies and studies of Curtis and Bradshaw it can be concluded that relatedness has an important influence on the amount of affiliative behaviour.

1.2.4 Age

Besides gender and relatedness, the age of cats in two- or multi-cat households can have an effect on the quality of the relationship. There is a variety of recommendations about how old a new cat should be when added to a resident cat. Some studies recommend a new cat should be a kitten (Landsberg *et al.*, 2003; and Crowell-Davis, 2007). They advised the adoption of a kitten, because a kitten is generally more social than adult cats and adult cats show less territorial aggression against a kitten. On the other hand, Beaver (1992) described feline asocial aggression, which is a type of aggression shown by older cats towards kittens. When one of two older cats dies, the cat and the owner might miss the diseased cat. Thus a new kitten may be brought into the household. However, the old cat can become very aggressive against the kitten, because of the overabundant play behaviour of the new housemate. It takes several months for the new kitten to become less interactive. The older the resident cat, the less tolerant it will be against a kitten. So, a kitten as a new housemate for the old cat can be even more at risk than an adult cat (Beaver, 1992; Moesta and Crowell-Davis, 2011).

Probably the personality of both cats is also important for the decision to choose a kitten or an adult cat as a mate for a resident cat. For example, when the 'old' cat is energetic and playful, a kitten can be a good housemate because it lowers the territorial aggression compared to an adult cat. On the other hand, when the 'old' cat is calm and independent, an adult cat can be a good housemate to prevent feline asocial aggression.

The idea that animals have personality is gaining a foothold in science. Applying knowledge of animal personalities is occurring more and more, but it is most often only considered informally. However, animal personalities are likely to affect the welfare that animals experience in captivity (Watters and Powell, 2012). Besides gender, age and relatedness, personality could be imported when choosing a second cat as well. Only 17 studies on cat personality have been published. Personality dimensions with a high validity for the domestic cat are being sociable, dominant and curious. There is some evidence that personality may play a role in how animals should be grouped (Webster and Ward, 2011). Nevertheless, there is no research done about the correlation between cat personality and the quality of relationships. So, more research is necessary to understand the effect of personality on the composition of two-cat households.

1.3 Recommendations on housing and introduction based on the literature.

The environment of a cat has a big effect on its level of welfare, stress and aggression. When the combination of cats, regarding the factors gender, relatedness and age, is right, but the introduction of the new cat is not carried out properly or the environment is poor, cats may still show problem behaviour and aggression. These two elements, introduction and environment, will be discussed below.

1.3.1 Density

In addition to gender, age and relatedness of cats, cat density can influence the level of aggression and problem behaviour in a multi-cat household. It has been found that cats without outdoor access showed significantly more behaviour problems than cats with outdoor access (Amat *et al.*, 2009). Conflicts between cats may be more likely with indoor cats, because of the small home range (Rochlitz, 2005). Naturally, cats are able to leave the group when the social density is too high, as high social density causes aggression and a lack of resources. This dispersal behaviour is not possible in shelters and households. So, it is important to investigate the maximum social density for cat groups in households and shelters to avoid aggression.

Free-roaming cats exploit a very wide range of habitats and their densities can range from less than one to more than 2000 animals per square kilometre. As described earlier, males have a large and overlapping home range, where females live together in an area of 0.03 to 4.2 hectare (Turner and Bateson, 1994). The density depends on the food resources. The research of Izawa (1984) on free-roaming cats on a garbage dump showed a density of 23.5 cats per hectare. Another study in Rome also showed a density of more than 10 cats per hectare (Natoli *et al.*, 1985). In the last few years more studies on density were done on farm cats. The results indicate a density of 6.3 animals per square kilometer. Thus, there is a large variety in the density in which free-roaming cats live (Turner and Bateson, 1994).

Besides these studies on free-roaming cats, studies on household and shelter cats were done. Bernstein and Strack (1996) described the use of space and patterns of interaction of 14 unrelated, neutered domestic cats. These cats lived together in a house with a density of one cat per 10 square meters, while the cats had no outdoor access. There was little aggression, since the cats did not fight. Individuals seemed to co-exist peacefully with each other, because they avoided each other most of the time. Neutered males used an average home range of 4 to 5 rooms and neutered females a range of 3 to 3.6 rooms. Thus, density of one cat per 10 square meters does not cause much aggression. A study by means of a checklist investigated the stress level of cats living in a density of 0.5 to 0.8 animals per square meters. Found was that a density of 0.6 animals per square meters is the maximum for a household or a shelter (Kessler and turner, 1999).

An investigation of the influence of indoor-cat group size on urinary cortisol levels was done by Lichtsteiner and Turner, 2008. They showed that in private households the basal urinary cortisol levels of cats

was neither influenced by housing style (single or group household) nor by density. They did find a positive correlation between the cortisol level and the human density, the number of people per household and the total surface of a household. There are two possible explanations for the fact that the cortisol level was correlated with human density. Higher human density may lead to high sound and unrest levels in the household, which in turn may elevate basal cortisol levels of the cat. Another explanation for the positive correlation can be that cats facing a high human density suffer from a lack of human-free space into which they can retreat. Both explanations can explain higher basal cortisol levels.

Previous studies show that density is important for the stress level of cats. A maximum of 0.6 animals per square metre needs to be taken into account. A house or shelter also needs places without humans and cats, to make sure a cat can retreat when it wants. When hiding is not possible, some behavioural problems may arise. These behavioural problems will be discussed below.

1.3.2 Problem behaviour

Apart from the problem of intercat aggression, indoor marking and inappropriate toileting are common behavioural problems in households. In a review study, information was collected on 65 feline cases, of which 30 cats were male and 35 female (Bradshaw *et al.*, 2012). The owners' major problem was indoor marking 28% (urine spraying, squat marking, middening and scratching) and inappropriate toileting problems 11%. Urine spraying was the biggest problem in neutered males, (20% of the cases), while in neutered females inappropriate toileting was the biggest problem (16% of the cases).

The development of inappropriate toileting can have different reasons. The most common cause for failures to use a litter box is directly related to the litter box, for example the location or contents of the litter box (Beaver, 1992). Health related problems, such as diabetes, cystitis, pain and food allergies can also cause house soiling problems (Beaver, 1992). Furthermore, it is possible that a more aggressive animal is controlling access to litter boxes (Kendall and Jey, 2008). This means that when the number of cats in a household increases more problems concerning toileting may occur.

Problems with urine marking/spraying are correlated with the number of cats in a household as well. The amount of urine marking can increase from 25% in single-cat households to 100% in households with more than ten cats (Bradshaw *et al.*, 2012). In free-roaming cats urine marking is related to sexual behaviour and territorial behaviour. Cats use urine to mark their territory. This may be a reason for the increase of marking behaviour in a higher density, because cats have a higher need to mark their territory, especially uncastrated males (Bradshaw *et al.*, 2012).

A research on 40 neutered males and 7 neutered females showed other reasons, basically based on stress, for the development of urine marking. These reasons were agonistic interactions with outside cats

(49%), aggressive interactions with other cats in the home (28%), limiting outdoor access (26%) and moving into a new home (9%)(Beaver, 1992).

Thus, there are many factors that can be the reason for the development of problem behaviour. However, one apparent major factor is density. An increased density results in an increase of problem behaviour. Fortunately, some recommendations can be given that may decrease problem behaviour in a household or shelter.

1.3.3 Housing requirements

The physical- and social environment is very important to lower the level of aggression and to improve the welfare of a cat in multi-cat houses. An example of problematic physical environment is a very small home range of an indoor cat. A cat that is restricted indoors may demonstrate more behavioural problems compared to cats that are allowed to roam freely with a bigger home range. The best option for cat owners, to enhance welfare and decrease problem behaviour, is to provide an outdoor access. When outdoor is not an option, researchers recommend that an indoor cat should have access to at least two rooms (Rochlitz 2005).

Bernstein and Strack (1996) described that most cats had favourite spots within the rooms that they used. Some cats had their own place, but more commonly it was seen that several cats chose the same favourite spot. As cats are also more likely to rest alone than with others, there should be enough resting areas for all the cats in the house. Schroll (2002) suggests at least two types of resting places per cat: one on the floor enclosed by three sides and another elevated with a good view. It is important to set these conditions in order to prevent behavioural problems in multi-cat households (Schroll, 2002).

Furthermore, it has been shown that cats spent most of their time out of each other's sight. When cats were together, they kept a distance of 1-3m between themselves and other cats (Barry and Crowell-Davis, 1999). So, sufficient hiding places and visual barriers are recommended in a household as well. Moreover, there should be structures within the home that enable cats to use the vertical dimension, such as climbing posts, platforms, windowsills and shelves. These structures increase the quality of the space (Barry and Crowell-Davis, 1999).

Besides the quality of space, social environment is also important. For a good use of a social environment, socialization at an early age is essential. Optimal socialization to humans and other cats occurs when kittens are handled between the 2nd and 7th week of life (Rochlitz, 2005). Socialization is important because it prevents stress in multi-cat households and prevents anxiety towards people. When there are several cats in a household, particularly when they are not related or not well socialized, it may be necessary to provide feeding, resting and elimination areas at a number of different sites, to prevent certain cats from monopolizing areas and denying other cats access to these areas (Bos, 1995).

Thus, to prevent problem behaviour and aggression cats need to have outdoor access, at last two types of resting places per cat, and platforms, etc. Besides the environment, socialization at an early age is essential for a good quality relationship between cats.

1.3.4 Introduction of a new cat

The introduction procedure of a new cat into a household with cats is important for the future quality of the relationship between the cats. In order to attain a more successful introduction, Robinson (1992) suggested that a new cat should be allowed to explore the house thoroughly before meeting resident animals. Namely, if only one cat is familiar with the room, this cat initially becomes the dominant animal, because the new cat, that is unfamiliar with the room, concentrates on exploring its surroundings (Robinson, 1992). To show its dominance, the dominant cat will follow the new cat and attempt to sniff its anal region. However, such advances are usually rejected by the stranger with a hiss or a defensive paw strike (Robinson, 1992). When the first meeting between two cats is aggressive, the continuation of the relationship will be more difficult.

When two cats are introduced it can take a certain amount of time before they accept each other. It is unclear how much time it takes for cats. Several studies have found that the time that cats are living together is negatively correlated with aggression, therefore most cats may eventually accept (tolerate) each other (Fig. 1; Bradshaw, 1992; Barry and Crowell-Davis, 1999; Beaver, 2003). In a study of Levine *et al*. (2005) the resident cat immediately accepted the new cat in less than a quarter of the households and in 40% of the households the new cat was accepted within one month (Fig. 2). Only three percent of the households indicated acceptation between the resident and the new cat after 12 months. As described earlier Monk (2008) found that group-housed cats showed a higher stress level than singly housed cats during the first 8 months. Thus, besides an adequate introduction, some cats may need 8 months to become more relaxed and to start forming a bond between each other.

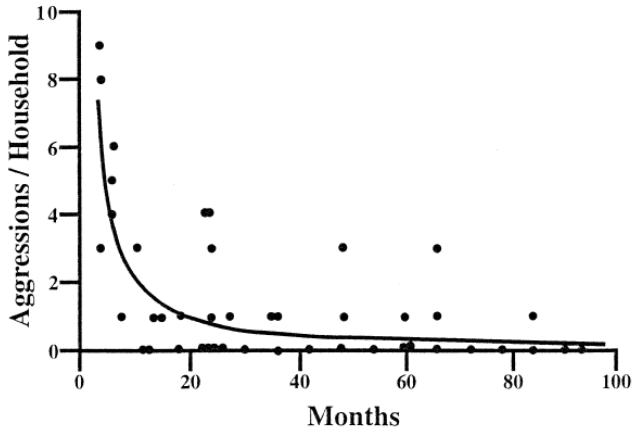

Fig. 1 The number of incidents of aggression as a function of how many months the cats have lived together (Barry and Crowell-Davis, 1999)

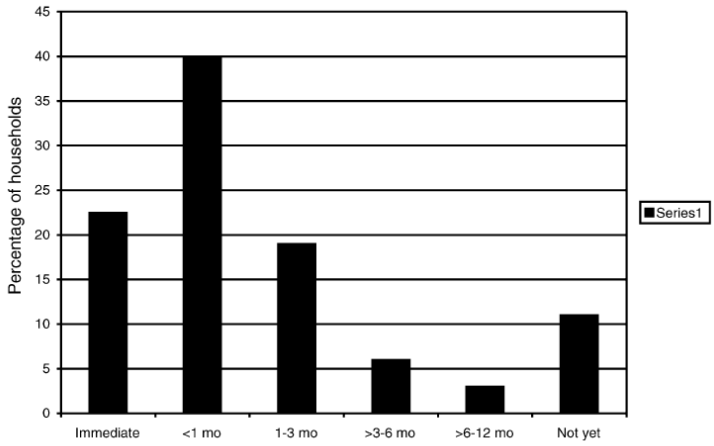

Fig. 2 The length of time it took for the original cat to accept the adopt (Barry and Crowell-Davis, 1999)

1.4 Research questions and hypotheses

The aim of this part of the thesis is to investigate the social behaviour of the domestic cat and to provide recommendations for choosing an additional cat regarding gender, relatedness and age. The main question of the study is: What is the effect of different factors, gender, relatedness and age, on the quality of the relationship between cats? This question will be answered with the following sub-questions:

What is the difference in the quality of the relationship between gender pairs? The hypothesis is: if gender has an effect on the quality of the relationship, then there will be a difference between the three different cat pairs; female-female, male-male and male-female. The prediction is: the female-female pairs will show a more 'very positive' quality of the relationship, the male-female pairs a 'positive' quality of the relationship and the male-male pairs will show a more 'negative' quality of the relationship.

What is the difference in the quality of the relationship between gender pairs in combination with relatedness? The hypothesis is: if relatedness has an effect on the quality of the relationship between gender pairs, then there will be a difference between relatedness and no relatedness in gender pairs. The prediction is: the male-female pair will live in a more 'negative' quality of the relationship when they are related compared to unrelated cats. The female-female pairs will live in a more 'negative' quality of the relationship when they are unrelated compared to related cats.

What is the difference in the quality of the relationship between related cats and unrelated cats? The hypothesis is: if relatedness has an effect on the quality of the relationship, then there will be a difference between the related cat pairs and the unrelated cat pairs. The prediction is: the related pairs will show a more 'positive' quality of the relationship compared to the unrelated pairs.

What is the difference in the quality of the relationship when cats differ regarding age? The hypothesis is: if age difference has an effect on the quality of the relationship, then there will be a difference between the age difference categories, no age difference, >5, <10 and >10. The prediction is: the smaller the age difference between cats the more they will show a 'positive' quality of the relationship.

2. Material and method

In the introduction part of this thesis, the quality of the relationship between different cat pair combinations was described. As described in previous research, gender, age and relatedness could have an effect on the amount of affiliative and aggressive behaviour. In order to investigate if these effects described in the literature were comparable with those in Dutch households and shelters, a case study was done.

Two types of resources were used. The first type was Dutch cat-forums (see appendix 1). On these forums people described their opinion about the quality of the relationship of their own cat pairs. A number of 71 case studies came from these forums. The other type of resource was an animal shelter, 'de Doornakker' at Eindhoven (see appendix 2). People who adopted a cat were called by telephone to investigate how the cat had settled in the new situation. The data from these two resources were used for this case study. A number of 107 case studies came from the animal shelter. Table 2 was used to transfer the different resources into one general table.

Table 2. The table which was used to investigate the different pair combinations.

Nazorg id.	**First cat**		**Second cat**		**Related**	**Quality of the relationship**			
	Gender	Age	Gender	Age	Yes/no	'very positive'	'positive'	'neutral'	'negative'

In order to investigate the quality of the relationship between two cats in the household, a distribution was made based on the description of the people. The quality of the relationship had four different categories:

'very positive': people described the quality of the relationship between the cats as good and/or the cats interact for a longer time with each other. So either the cats play, groom or sleep in close contact with each other.

'positive': people defined the quality of the relationship between the cats as good and/or the cats sometimes interact, but did not interact for a longer time with each other.

'neutral': people described no specific quality of the relationship between the cats.

'negative': people defined the quality of the relationship between the cats as not good and/or the cats were aggressive against each other, hide themselves or when one cat blocks the litter box for the other cat.

For the analyses the first table was transformed into a new table (table 3). The factor gender was divided into male-male, male-female and female-female, with no distinction in neutering. The genetic relationship was based on the description of the people, for example brother and sister, or the birth date was used. The factor age was based on the age difference between the two cats. This age difference was divided into four different categories, no difference, <5 years, >5 - <10 years and >10 years.

Table 3. The table which was used for the analysis.

Nazorg id	Gender pair			Related	age difference	Quality of the relationship			
	m-m	m-v	v-v	Yes/No	(=)age first cat - age second cat	'very positive'	'positive'	'neutral'	'negative'

A crosstabs was used to invest the effect of gender, relatedness and age on the quality of the relationship. Chi-square was used as the statistic test. The expected value was a hypothetical value that would occur if there was no relationship between the two variables. Multiplying the total of two categories and dividing this number by the total of all categories calculated the expected value. The adjusted residual was calculated to investigate the difference between the value and the expected value. The adjusted residual was calculated by the follow formula:

$$\text{Adjusted Residual} = \frac{\text{observed-expected}}{\sqrt{\text{expected} \bullet \text{row total proportion} \bullet \text{col total proportion}}}$$

The bonferroni-corrected critical alpha of 0.05 was used for the comparison with the adjusted residual. When the corrected critical alpha was absolute bigger compared to the z-value of the adjusted residual, there was a significant difference between the value and the expected value. A bonferroni-corrected critical alpha of 0.10 was used for the trends in the tests.

3. Results

3.1 Gender

Based on these results the quality of the relationship was dependent on the gender combination in two-cat households (n=160; chi-square 23.1; P<0.01; see table 4). The female-female combination showed the most 'very positive' situations but not significantly. The female-female combination was also described, as a trend, as more 'negative' (Adjusted residual=2.8; p=0.0026; Bonferroni- corrected critical alpha = 0.0021; see table 4). The male-female combination was significantly more described as 'positive' by most people (Adjusted residual=3.0; p=0.0014; Bonferroni- corrected critical alpha=0.0021; see table 4), but significant less described as 'very positive' as well (Adjusted residual=-3.2; p=0.0007; Bonferroni- corrected critical alpha = 0.0021; see table 4). So, the female-female combination seemed to be the most 'positive' combination, however this combination also seemed the most 'negative' combination.

Table 4. The effect of gender-pairs assessment of quality of the relationship between the cats, with the observed value and expected value. 12 Tests were conducted, the bonferroni-critical p-value was 0,0021 which corresponds whit the absolute z-value=2,87. A significant difference is marked with *.

			Quality of the relationship				Total
			'very positive'	'positive'	'neutral'	'negative'	
sexes	Male-Male	Value	8	31	11	6	56
		Expected Value	5,6	34,3	8,4	7,7	56,0
		Adjusted residual	1,4	-1,0	1,1	-,9	
	Male-Female	Value	1	52	10	6	69
		Expected Value	6,9	42,3	10,4	9,5	69,0
		Adjusted residual	-3,2*	3,0*	,0	-1,4	
	Female-Female	Value	7	15	3	10	35
		Expected Value	3,5	21,4	5,3	4,8	35,0
		Adjusted residual	2,3	-2,4	-1,3	2,8*	
Total		Value	16	98	24	22	160
		Expected Value	16,0	98,0	24,0	22,0	160,0

3.2 Gender and relatedness

In order to understand if the effect of gender was based on relatedness, a combination of both factors was calculated. When the cats were related there was no difference between the gender pairs (n=32; chi-square 10.1; P=0.10; see table 5). However, when the cats were unrelated there was a significant difference between the gender pairs (n=131; chi-square 15.0; P=0.02; see table 5). The females that were unrelated showed a trend into more 'negative' quality of the relationship compared to other gender pairs (Adjusted residual=3.0; p=0.0014; Bonferroni- corrected critical alpha = 0.001; see table 5). The related male-female combination was described as less 'very positive' as well. So, relatedness was important for the quality of the relationship in female pairs.

Table 5. The effect of gender-pairs and relatedness assessment of quality of the relationship between the cats, with the observed value and expected value. 24 Tests were conducted, the bonferroni-critical p-value was 0,001 which corresponds whit the absolute z-value=3,08, trend z=value=2,87. A significant difference is marked with *.

Relatedness				**Quality of the relationship**				**Total**
				'very positive'	'positive'	'neutral'	'negative'	
A relatedness	Gender	Male-Male	Value	6	5	2	1	14
			Expected Value	4,4	7,4	1,8	,4	14,0
			Adjusted Residual	1,2	-1,7	,3	1,2	
		Male-Female	Value	0	9	2	0	11
			Expected Value	3,4	5,8	1,4	,3	11,0
			Adjusted Residual	-2,8*	2,4	,7	-,7	
		Female-Female	Value	4	3	0	0	7
			Expected Value	2,2	3,7	,9	,2	7,0
			Adjusted Residual	1,7	-,6	-1,1	-,5	
	Total		Value	10	17	4	1	32
			Expected Value	10,0	17,0	4,0	1,0	32,0
No relatedness	Gender	Male-Male	Value	2	26	9	5	42
			Expected Value	1,9	26,3	6,7	7,1	42,0
			Adjusted Residual	,1	-,1	1,2	-1,0	
		Male-Female	Value	1	44	9	7	61
			Expected Value	2,8	38,2	9,8	10,2	61,0
			Adjusted Residual	-1,5	2,1	-,4	-1,5	
		Female-Female	Value	3	12	3	10	28
			Expected Value	1,3	17,5	4,5	4,7	28,0
			Adjusted Residual	1,8	-2,4	-,9	3,0*	
	Total		Value	6	82	21	22	131
			Expected Value	6,0	82,0	21,0	22,0	131,0

3.3 Relatedness

Based on these results, the quality of the relationship was dependent on the relatedness of the cats (n=175; chi-square 24.8; P<0.01; see table 6). There was a significant difference. Related pairs resulted into significantly more 'very positive' situations (Adjusted residual=4.8; p<0.000; Bonferroni- corrected critical alpha=0.003; see table 6) and less 'negative' situations compared to unrelated pairs. The cats without relatedness showed significantly less 'very positive' behaviour (Adjusted residual=-4.8; p<0.000; Bonferroni-corrected critical alpha = 0.003; see table 6). When looking at the case studies were there was no age difference between the cats that grew up together, no significant difference between related and unrelated emerged (n=33; chi-square 3.8; P=0.265; see table 7).

Table 6. The effect of relatedness assessment of quality of the relationship between the cats, with the observed value and expected value. 8 Tests were conducted, the bonferroni-critical p-value was 0,003 which corresponds whit the absolute z-value=2,73. A significant difference is marked with *.

			Quality of the relationship				Total
			'very positive'	'positive'	'neutral'	'negative'	
Relatedness	Yes	Value	10	17	4	1	32
		Expected Value	2,9	19,7	4,9	4,4	32,0
		Adjusted residual	4,8*	-1,1	-,5	-1,9	
	No	Value	6	91	23	23	143
		Expected Value	13,1	88,3	22,1	19,6	143,0
		Adjusted residual	-4,8*	1,1	,5	1,9	
Total		Value	16	108	27	24	175
		Expected Value	16,0	108,0	27,0	24,0	175,0

Table 7. The effect of relatedness and no age difference assessment of quality of the relationship between the cats, with the observed value and expected value. 8 Tests were conducted, the bonferroni-critical p-value was 0,003 which corresponds whit the absolute z-value=2,73. A significant difference is marked with *.

Age				**Quality of the relationship**				**Total**
				'very positive'	'positive'	'neutral'	'negative'	
No difference	Relatedness	Yes	Value	9	7	1	0	17
			Expected Value	6,7	7,7	2,1	,5	17,0
			Adjusted Residual	1,6	-,5	-1,1	-1,0	
		No	Value	4	8	3	1	16
			Expected Value	6,3	7,3	1,9	,5	16,0
			Adjusted Residual	-1,6	,5	1,1	1,0	
	Total		Value	13	15	4	1	33
			Expected Value	13,0	15,0	4,0	1,0	33,0

3.4 Age

Based on these results the quality of the relationship was dependent on the age difference between the cats (n=77; chi-square 20.7; P=0.01; see table 8). Cats with no age difference were significantly more described as 'very positive' (Adjusted residual=4.2; p<0.000; Bonferroni- corrected critical alpha = 0.0015; see table 8). Less than five and ten year's age difference was both described as 'positive'. No effect of more than 10 years of age difference was found, because only four case studies were found with more than 10 years difference.

Table 8. The effect of age difference assessment of quality of the relationship between the cats, with the value and expected value. 16 Tests were conducted, the bonferroni-critical p-value was 0,0015 which corresponds whit the absolute z-value=3,6. A significant difference is marked with *.

			Quality of the relationship				**Total**
			'very positive'	'positive'	'neutral'	'negative'	
Age	No difference	Value	13	15	4	1	33
		Expected Value	6,0	18,9	4,7	3,4	33,0
		Adjusted residual	4,2*	-1,8	-,5	-1,8	
	<5	Value	1	14	4	4	23
		Expected Value	4,2	13,1	3,3	2,4	23,0
		Adjusted residual	-2,1	,4	,5	1,3	
	<10	Value	0	12	2	3	17
		Expected Value	3,1	9,7	2,4	1,8	17,0
		Adjusted residual	-2,2	1,3	-,3	1,1	
	>10	Value	0	3	1	0	4
		Expected Value	,7	2,3	,6	,4	4,0
		Adjusted residual	-1,0	,7	,6	-,7	
Total		Value	14	44	11	8	77
		Expected Value	14,0	44,0	11,0	8,0	77,0

4. Discussion

The aim of this study was to investigate social behaviour of the domestic cat and to provide recommendations for choosing an additional cat regarding gender, relatedness and age. Castration, density and environmental enrichment were also part of the investigation. The different parts of the study will be discussed below.

4.1 Gender

The studies on free-roaming cats provide a general overview of group composition regarding gender. The most frequently observed gender pair is two related females. A male-female pair occurs in nature as well, but this combination occurs especially when there is a high social density. The male-male pair is seen less in groups and shows more aggression. There is also a gender difference in the social behaviour of the domestic cat. Female cats show more affiliative behaviour to both sexes compared to males, whereas males show more proximity to other males compared to females. Furthermore, there is equal aggressive behaviour in both sexes when the cats are neutered. In order to understand the effect of gender on the quality of the relationship, the different gender pairs are discussed separately.

4.1.1 Female-female pairs

As predicted, the results of the case study show that a female-female combination reacts more 'very positive' and significantly more 'negative' to each other. The positive quality of the relationship concurs to the expectations based on free-roaming group compositions and previous research. Females live together in a small colony and help each other in raising kittens. Moreover, they show more affiliative behaviour (Dards, 1983; Macdonald *et al.*, 1987 and Natoli 2000). There is an explanation for the significant 'negative' quality of the relationship as well. When females are not familiar with each other or when there are not enough resources for all females, they are more defensive against each other (Crowell-Davis, 2007). A female wants to defend its resources, such as nest places and food resources, especially against strange females (Yamane *et al.*, 1997). The results of the case study test (table 5) with a combination of gender and relatedness shows that unrelated females are significantly more in a 'negative' quality relationship. This result confirms the thought that when females are unrelated they commit more aggression against each other than other gender combinations do.

4.1.2 Male-female pairs

The fact that a male-female pair is indicated significantly as 'positive' in the case study is comparable with the predictions based on results of studies in the wild. Unrelated males and females can live together in a colony, when there are enough resources (Natoli *et al.*, 1985; Macdonald, *et al.*, 1987). In free-roaming cats, females and males do not often show a strong bond, but live together in good harmony. Moreover, the male-female combination is described significantly less often as 'very positive' when they are related compared to the other gender combinations. This can be expected because in nature it is uncommon for littermates to stay together or to form strong social bonds. This can prevent inbreeding, especially in groups with a low social density. Unfortunately, no study has investigated the possible differences in quality of the relationship between related and unrelated females and male pairs.

4.1.3 Male-male pairs

The male pairs are not indicated as 'negative' in the case study. This is in contrast with previous studies where a 'negative' situation was found for the male-male combination (Dards, 1983). The males in the case study do not show more 'negative' behaviour than other gender pairs. The reason for this is probably that there was no female present in the household, which may reduce competition, and the males were castrated, which reduces the level of aggression (Bradshaw *et al.*, 2012).

4.2 Relatedness

The fact that related cats are indicated as showing significantly more 'very positive' relationships and unrelated cats significantly less 'very positive' relationships in the case study was expected based on literature. Namely, in nature cats (especially females) live together with related cats (Crowell-Davis, 2007). Studies that compared behaviour of related cats with nonrelated cats also found that related cats show more affiliative behaviour and live in closer proximity (Bradshaw and Hall, 1998; Curtis *et al.*, 2003). In addition to the relatedness, there can be another explanation for this effect. Most related cats were adopted at the same time. So, compared to cats that were placed together later, these cats grew up with each other, they were able to perform social behaviour during their life and they did not need to get used to another cat. The effect of relatedness and non-relatedness was tested within the category of no age difference. Without this extra factor, no significant difference was found between relatedness and non-relatedness. When unrelated cats have the same age and are placed together shortly after birth, the relatedness is not important for the quality of their relationship.

The case study supports the idea that related females are the best combination for a 'very positive' quality of the relationship. Females that are unrelated can cause a negative situation. Thus, when people want to adopt two cats, the best recommendation is to choose related female cats. If there already is a female cat in the house, it is better to choose a male and when the resident cat in house is a male, the gender of the new cat makes no difference in the quality of the relationship.

4.3 The age factor

The only conclusion, based on age related data in the case study, is that being of the same age is important for a 'very positive' quality of the relationship. This result corresponds with the results of other studies. Namely, being of the same age prevents asocial aggression by the resident cat (Beaver, 1992; Moesta and Crowell-Davis, 2011). The fact that the quality of the relationship depends on age difference was not described in literature. Levine *et al*. (2005) did not find a relation between the level of aggression and age differences. They looked at the age of the adopted cat and the age of the resident cat separately, but the age difference between the cats was not taken into account. This means that it is not possible to compare the results of the case study with other research. There may be more age-effects on the quality of the relationship. However, there was less data about the age difference of <10 and >10 years, which made it difficult to understand the age-effect. Further research is necessary to draw more distinct conclusions.

4.4 Territorial behaviour

The previous factors, gender, relatedness and age, are probably overruled by one factor that influences the quality of the relationship between cat pairs. This factor is the territoriality. Cats are animals with a strict territory that they defend towards other cats. The results of the case study confirm the effect of territorial behaviour on the relationship between cat pairs. Namely, when cats are related or they know each other for a long time, they can live in the same territory. When cats are unrelated, they show more negative relationships. This difference is probably due to territorial behaviour. As described earlier in feral cats, females defend their territory more towards females than to males. A female wants to defend its resources, such as nest places and food resource towards other females, while males are seen as potential sexual partners. The aggression between male pairs is probably also due to territorial defence. However, when males are castrated, they are more tolerant towards other male because of the lower level of testosterone. A lower level of testosterone leads to a lower level of territorial aggression. The age of the cats may also have an effect on the territorial aggression. Unfortunately, the sample size of the case study was too small for a conclusion on age effects.

Thus, territorial behaviour can have an effect on the quality of the relationship between cats and, as described in the introduction, on the amount of problem behaviour as well. So, besides the previous factors, the territorial factor in cats is important to understand, because it can help to prevent aggression and problem behaviour in multi-cat households.

Gender, relatedness and age are important factors that influence the quality of the relationship of cats in a household. However, besides these factors, there are several other recommendations based on density, housing requirements and the introduction of the new cat for a good quality of the relationship. The maximum social density is 0.6 cats per square meters and there should be a possibility for the cat to go outside to reduce the chance of aggression. Overall, an early socialization is the most essential factor for a proper relationship between cats. The last recommendation is that the introduction needs to be done following the right procedure. An introduction can take eight months before cats become calm and after these few months they really may start to get to know each other.

5.Conclusion

This research provides a better understanding of the effect of the factors gender, relatedness and age on the quality of the relationship between cats. It has been shown that related females can live together in a 'very positive' quality of the relationship. They help each other and perform more affiliative behaviour. Moreover, the combination of female and male or two males, when castrated, provide a 'positive' relationship as well. Relatedness is an important factor for a 'positive' relationship. However, familiarity may be even more important. There is not one specific advice possible for the age of the new cat. Studies suggest an influence of age differences on the relationship, but the case study does not contain enough data to draw a conclusion. Thus, further research needs to be done on age difference and the quality of the relationship between new combinations of cats.

This study had limitations. Namely, the case study was not set up especially for this research. Two different sources were used to get an indication of the quality of the relationships between cats. The information from the resources was not verified and it was not always complete. Owners described the situation between the two cats, which is not an objective evaluation of the relationship. Research with more objective observations and a bigger sample size would give a better understanding of the effect of different factors on the quality of the relationship.

Future studies may focus specifically on the quality of the relationship and they may look separately at the influence of the different factors. More experimental studies on, for example the difference between related and unrelated cats are probably necessary to formulate better recommendations. More structured research in animal shelters can also give a better insight in the factors that are important for the quality of the relationship. For example, when an owner adopts a new cat into a house with a resident cat, the owner may fill out two questionnaires: one after one month and another after ten months. This questionnaire should give a more objective view of the situation and the development of the relationship. The entire questionnaire should provide a clearer indication of the factors that influence the quality of the relationship. Further research like this is necessary, because in shelters there are still a large percentage of rehomed cats that were returned because of problems with the resident cat. A document with recommendations about factors that influence the quality of the relationship can help cat owners to make a right choice and to prevent aggression between cats and problem behaviour.

Summary of recommendations:

- Cats can live together in a household when they are socialized towards other cats early in life.
- When people want to adopt two cats at the same time, the best recommendation is to choose related female cats or a male-female pair that are unrelated.
- If there is already a female cat in the house it is better to choose a male and when the resident cat in house is a male, the gender of the new cat makes no difference in the quality of the relationship.
- The amount of problem behaviours increases exponential with the number of cats in a household. However, enough resources for the cats and a gradual introduction of the new cat can prevent problem behaviour and inter-cat aggression.
- The acceptation of the resident cat towards the new cat can take eight months.

6.Literature

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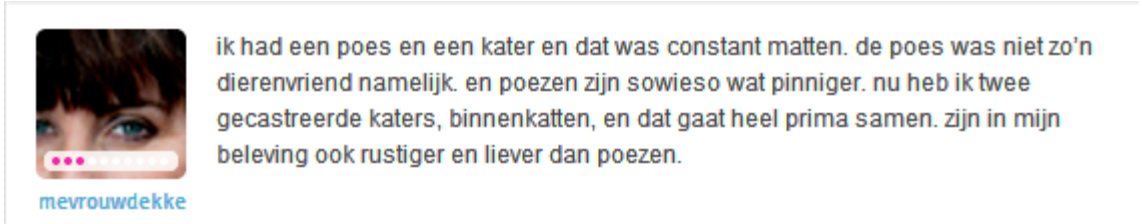
Appendix 1

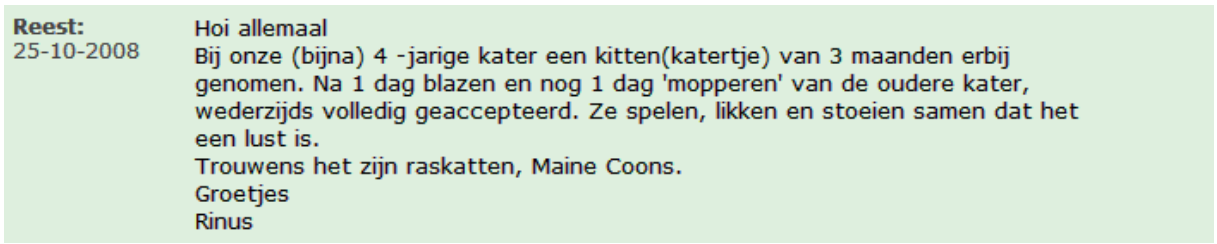
Three examples of Dutch forms:

I: http://forum.fok.nl/topic/1309331

II: http://www.goeievraag.nl/vraag/huis-tuin/huisdieren/tweede-kat-erbij-kater-poes.13490



III: http://www.groeninfo.com/forum/huisdieren_forum/33283-katten_bij_oude_poes_plaatsen.html#.UdwUNDv0Gpd



Appendix 2.

Aftercare form shelter:

Dierenopvangcentrum "De Doornakker"

Nazorgformulier **Datum:**

Naam eigenaar:
Adres:
Postcode en woonplaats:
Telefoon:

Email:

Nazorgid.:
Diernr./reg.nr.:
Plaatser:
Bezoeker:
Datum:

Naam:
Ras:
Geboortedatum:
Leeftijd:
Behandeld:
Kleur:
Chipnr.:

Gegevens kat:
Zwerfdier:
Ontvangen:
Geplaatst:

Is dit uw eerste asiel kat? Was u al bekend met katten?
Heeft de kat zich inmiddels goed aangepast, zijn er nog problemen?
Is de kat goed zindelijk? Hoeveel kattenbakken heeft u?
Kan de kat naar buiten? Zo niet, in welke ruimtes verblijft de kat?
Heeft de kat een krabpaal? Gebruikt hij deze?
Heeft de kat omgang met andere dieren en/of kinderen? Hoe verloopt dit?
Bent u bekend met ontvlooien/ontwormen?
Hoe is de opvang geregeld tijdens de vakantie?
Bent u tevreden over de begeleiding/ informatie van het asiel?
Heeft u verder nog op- of aanmerkingen?
Indruk nazorger?