

Neophilia in the Domestic Cat (*Felis catus*)

by

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Abstract

Neophilia, the preference for novelty, has been proposed as one supportive aspect in the process of dog domestication. Dogs exhibited this inclination through a line up test of three toys, one novel and two familiar (Kaulfuß & Mills, 2008). This study was based on the aforementioned research and examined whether domestic cats also display this trait. Twenty-four domestic cats were given a three-trial novel object preference test and chose the novel object 32 times out of 65 actual choices. This presented a strong trend and two of the three trials shared a significant preference for the novel object. Neophilia may not be as strong a tendency in cats as in dogs, but it may still have played a vital role in the domestication of the cat.

Neophilia in the Domestic Cat (*Felis catus*)

Neophilia

Neophilia is the preference for novelty. This preference may have promoted the process of dog domestication as it may have encouraged some wolves to interact with humans (Kaulfuß et al., 2008). Neophilia has also been proposed to partly measure behavioral flexibility, which may also facilitate success in novel situations (Bergman & Kitchen, 2009).

The selective pressure for neophilia may be affected by ecological factors. For instance, wild chacma baboons (*Papio ursinus*) and geladas (*Theropithecus gelada*) are under different ecological constraints. In regards to dietary habits, baboons are generalists and geladas are specialists (Bergman et al., 2009). When presented with novel objects, baboons display neophilic tendencies, exploration of the objects, while geladas do not. The evolution of the specialized gelada diet may result in a decrease in neophilic behaviors (Bergman et al., 2009).

Food neophobia has been proposed as a strategy to avoid poisonous food (Barnett, 1963) although food neophobia seems to be low in nonhuman primate infants and juveniles (Fragaszy, Visalberghi, & Galloway, 1997; Ueno & Matsuzawa, 2005). Young chimpanzees (*Pan troglodytes*) are attracted to novel food over familiar ones but inspect it and look at their mothers before ingesting it (Ueno et al., 2005). Infant capuchins (*Cebus apella*) picked up food more often when it was novel and ate novel foods more than familiar ones (Fragaszy et al., 1997). Interestingly, food neophobia in capuchins also decreases after they observe another group member eating the novel food (Visalberghi & Addessi, 2000).

Cats may be neophobic in their dietary tendencies, and reject unfamiliar foods (Bradshaw, 1986). In comparison to farm cats, house cats are more neophobic towards novel food (Bradshaw, Healel, Thorne, Macdonald, & Arden-Clark, 2000). This is probably due to their different environments rather than any genetic differences (Bradshaw et al., 2000).

Response to a novel food was also studied in captive, handreared jackdaws (*Corvus monedula*) (Katzir, 1983). The birds were frightened at first but gradually began to eat it. Mid and low ranking birds were the first to explore the food. The authors propose that these birds were exploiting the new resource before high ranking birds could keep them from it. High ranking birds were less exploratory and depend more on information from the rest of the group. If a mid or low ranking bird started the feeding bout, it was more likely to defend the food against dominant birds during the first stages of habituation. As the dominant habituated, it was more successful in replacing others and frequently interrupted the feeding of the low and mid ranking birds (Katzir, 1983).

In black lemurs (*Eulemur macaco macaco*), novel food utility depended on whether the food was of high or low quality (Gosset & Roeder, 2001). When the food was high quality, lemurs ate without hesitation and when the food was low quality, dominant females were usually the first to try it (Gosset et al., 2001).

Neophilia may allow animals to learn through experience. Heinrich (1994) proposed that, in ravens, neophilia may result in exploring novel objects, with trial-and-error learning leading to foraging for appropriate items. He found that juvenile birds were always attracted to novel items but older ravens did not show as much neophilia (Heinrich, 1994). Another study focused on callitrichid monkeys and found that age did

not make a difference in neophilic behaviors (Kendal, Coe & Laland, 2005). However, older monkeys were more innovative and better at solving novel tasks than juveniles and infants. This suggests that experience may help in novel situations (Kendal et al., 2005).

Neophilia may also be affected by social structure. Jackdaws respond to novel space based on their rank in the dominance hierarchy, independent of age or sex (Katzir, 1982). The first birds to explore novel spaces were usually low or mid ranking birds, similar to exploring novel food, while top ranking birds did not initiate exploring. The authors proposed that high-ranking birds were not exploratory because of its risky nature and the potential loss if the bird's social position is negatively affected from a dangerous encounter. Conversely, the low and mid ranking birds explore because the resources in their familiar environment are limited by their dominant counterparts; they have more to gain and less to lose by exploring than do high-ranking birds. It is interesting to note that low-ranking birds show high levels of exploration even when not in the presence of dominant birds or kept from using a resource (Katzir, 1982).

As jackdaws explored the novel spaces, two behaviors continuously recurred, following and aggression (Katzir, 1982). Some birds followed the initiating exploratory birds, seemingly following certain birds over others. Also aggression increased as birds spent more time near the novel space, although almost no aggression was present during the first periods of exploration (Katzir, 1982). In each group of birds, one or two birds investigated the area more frequently than the rest. As these birds explored, others observed. The rate of habituation typically increased after the first few exploration attempts (Katzir, 1982).

Neophilia may also affect mating behaviors. The novelty of a mating partner and mating situation may be important in the sexual behaviors of animals in certain situations (Dewsbury, 1982). For instance, after reaching sexual exhaustion from mating with estrous females, a male rat may be able to mate again if introduced to a new female mate (Wilson, Kuehn & Beach, 1963).

The Domestic Cat

History and Sociality. There are five genetically distinctive *Felis silvestris* wildcat subspecies (Driscoll et al., 2007). They are the European wildcat (*F. s. silvestris*), the Near Eastern wildcat (*F. s. lybica*), the central Asian wildcat (*F. s. ornata*), the southern African wildcat (*F. s. cafra*), and the Chinese desert cat (*F. s. bieti*). The domestic cat is sometimes referred to as the sixth subspecies, *Felis silvestris catus*, although it evolved from *Felis silvestris lybica* (Driscoll et al., 2007). *Felis silvestris lybica* has been referred to as both the Near Eastern Wildcat (Driscoll et al., 2007) in recent research and the African wildcat (Macdonald, 1992) in early research. This paper will refer to it as the latter because it has more background in the literature.

The first domestic cats were domesticated in the Near East, in the Fertile Crescent (Driscoll et al., 2007). They were probably attracted to rodent infestations in human settlements and the humans let them stay to protect their grain storages (Driscoll et al., 2007). Archaeological evidence suggests that cats were domesticated 9500 years ago (Vigne, Guilaine, Debue, Haye, & Gerard, 2004) but mitochondrial DNA suggests that cats were domesticated 130,000 years ago (Driscoll et al., 2007). This recent research makes domestic cats about as old as domestic dogs, who were domesticated 14,000 years

ago based on archeological evidence (Lindsay, 2000) or up to 135,000 years ago based on mitochondrial DNA (Vila et al., 1997).

Domestic cats, like their ancestors, are often described as solitary (Miklosi, Pongracz, Topal, Csanyi & Lakatos, 2005). However, it has been proposed that domestic cats are social (Kitchener, 1991; Macdonald, 1992), and the evidence seems to support this notion. Most small cats have social lives similar to *Pseudaelurus*, an ancient cat that lived 20 million years ago and crossed from Eurasia to North America (Macdonald, 1992). *Pseudaelurus* evidently practiced territorial polygyny and a single male's territory overlapped that of multiple females (Macdonald, 1992).

Domestic cats are flexible in their sociality (Neilson, 2005). Feral domestic cats live in groups that are organized around food supplies and matriarchs (Neilson, 2005). The females may engage in communal nursing and kitten rearing (Macdonald, 1992) and there may even be multiple female lineages within a society (Neilson, 2005). Females within the same lineage spend more time around one another than those in different lineages but are friendlier towards non-lineage group members than outsiders (Neilson, 2005).

Thomas (1994) believes that the cat social system is like a wheel where the alpha is the hub and the other cats are the spokes; they are equal but subordinate to the alpha. Leyhausen (1979) adds that social position is not determined by sex, size, or strength alone and the hierarchy can change without fights; thus there is little tendency to solidify ranks and structure (Leyhausen, 1979). Farm cats may even be egalitarian with a social ladder where multiple cats are on each rung (Thomas, 1994). In feral populations, kittens

are an integrated part of the group but may disperse at one or two years old (Neilson, 2005) or even four months old (West, 1974).

Male cats may have a territory that is three times the size of the females' (Neilson, 2005). The tomcats roam female territories and may cover multiple colonies of females (Macdonald, 1992). They do not need to form coalitions because their food is abundant and they are adept hunters (Macdonald, 1992). Tomcats also practice infanticide and the matriarchal group den may help safeguard against this (Macdonald, 1992).

The cat's high degree of sociality is reflected in their ability to exchange information with one another. Cats use various vocalizations and body postures to communicate with other cats (Thomas, 1994). Furthermore, the mobility of their eyelids, lips, cheeks, ears, and whiskers allow them to express emotion (Thomas, 1994). Cats also use scent to exchange information (Thomas, 1994). When two unfamiliar cats meet, they sniff the other's nose and then sniff and feel with their whiskers the nape and the flank of each other and then smell the anal region (Leyhausen, 1979).

Cat Diet. Wildcats live in various habitats but seem to be more abundant in open bushland, in both rocky hills and on the plains (Kingdon, 1977). African wildcats are solitary, nocturnal hunters (Kingdon, 1977). They predominately eat rodents but also eat some birds and insects (Rowe-Rowe, 1978), although it has been suggested that the southern African wildcats are adaptable predators and can change their diet according to long term prey abundance (Herbst & Mills, 2010). The diet of domestic cats is similar to their ancestor's diet.

Feral cats cover a wide geographic distribution and eat a variety of prey. Although they live in social groups, feral cats do not hunt together (Kitchener, 1991). In

Australia, feral cats (an introduced species) mainly eat mammals but also eat some insects and birds. The mammals were mostly rabbits, mice, and ringtail possum (Coman & Brunner, 1972). In England, domestic cats eat mice, voles, shrews, rabbit, and some birds (Churcher & Lawton, 1987) and, in Sweden, domestic and feral cats also eat rabbits and voles (Liberg, 1984).

Diet also varies across the United States of America. In California, cats mainly eat voles (Pearson, 1966) and, in Wisconsin, they eat a lot of voles but also mice, rabbits, and rats (Kitchener, 1991). Lastly, in Baltimore, domestic cats in urban area prey on juvenile and subadult rats (Childs, 1986).

Cat Play. Play has been proposed to establish friendships in social but potentially aggressive animals who also develop close bonds (Lindsay, 2001). Social play is often exaggerated and done at a safe intensity. It is used to create bonds, increase strength, and for fun (Lindsay, 2001).

Domestic cats engage in social play. Social play occurs most often in cats that are 4 weeks to 4 months old (West, 1974). This further suggests that play is used for exercise and developing social bonds as it starts at a time when kittens can move and stops when they typically disperse (West, 1974). Moreover, kittens tend to play more with their own littermates (Neilson, 2005). Eight patterns of behavior are associated with social play; they are pounce, side-step, belly-up, stand-up, face-off, vertical stance, horizontal leap, and chase (West, 1974).

Cats also play with objects. Kittens begin to play often with objects at 7-8 weeks old, after social play develops, when they develop the eye-paw coordination to move small objects around (Turner & Bateson, 1998). Kittens tend to play with novel objects

by looking at, sniffing, licking, touching, and circling them and then they repeat these behaviors from multiple angles (Bradshaw, 1992). Kittens, both feral and domestic, that have been socialized to humans do not show a difference in object play at one year old compared to non-socialized kittens (Neilson, 2005). However, indoor kittens are quicker to initiate play with toys than outdoor cats. Also, the amount of play and degree of willingness to be held increases with the number of people that handle the cat (Neilson, 2005). Object play tends to increase with age until it begins to decrease at 4 months in a gradual decline (West, 1974).

Object play may be motivated by predatory behaviors (Hall et al., 1998). The motor patterns used in object play usually resemble those used in catching prey (Turner et al., 1998). Kittens start to use the prey-catch movement, a cautious lunge with one paw, when they are around 3 weeks old (Leyhausen, 1979). This behavior can be seen in adults as they inspect small, novel objects (Leyhausen, 1979). Cats typically play with relatively small toys unless they are hungry (Hall et al., 1998). Hunger increases play and toy interaction. When hungry, cats sniff at larger toys and their fear of the large toy is reduced (Hall et al., 1998).

Cat Cognition. Similar to dogs, domestication modified the cognitive abilities of the cat, which has permitted them to live in a human environment (Miklosi et al., 2005). Some of these adaptations help specifically to live among humans. For instance, when trying to find hidden food, cats, like domestic dogs, will gaze back and forth between humans and the hidden food (Miklosi et al., 2005), as an apparent glance for help.

There are some other interesting features of cat cognition. Cats learn faster after observing other cats complete a task (Herbert & Harsh, 1944). Cats also may not pass the

mirror test. The first time that they see their reflection it is as if they see another cat, and the second time they see their reflection they appear uninterested (Leyhausen, 1979). However, the author did not find any studies that actually ran the mirror test on cats. Cats can also differentiate between the quantities of two and three and may use visual cues associated with quantity (Pisa & Agrillo, 2009). Lastly, cats possess the required neural mechanisms for color vision and can discriminate between some colors, such as blue from gray or green, if the stimuli has a large visual angle and stimulates a large retinal area (Loop, Bruce & Petuchowski, 1979).

Neophilia and Domestication

Neophilia has been proposed as one supportive aspect in the process of dog domestication. Kaulfuß and Mills (2008) found that dogs have a strong preference for novel items. They state that being neophilic may have helped the first dogs adapt to living with humans because neophilia is associated with producing novel behaviors and exploring new environments. Dogs exhibited this inclination through a line up test of three toys, one novel and two familiar (Kaulfuß et al., 2008). The authors suggest that neophilic tendencies in a sub-population of wolves assisted in their increased contact with humans and their utilization of human settlements (Kaulfuß et al., 2008).

This study was based on the aforementioned work of Kaulfuß et al. (2008) and focused on the domestic cat. It examined whether domestic cats also display neophilic tendencies to determine if neophilia may have aided in the domestication process of the cat. It involved a similar line-up test, consisting of three trials with one novel and two familiar toys, with some fundamental modifications for cat behavior. I hypothesized that, similar to dogs (Kaulfuß et al., 2008), cats will prefer novel objects. If cats do prefer the

novel objects, it suggests that they are neophilic. Displaying a neophilic tendency would suggest that neophilia aided in cat domestication.

Method

The method described below was based on a study of neophilia in dogs (Kaulfuß et al., 2008) but was modified for cats' play behaviors and motivations. After some preliminary tests, the following method appeared to be best suited for cats.

Subjects

The subjects were 24 domestic cats (*Felis silvestris catus*) from the Mosaic Feline Refuge located in Ann Arbor, Michigan. An assortment of breeds, ages, and sexes were represented (Table 1). All sessions were conducted at the Mosaic Feline Refuge and took place in a small room away from other cats, as cats are allowed to roam the shelter during the day. Cats were fed between 4:00 and 8:00 am and again at 8:00 pm. Sessions were conducted in the early evening before the cats ate dinner.

Materials

Five cat toys were used. These included a large, silky pink mouse, a crinkly gold and purple ball, a yellow/green ball with raised bumps and a bell inside, a blue gemmed ball with a bell inside, and a small, white furred mouse that rattled (see Appendix C). The variation in toys was used to control for any toy type preference. The toys were cleaned off with liquid dish soap and water before each training session.

A tray was used in experimental sessions so that all 3 toys could be presented to the cat at once, eliminating any choice based on order of appearance (Appendix C). It was 55.5 cm by 37.8 cm and covered with white paper, for minimal distraction, and clear tape, for easy cleaning. Attached to the top of the tray were 3 clear plastic Tupperware

containers. The containers were cut down to approximately 3 cm tall, had a width of 7.2 cm, and a length of 11.4 cm. The front wall was also cut out of each container so that cats could easily see inside. The containers were placed 25.5 cm away from the middle of the tray's edge in a "V" shape (Appendix C). The tray was wiped down with an antibacterial cloth before each training session. The tray was chosen as the method for choice tests through a series of preliminary trials. Out of all the methods tested, it had the highest rate of responses and the fewest confounding variables. A tray was not used in Kaulfuß et al. (2008).

Procedure

The cat was first given 5 minutes to explore the testing room. The experimenter (always the author) sat on the floor and only interacted with the cat when the cat rubbed against her or sat in her lap. The experimenter responded by giving positive encouragement and petting the cat. The tray was on the floor and accessible to the cat so that its novelty would not affect the cat's choices in the experimental session. Immediately after the exploration period, the cat was given a training session to establish familiarity with two of the toys. During the training session, the experimenter played with two toys with the cat for 10 minutes (Appendix D). The two toys were chosen at random from a pool of five toys by turns of a die (Appendix A). The training session confirmed that the objects were of interest and not distasteful to the cats. Play was encouraged by the experimenter with positive vocalizations and by tossing the toys. The cat was required to touch each toy a total of 5 times before the ten minutes was over, since it showed toy interaction motivation. If the cat did not meet this requirement, he/she was eliminated from the experimental trials because the toys were assumed to be

uninteresting to the cat. Kaulfuß et al. (2008) did not require this because toys motivated all of their subjects. Based on the results of the preliminary training sessions, the allotted time for familiarization was 10 minutes, rather than the total of 80 minutes used in the dog study (Kaulfuß et al., 2008), to keep the cat's attention and avoid their boredom. The preliminary tests showed that cats typically became uninterested in the toys over longer periods of time. The shortened time eliminated putting the cat in his/her cage, with the two toys, for one hour. Since cats at the center were punished by caging, it was important to avoid caging them during the experiment, as was done for dogs in Kaulfuß et al. (2008). This also eliminated 5 minutes for the cat to reacclimatize to the room and 10 more minutes of playtime, also in Kaulfuß et al. (2008).

Next an experimental session was conducted to determine whether cats showed a preference for novel toys similar to domestic dogs (Kaulfuß et al., 2008). In this session the cat was given three trials to choose a toy from a group of three toys, two familiar and one novel (Appendix E). The two familiar toys were the toys used in the training session. The novel toy was chosen randomly from the remaining three toys (Appendix A).

The cat stayed in the room the entire time, unlike Kaulfuß et al. (2008), where the dog left the room between trials. In the experimental session, the experimenter brought out another toy, one that the cat had not yet seen. The toys were put into the 3 containers on the tray, one toy per container, while out of the cat's view. The location of the toy was randomly determined (Appendix B). The tray was then put down on the floor, centered in front of the cat, whereas the toys were put 2 meters away from the dogs (Kaulfuß et al. 2008). If this was not possible (e.g. if the cat was facing the wall), the tray was put beside the cat and the cat was turned to face the tray. The experimenter stood

behind the tray, unlike Kaulfuß et al. (2008), where the experimenter stood behind the dog and said, “fetch”.

The cat was given 1 minute to choose a toy, whereas the dogs had 30 seconds (Kaulfuß et al. 2008). The choice was indicated by sniffing, touching, or biting the object. The first object that the cat chose was recorded and the cat was praised. If the cat did not contact any of the toys, that trial was discarded and the session moved on to the next trial (cats who did not choose were also praised at the end of the 1 minute trial). This was unnecessary in Kaulfuß et al. (2008) as each dog chose a toy every time.

The trial was repeated twice more for a total of three trials per cat. Each trial was conducted with a different novel toy so that three novel toys were eventually used. The location of the novel toy in the lineup changed each trial as well so that each location of the lineup contained one novel toy at some point (Appendix B). The novel and familiar toys used and the lineup locations were randomized for each trial (Appendix B).

The toys were cleaned only before the training session started and not between trials, as was done in the previous study (Kaulfuß et al., 2008). As mentioned above, cats rely heavily on their sense of smell and almost always investigate novel objects by sniffing them (Bradshaw, 1992). Not washing the familiar toys ensured continued familiarity throughout the experimental session, whereas washing them would eliminate familiar smells to the cat, who might deem the toys unfamiliar.

After the cat completed the 3 trials, he/she was given a treat and put back into the shelter area. All three sessions were done one after the other in succession on the same day. If the cat went to the same side for each of the 3 trials, the results were discarded and he/she was retried another day. Three cats did this and, upon another test, qualified

to be included into the dataset. This precaution was not taken in Kaulfuß et al. (2008). Cats were also required to make at least 2 choices during their experimental session for their data to qualify. This was, again, unnecessary in Kaulfuß et al. (2008).

Data Analysis

The results were analyzed similarly to the dog study (Kaulfuß et al., 2008). Thus the cats' responses for their first, second, and third test ($n=23$, $n=20$, and $n=22$, respectively) were analyzed separately (the number of choices (n) differed for each trial as not every cat made a choice for each trial). The preference for novelty was determined through a binomial probability distribution test, using a probability of 0.33 for a novel choice in each test (Kaulfuß et al. [2008] used 0.3333). The results were not, however, analyzed by combining all three tests, as was done in the previous study (Kaulfuß et al., 2008). Results were not combined because trials could not be considered independent of each other. Also, since some cats only chose two objects, analyzing all three tests together would count some cats three times and others twice.

The p value was <0.05 , one tailed. The test was one tailed because this study was interested in results that were biased in one direction and would reject the hypothesis only if obtained values were at the upper tail of the distribution (Leach, 1979). More specifically, this study expected a novelty effect and thus only examined the response to novelty (it was not concerned with familiarity). Kaulfuß et al. (2008) did not describe whether their test was one tailed or two tailed.

Results

A total of 29 cats were tested and, of these, 24 chose an object in two or three trials, thus meeting the criteria to be entered into the dataset (Table 2). Five cats were

eliminated due to either being scared of the test, not playing, or not making any choices. Three cats were retested due to a lack of motivation in their first experimental session, and all of them were entered into the data set after their second experimental session.

Out of the 24 eligible cats, 21 chose a novel object at least once. Overall, the cats chose a novel object 32 times out of 65 actual choices. The proportion of novel choices for the first, second, and third trial (0.52, 0.40, and 0.55, respectively) was greater than the expected proportion (0.33) in all three trials (Table 3). Overall the proportion of novel choices (0.49) was also greater than the expected value. Table 3 shows that there was a strong trend to choose a novel toy and that the first and third trials were significant ($p=0.045$ and $p=0.030$, respectively). The second trial was not significant ($p=0.327$).

Discussion

The results supported my hypothesis. The cats showed a strong tendency to choose novel toys over familiar toys. This was demonstrated by the greater than expected proportion of novel choices over familiar choices and the significant values of the first and third trials. This suggests that cats have a neophilic tendency. This finding has several implications.

The first implication is that, similar to domestic dogs (Kaulfuß et al., 2008), neophilia may have helped facilitate the domestication of the cat. As stated above, neophilia has been associated with innovative behaviors and an increase in the tendency to explore novel environments (Kaulfuß et al., 2008). Neophilic wildcats may have followed this inclination and investigated the novel environment of humans. The tendency to explore novelty allowed them to successfully integrate into a new niche beside humans. Indeed, archeological evidence suggests that the domestication of the cat

began in the same place and time that human settlements and agriculture developed (Driscoll et al., 2007). A neophilic population of wildcats may have integrated into this novel environment for its ample food supply of rats (Driscoll, Macdonald & O'Brien, 2009b), and thrived there.

The second implication involves future research. The neophilic tendencies of cats must be accounted for in future research, particularly in studies that focus on cats' preferences or choices. The neophilic tendency must also be considered in studies that examine cognitive abilities of the domestic cat. Kaulfuß and Mills (2008) point out that experimental methods for cognitive abilities must control for behavioral tendencies such as this before higher cognitive abilities are attributed.

The present study did have a built-in bias. This study examined cats who were willing to play with the toys. This may have indirectly selected for cats who want to explore new items and exhibit neophilic preferences. Clearly this would skew the results and may reflect a neophilic tendency that is not represented across the entire species. The play required in the study also led to many young cat subjects. This may bias the results as well if young cats are more neophilic than older cats, as in chimpanzees and capuchins (Fragaszy et al., 1997; Ueno et al., 2005). As mentioned above, feral cats disperse as old as one or two years of age (Neilson, 2005). Perhaps young, neophilic cats were the first to explore human settlements. Another possible bias could result from the experimenter unconsciously giving the subjects cues to choose novel objects (i.e., the Clever Hans effect). Methods to avoid this will be discussed later.

Additionally, it is possible that neophilia in toy choice is distinctive from neophilia as an exploratory preference. The former could be either weaker or stronger

than the latter. If weaker, cats may not have as strong a preference for novel toys as dogs but do have a preference for exploring novel situations and environments. Cats may be more inclined to explore novel surroundings and are less interested in novel objects. Conversely, cats could be neophilic toward objects but may not be inclined to explore novel environments. Perhaps, as predators, cats show greater awareness of objects than of their surroundings.

This study did not find as great a neophilic tendency as found for dogs. Domestic dogs chose novel items at greater proportions (0.71, 0.75, 0.82) and had significance in all three trials (Kaulfuß et al., 2008). This may be due to the different selective pressures of domestication.

Dogs were domesticated while humans were hunter-gatherer nomads (Clutton-Brock, 1995; Vila et al., 1997). It has been suggested that some less-fearful wolves associated with human camps to scavenge food. Then they functioned as barking signalers to alert against camp invaders (Lindsay, 2000). The selection from living with humans allowed this new group to diverge from wolves (Driscoll et al., 2009b). Humans began to unintentionally select for certain pups that were sociable (Muller, 2002). This new population was eventually subjected to artificial selection for specific traits and the product was the domestic dog (Driscoll et al., 2009b).

Although bred for many different specific abilities, dogs tend to be naturally and artificially selected for rigorous social interactions with humans (Call, Brauer, Kaminski & Tomasello, 2003). Dogs have been under such great selection for this that they can read human body cues. For instance, dogs can utilize human pointing gestures to find food. They can even use pointing gestures that they may have never seen before such as

leg pointing or cross-pointing (Miklosi, Topal & Csanyi, 2006). Dogs are also sensitive to human eyes. They can follow human gazes and distinguish when humans are looking into or above a container (Miklosi et al., 2006). Furthermore, they tend to beg from visible eyes and faces (Gasci, Miklosi, Varga, Topal, & Csanyi, 2004). Dogs may even have an internal representation of their owner's face when being called (Adachi, Kuwahata, & Fujita, 2007).

Domestic cats may not have faced the same selective pressures and may not have needed to interact so effectively with humans as dogs. The first domestic cats may have been used to guard grain storages from rats (Bradshaw, 1992). However it has also been proposed that cats lacked this utility as cats were ineffective at ridding farms of Norway rat infestations unless the existing infestation was first eliminated through other means (Elton, 1953). Perhaps it is doubtful that early agricultural communities would have selected the wildcat as a pet (Driscoll et al., 2009b). Cats may have lived in human environments, being only tolerated by the humans and not directly interacting with them, and gradually diverged from their ancestors (Driscoll, Clutton-Brock; Kitchener & O'Brien, 2009a).

Furthermore, the first wolves being domesticated into dogs were probably under different selective pressures than the first African wildcats being domesticated into cats, due to their different degrees of sociality. Wolves are cooperative hunters (Mech, 1970) while African wildcats are mostly solitary hunters (Kingdon, 1977). This difference in sociality (i.e. cooperative behaviors) may have caused humans to put different selection pressures on dogs and cats. Even today dogs seem to be more cooperative with humans

and may act as our guards, hunting escorts, or set of eyes. The different pressures may have selected for dogs to live closer as human companions compared to cats.

Thus perhaps cats did not need to have neophilic tendencies as strong as those of dogs. Cats may have lived alongside humans in order to exploit the new human environment rather than lived with humans. This would cause different selective pressures on neophilia compared to dogs, who were selected to interact with humans. Perhaps cats needed to have some neophilic tendencies in order to live in a novel environment but they did not need as strong neophilic tendencies as dogs because they were not directly concerned with humans or selected upon by them.

This suggestion is supported by studies that examine human-cat interactions. As mentioned above, cats will gaze at humans when searching for hidden food (Miklosi et al., 2005). They do this, however, at a lower rate than dogs and rarely looked at the human's face. Cats also spent more time poking at the hidden food than did dogs and appeared to try to figure it out themselves for a longer duration (Miklosi et al., 2005). Wolves raised by humans had results similar to the cats (Mikolosi et al., 2003), which may be attributed to both species being relatively independent from humans (Miklosi et al., 2005). That degree of independence may have allowed for some preservation of neophobic tendencies and some transformation to neophilic tendencies in cats. Perhaps a population of fairly neophilic African wildcats ventured into human settlements and, as they remained more independent from humans than dogs, they acquired enough neophilic preferences to live in the same environment as humans. However, because they did not rely as heavily on direct human interaction as dogs, they also retained some neophobic tendencies.

Dogs may be more neophilic than cats for another reason. Perhaps wolves were more neophilic than wildcats before they ever interacted with humans. Wolves often live in large home ranges, ten to thousands of square kilometers (Mech & Boitani, 2003). Wildcats live in smaller home ranges; male African wildcats have a home range of 4.3 km² (Kitchener, 1991) and female European wildcats have a home range of 500 acres (Macdonald, 1992). The larger home range of wolves could mean that wolves encounter more prey species than wildcats. This may lead to stronger selection for neophilia in wolves in regard to prey choice. However, no study has directly compared the number of prey species of wolves and wildcats.

It is interesting to note that the ability for an organism to establish itself in a novel environment has been correlated with large brain size, relative to body mass (Sol, Duncan, Blackburn, Cassey & Lefebvre, 2005). Neocortex size is also correlated with ecological complexity (Barton, 1996). However, domestic cats have small brains relative to body size (Kitchener, 1991) and the domestication of the dog led to a reduced cranial capacity (Lindsay, 2000). The ability of the cat and dog to thrive in a novel environment, despite their brain size, may be due to living among humans and having a stable food resource.

Future research in this area should be continued in several ways. It has been suggested that some cats are more neophobic toward novel foods than other cats and that the difference is due to environment (Bradshaw et al. 2000). Similar to the baboon and gelada study (Bergman et al., 2009), cats who live in an environment that requires them to be generalists should be more neophilic. The next study should examine cats' response to novel foods in regards to their ecological complexity while controlling for

human contact. Bradshaw et al. (2000) had humans feeding farm and pet cats but did not account for pet cats being less neophobic simply due to more human contact. Controlling for human contact and examining food neophilia would lead to more conclusive results regarding cat domestication, as a novel food source was probably the catalyst for cat domestication (Bradshaw, 1992).

Future research should also examine whether neophilia helps encourage learning (Heinrich 1994). A study could investigate whether young cats are more neophilic than older cats, as in ravens (Heinrich 1994). It would also be interesting to examine whether rank affects neophilia in cats. Possibly, similar to jackdaws (Katzir, 1983), mid and low ranking cats are more neophilic than high ranking cats. Perhaps other cats followed the neophilic cats, as in jackdaws (Katzir, 1983), into the novel human environment since cats may learn through observation (Herbert et al., 1944).

Lastly, future research should avoid the possibility of a Clever Hans effect. Ward and Smuts (2007) overcame this effect when they required dogs to choose quantities of food. The experimenter wore sunglasses so that the dog could not read inadvertent eye cues. For a control test, they also had both an experimenter and an assistant run the experiment. The assistant set up the choices and the experimenter offered them to the subject (Ward et al., 2007). The experimenter did not know what the control and experimental variables were and could not provide any cues.

The presented study suggests that cats do have neophilic tendencies. Overall, cats preferred novel objects to familiar ones. Cats did not display as great a neophilic tendency as dogs, which may be due to their differing domestication processes and selection pressures. Cats may have been domesticated as a side effect of proximity to

humans while dogs were domesticated through social interactions with humans. Still, neophilic tendencies may have allowed a population of wildcats to explore a new niche and live among humans. Neophilia appears to have facilitated the domestication of the cat to some degree.

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Table 1

Subject Information

Subject	Sex	Spay/ Neuter	Age (Months)	Time at Shelter (Weeks)
100	F	-	3.5	8
101	F	+	6	3
102	M	+	12	1
103	M	-	5.5	16
104	M	+	5	1
105	M	-	5.5	16
106	M	+	5	1
107	M	+	4.25	17
108	M	-	4.25	17
109	F	-	3	2
110	M	-	3	2
111	F	+	5	2
112	F	-	5	2
113	F	+	7.25	*
114	F	+	8	32
115	M	+	66	24
116	M	+	17	1
117	F	+	6	44
118	F	-	12	5
119	M	-	3	4
120	M	-	3.5	8
121	F	-	2.5	*
122	M	-	2	16
123	M	-	2.5	*

* = Unavailable

Note. Table 1 provides background information on each test subject whose data qualified to be in the dataset.

Table 2

Experimental Results

Subject	Choice 1	Choice 2	Choice 3	Toy 1	Toy 2	Toy 3
100	Novel	None	Novel	BL	None	PM
101	Novel	Familiar	Novel	BL	PM	BB
102	Familiar	Novel	Familiar	BB	WM	BB
103	Familiar	Familiar	None	WM	WM	None
104	Novel	Familiar	Novel	CR	BL	PM
105	Familiar	Familiar	Novel	CR	CR	BB
106	Familiar	Familiar	Novel	CR	CR	PM
107	Familiar	Familiar	Novel	CR	WM	BL
108	Novel	Familiar	Familiar	PM	WM	BB
109	Familiar	Familiar	Familiar	BL	BL	BL
110	Familiar	Novel	Familiar	CR	BL	CR
111	Familiar	Novel	Familiar	CR	WM	PM
112	Novel	Novel	Novel	WM	PM	CR
113	Novel	None	Familiar	CR	None	PM
114	Familiar	Familiar	Familiar	BL	CR	CR
115	Novel	Familiar	Novel	BB	CR	WM
116	None	Novel	Novel	None	WM	CR
117	Novel	None	Familiar	PM	None	WM
118	Novel	Novel	None	BB	BL	None
119	Novel	Familiar	Familiar	BB	WM	PM
120	Novel	Familiar	Novel	BL	CR	WM
121	Familiar	Novel	Familiar	CR	BB	WM
122	Familiar	Novel	Novel	BB	PM	BL
123	Novel	None	Novel	PM	None	WM

BL=blue ball, CR=crinkle toy, PM=pink mouse, BB=bumpy ball, and WM=white mouse

Note. Table 2 provides experimental data of all 3 trials for each test subject whose data qualified to be in the dataset.

Table 3

Results of the Choice-Test for Each Trial

	Item Chosen	Number of Cats	Observed Proportions	p^a
First Trial	Novel	12	0.52	0.045
	Familiar	11	0.48	
Second Trial	Novel	8	0.40	0.327
	Familiar	12	0.60	
Third Trial	Novel	12	0.55	0.030
	Familiar	10	0.45	

^a Binomial probability distribution test

Note. Table 3 shows the data analyses of the choice tests. In the first and third trials, cats proportionally chose the novel object greater than expected. The first and third trials also produced significant values ($p=0.045$ and 0.030 , respectively).

Appendix A

Determining Toys' Assignments

1. Start with a 5 toy line up where the far left toy is "1" and the far right toy is "5" and the in between toys are labeled "2", "3", and "4" appropriately.
 2. Roll the die. The number rolled corresponds to which toy will be the "first" familiar toy ("first" and "second" familiar toy label is used later)*.
 3. Roll the die again. This number corresponds to which toy will be the "second" familiar toy*.
 4. The novel toys are the last 3 remaining toys. The order in which they are laid out corresponds to the order that they will appear in the experiment.
- * Roll again as necessary (e.g. if a "6" is rolled or if a number is rolled twice).

Appendix B

Determining Toys' Positions for the Test

This entire procedure is done once for each trial for a total of 3 times per cat.

1. First roll corresponds to the first novel toy used. A "1" or "2" rolled places the toy in the left position. A "3" or "4" rolled places the toy in the middle position. A "5" or "6" rolled places the toy in the right position. *
2. The second roll corresponds to the "first" familiar toy (from above). An odd number places the "first" familiar toy in the first left position from the novel toy's position. An even number places the "first" familiar toy in the first position on the right of the novel toy.
3. The "second" familiar toy is placed in the last available position.

* Roll again as necessary (e.g. if the position rolled for the novel toy has already been used for another novel toy within those 3 trials).

Appendix C

Testing Tray and Toys



Appendix D

Training Session



Appendix E

Cat Making a Choice

