Spring 5-2-2019

Contagious Yawning in the Domestic Cat (Felis catus)

Ariel M. Lombardo Aghishian
CUNY Hunter College

Contagious Yawning in the Domestic Cat (*Felis catus*)

by

Ariel Lombardo Aghishian

Submitted in partial fulfillment

of the requirements for the degree of

Master of Arts in

Animal Behavior and Conservation, Hunter College

City University of New York

2019

Thesis Sponsor:

April 22nd, 2019	Joshua Plotnik
Date	Signature of First Reader
April 22nd, 2019	Diana Reiss
Date	Signature of Second Reader

Acknowledgements

I would like to thank my advisor, Dr. Joshua Plotnik, for all his hard work and invaluable advice to make this project possible. Thank you to my second reader, Dr. Diana Reiss for her guidance and suggestions. I'd also like to thank Dr. Martin Chodorow for his help with the statistics and advice on the methods for this study. Thanks also to Dr. Steven Zawistowski and Julie Hecht who helped advise and guide me to make my project as good as it can be and cat friendly. I would also like to thank Sarah Jacobson and all my peers in Dr. Plotnik's lab for their support and suggestions. A special thanks to Jamie Abbt for assisting me with data collection and listening to me talk out my thoughts and ideas. Many thanks to the volunteers, cat and human alike. Finally, a huge thanks to my friends and family, particularly my husband John, who supported me throughout this process.

Abstract

This study investigates contagious yawning in domestic cats in response to their owners' yawns. Contagious yawning has been linked with the capacity for empathy in humans and is a type of emotional contagion that can be studied in animals. Some wild species (chimpanzees, bonobos, baboons, macaques, and wolves) as well as several domesticated animals (dogs, sheep, rats, and budgerigars) have demonstrated contagious yawning, suggesting that basic empathic mechanisms can be investigated in non-human animals. Dogs yawn contagiously in response to humans, and it has been hypothesized that this strong interspecific social response may be a result of the domestication process. Because of the close relationship between domestic cats and their owners, cats would also be a good candidate for studying contagious yawning. Thus, in the current study, twenty-six owner-cat dyads were tested in two conditions: in the first, the owners yawned in the presence of the cat; in the second, a control condition, the owner made a gaping open mouth face in the cat's presence. Results showed no significant difference in yawning between conditions. This study suggests that cats do not yawn contagiously in response to human yawning. Stress is a potential confounding variable that could have impacted the results. The solitary nature of many cat species and the common cat ancestor, as well as the uniqueness of interspecific social behavior in domesticated cats may help explain the current study's findings.

Keywords: domestic cat, Felis catus, yawning, contagious yawn, empathy, emotional contagion

Table of Contents

Contagious Yawning in the Domestic Cat (*Felis catus*)

Contagious yawning, whereby one individual's yawn triggers another individual to yawn, is an interesting phenomenon that has caught the attention of animal behavior researchers (de Waal & Preston 2017; Massen & Gallup 2017; Senju 2010). The mechanisms underlying contagious yawning are thus far inconclusive; however, one of the predominant theories is that it is linked to empathy (de Waal & Preston 2017; Norscia & Palagi 2011; Platek et al. 2003; Platek et al. 2005; Preston & de Waal 2002; Provine 2005; but see, Massen & Gallup 2017; Yoon & Tennie 2010). Empathy is a complex cognitive function involving taking the perspective or emotion of another individual. Some scientists argue that empathy is a large umbrella category that can be broken down into different components, some involving higher or lower cognitive capabilities (Preston & de Waal 2002). They argue, however, that all the components of empathy share the same underlying mechanism (Preston & de Waal 2002). Emotional contagion, in which one individual will 'catch' the emotion of another individual, is one of those components involved in empathy that does not necessarily require high level cognition, and may be an indicator of empathy (in some form) in animals (Preston & de Waal 2002). Yawning has been specifically described as a type of emotional contagion, and it can be tested and compared across species, as most vertebrates are capable of yawning (Heusner 1946).

The link between contagious yawning and empathy has been tested broadly and there is a wide range of studies supporting the link (Senju 2010). Humans have been shown to contagiously yawn (Provine 1989), and studies have since looked into the underlying mechanisms. Social bond, or familiarity, which is associated with empathy, has been shown to correlate with contagious yawning, with yawn response latency decreasing as social bond increased (Norscia & Palagi 2011). Others have linked contagious yawning to self-information

processing, an important component for empathic abilities (Platek et al. 2003). Children show contagious yawning at about the same age as they show development of empathy (Helt et al. 2010). An fMRI of brain activity showed that, when compared with other contagious activity, contagious yawning showed similar brain region activity as self-referent information needed for empathy (Platek et al. 2005).

Disorders and personality traits associated with low levels of empathic responses have been tested for correlations with contagious yawning, and results support the link with empathy (Platek et al. 2003; Rundle et al. 2015). For example, schizotypal personality traits are linked with low performance on theory of mind tests and inhibited self-information processing, indicating potential disruption in empathy (Platek et al. 2003). Contagious yawning is also negatively correlated with schizotypal personality traits (Platek et al. 2003). Individuals with clinical psychopathy show lower average levels of contagious yawning (Rundle et al. 2015). Higher scores of coldheartedness (a measure of negative or absent social emotions) significantly predict lower levels of contagious yawning (Rundle et al. 2015). However some studies were unable to show a link between empathy and contagious yawning. Empathy self-report scores did not correlate with contagious yawning in Bartholomew & Cirulli's study (2014), although their population came from the general population, not individuals known to have low empathy, and it may be the case that empathy levels do not vary enough in the general population to affect contagious yawning.

People with Autism Spectrum Disorders (ASD) have been shown to score lower than the general population on measures of empathy (Baron-Cohen & Wheelwright 2004). Because of the characteristic difference in reported empathy levels in people with ASD versus people with typical development, some studies have tested contagious yawning in people and children with

ASD, finding significantly less contagious yawning in those with ASD (Helt et al. 2010; Senju et al. 2007). Others suggest that the atypical focusing in the face region, such as reduced eye contact and less spontaneous attention to the face, characteristic of individuals with ASD may be the reason for low contagious yawning in children with ASD (Senju et al. 2009), and that when attention is focused on the eyes, there is no difference between children with ASD and children with typical development (Usui et al. 2013).

There is still skepticism of the link between equating contagious yawning with empathy; however, most of the criticism is based in the need for more studies, not the idea of the link itself (Massen & Gallup 2017). Contagious yawning has also been investigated in several non-human primates. Evidence of contagious yawning was found in chimpanzees (Amici et al. 2014; Anderson et al. 2004; Campbell et al. 2009; & Campbell & de Waal 2011), bonobos (Demuru & Palagi 2012; & Palagi et al. 2014), baboons (Palagi et al. 2009), and stumptail macaques (Paukner & Anderson 2006). Gorillas and orangutans (Amici et al. 2014), and ring-tailed and ruffed lemurs (Reddy et al. 2016) were tested but did not demonstrate contagious yawing.

Aside from primates, evidence for contagious yawning has been found in wolves (Romero et al. 2014), rats (Moyaho et al. 2015), budgerigars (Gallup et al. 2015), sheep (Yonezawa et al. 2017) and domestic dogs (Joly-Mascheroni et al. 2008; Madsen & Persson 2013; Romero et al. 2013; Silva et al. 2012; but see Buttner & Strasser 2014; Harr et al. 2009; O'Hara & Reeve 2011). The red-footed tortoise was tested but no evidence of contagious yawning was found (Wilkinson et al. 2011). Though not specifically tested, lions were not seen to contagiously yawn in an observational study (Baenninger 1987). To test the hypothesis that contagious yawning is linked to empathy, some studies have tested for familiarity biases in yawn responses. For example, several of the primate studies tested contagious yawning as it relates to

familiarity (Palagi et al. 2009), social bonding and/or relatedness (Demuru & Palagi 2012; Palagi et al. 2014), and in-group versus out-group relationships (Campbell & de Waal 2011), finding familiarity to be an important factor. One study, however, did not find familiarity to be relevant (Campbell & de Waal 2014). Overall, results on the role familiarity plays in yawn contagion in animals has been mixed (Romero et al. 2013; Romero et al. 2014; Silva et al. 2012; but see Gallup et al. 2015; Madsen & Persson 2013; Moyaho et al. 2015).

Research on interspecific contagious yawning has also been limited to chimpanzees and dogs. Only one study found chimpanzees contagiously yawn with humans (Campbell & de Waal 2014). Joly-Mascheroni and colleagues (2008) were the first to demonstrate contagious yawning in dogs, providing an initial standard for controls and methodology. Interestingly, results on contagious yawning in dogs have been mixed, with some studies finding strong evidence for it (Joly-Mascheroni et al. 2008; Madsen & Persson 2013; Romero et al. 2013; Silva et al. 2012), and others finding none at all (Buttner & Strasser 2014; Harr et al. 2009; O'Hara & Reeve 2011). Nevertheless, results of these studies support the need for more research on contagious yawning in domesticated species, including domestic cats.

Experimental studies on contagious yawning typically have similar methodologies. In primates, the experimental condition is usually presented as a video recording of another conspecific yawning, and the control is presented as a video of an open mouth gape (Anderson et al. 2004; Campbell & de Waal 2011; Paukner & Anderson 2006). The studies on dogs used different methodologies, with some using video (Harr et al. 2009; O'Hara & Reeve 2011), audio (Silva et al. 2012), and stimuli presented to the dogs live (Buttner & Strasser 2014; Joly-Mascheroni et al. 2008; Madsen & Persson 2013; O'Hara & Reeve 2011; Romero et al. 2013). With the exception of one (Silva et al. 2012), all of the dog studies used a yawn as the

experimental stimulus and an open mouth gape for the control. Joly-Mascheroni and colleagues (2008) were the first to test contagious yawning on dogs. This study's methodology, as well as that of Romero and colleagues (2013), forms the basis for the present study. In both studies, the research was conducted in a place familiar to the dog, such as the home, and owners called the dogs' names to make eye contact, indicating attention (Joly-Mascheroni et al. 2008; Romero et al. 2013).

Due to the domestication of dogs and cats through artificial selection, recent research has focused on the relationship between these animals and their human owners, though the majority of studies have focused on dogs. For example, it has been hypothesized that domestication via artificial selection is responsible for the dogs' capacity for reading and interpreting human communicative signaling (Hare et al. 2005; Hare et al. 2010). Dogs also attend to vocal and gestural cues of humans and use information to socially eavesdrop on them (Marshall-Pescini et al. 2011). They are able to distinguish happy and angry faces in humans (Müller et al. 2015), and are capable of recognizing attentional states in humans, most likely through learned experience (Udell et al. 2011). The relationship dogs and cats share with humans is unique, even compared to other domesticated species, in that they share our homes and are incredibly social with us.

Some researchers hypothesize that dogs may have the ability to empathize with humans, not just exhibit emotional contagion alone (Silva & de Sousa 2011). Several studies have focused on empathic responses and emotional contagion through different methods other than contagious yawning. Empathic like responses from dogs to humans in distress (Custance & Mayer 2012; Sanford et al. 2018), and infant cries (Yong & Ruffman 2014) have been reported. Custance and Mayer (2012) analyzed approach behaviors in dogs during human humming, crying and talking; their results show dogs approach crying in strangers and owners equally, as well as qualitative

differences in approach between crying and humming. This aligns consistently with empathic concern. Yong & Ruffman (2014) found similar behavior changes in dogs' responses to infant cries, such as submissiveness and increased levels of cortisol. The study by Sanford and colleagues (2018) took it a step further, examining dogs' actions in response to human distress, showing dogs to be capable of an emotional response, as well as of engaging in help-giving behavior. The results of their study were consistent with prosocial helping behavior as result of an empathic response to the crying (Sanford et al. 2018). Emotional contagion has also been measured in dogs through changes in performance on a cognitive task when owners were stressed, finding dogs 'catch' stress from their owners (Sümegi et al. 2014).

Interestingly, the dogs' social relationships with humans have been the basis for contagious yawning studies in dogs, and yet, no such studies have been done on cats. Although research on cat behavior in general is lacking, recent studies suggest that further attention to the social relationships between domesticated cats and humans is needed. Much of the existing research on cat - human social relationships has investigated either the cats' attachment or their attention to humans. For example, Zasloff (1996) reported that humans report similar levels of attachment to cats and dogs, while Edwards and colleagues (2007) looked at attachment between cats and humans, and found evidence that cats may be able to form attachment bonds to their owners. After long separations, cats and owners increased contact seeking behavior, possibly filling a need in the relationship to reacquaint (Eriksson et al. 2017). Shreve and colleagues (2017) tested preferences in cats and found that social interactions with humans were preferred over toy and scent stimuli in preference tests. Contrastingly, a different study found no evidence of attachment in cats to their owners based on the Ainsworth Strange Situation Test (SST) (Potter & Mills 2015). The SST was developed by Ainsworth to test

attachment styles of infants to their mothers in humans (Ainsworth & Bell 1970). This test measures attachment with objective measures of safety and security, using the mother as a secure base (Ainsworth & Bell 1970). In the SST, the cat was brought to a new room and it's behaviors were measured in nine different situations with varying owner, stranger or no human presence, and varying interactions with the cat (Potter & Mills 2015) The authors suggest that the SST is not an appropriate method to measure cat attachment for a few reasons, mainly that cat behaviors resulting from this test are unreliable measures of attachment, as many of the behaviors measured show order effects, and the behaviors chosen to assess attachment are not biologically relevant to cats (Potter & Mills 2015). However, they do not think the study suggests cats do not form affectionate social relationships with humans, just that safety and security are not the basis of their attachments (Potter & Mills 2015). In another study, Saito & Shinozuka (2013) found evidence of vocal recognition of owners by their cats. Evidence for recognition and attachment to owners led to questions regarding attention. For example, Galvan & Vonk (2015) conducted tests of cat attention to human emotion, and found that cats were more attentive to their owners over strangers when they displayed emotion. Other researchers found that cats understand human's attentional states using visual and vocal cues together and adjust begging behavior accordingly (Ito et al. 2016). Additionally, Merola and colleagues (2015) tested social referencing in cat-human communication, finding that cats may reference owners when in the presence of novel stimuli. Miklosi and colleagues (2005) compared dogs' and cats' use of visual communication signals with humans, finding no difference between the two species in their ability to follow pointing gestures. This study also looked at comparing the cats' tendencies to seek help from an owner with those of dogs; results suggested that cats spent more time trying to solve the problem independently than dogs.

The cat-human relationship is unique in the way that domestication has adapted a non-social animal to social living with humans (Driscoll et al. 2009). As such, this relationship is important for understanding general domestic cat behavior. Sociality in the *Felidae* group is rare, with cheetah and lions the exceptions (Bradshaw 2016). Wildcats, which are most closely related to domestic cats, do not generally live in groups, though feral cats can be found in socially flexible colonies as well as solitary (Bradshaw 2016). Interestingly, one study supports the idea that domestic cats are social, forming colonies and using affiliative greeting behaviors and purrs as affiliative, social actions (Crowell-Davis et al. 2004). The uniqueness of the social system of domestic cats is adapted for interspecific sociality with humans (Bradshaw 2016). It is further speculated that cats, contrasted with their wild ancestors, may have developed a visual modality bias, similar to dogs, that is influenced by their relationship with humans (Mayes et al. 2015).

Shreve and Udell (2015) and Turner (2017) wrote reviews of the current body of research on cat behavior, and argued that further research on cat behavior is crucial. Specifically, research on cat social behavior could better inform our understanding of the cat - human bond and changes in sociality due to domestication between wild and domesticated cats. Neither of these reviews identified studies on domestic cats and contagious yawning, or the potential meaning of yawns for cats. One researcher of contagious yawning in dogs reported that they received numerous anecdotes from cat owners that their cat contagiously yawned, although this was not tested empirically (Senju 2010).

The present study aims to determine if cats demonstrate contagious yawning with human owners. Such a study is novel and timely, and would provide important insight into understanding domestication’s role in the evolution of interspecific social behavior in cats. Given the similarity of the relationships between dogs and cats with humans, it is reasonable to suggest

that contagious yawning should be studied in cats as it has with dogs. In this study, contagious yawning will be investigated in 26 cats by comparing cats' yawn frequencies in experimental and control trials. In the experimental condition, owners will yawn for as many times as they can get the attention of their cat for ten minutes. In the control condition, owners will gape by opening their mouth by the lower jaw only, instead of yawn. The setting of the study will be in the owners' homes and owners will call their cats' attention in a way that is normal for the individual to simulate as natural a situation as possible and to reduce stress. Specifically, I predict that: 1) cats will yawn more often when in the presence of the owner yawning than in the control condition, 2) more individual cats will yawn during the yawning condition than during the control, and 3) owner's affiliation score will positively correlate with yawns produced in the yawning condition.

Methods

Subjects

Thirty-one cat owners volunteered to participate in this study with their domestic cats (*Felis catus*). Three of the 31 cats did not complete the study either due to lack of habituation or attention to the owner, and two cats were excluded due to complications with the owner yawning during the control condition, resulting in a total of twenty-six cat-owner dyads (N=26). There was an equal number of male (n=13) and female (n=13) cats, 18 were domestic short hairs, 7 were domestic long hairs, and 1 purebred ragdoll. The average time the cats had lived with their owners was 5.7 years. Nineteen of the cats lived with other animals in the house (including other cats, dogs, snakes, and frogs), while 7 were the only animal in the house at the time of the study. All cats ranged in age from 1-13 years old (X=6.6 years old); no kittens were tested to control for confounding variables that may arise due to developmental differences. Vogt et al. (2010) note

that while life stages are variable, kittens are aged between 0-6 months and junior cats range from 7 months to 2 years. One year of age was picked as the cut off to exclude kittens and account for variability in development. Owner participants were sought through flyers posted and emailed at a couple of pet service businesses, and at Hunter College, New York, NY.

Survey

Owners were asked to fill out a short survey with demographic information about the cat as well as four Likert-type scale questions about how affectionate they perceived their cat to be towards them. Questions included were:

1. Does your cat purr when stroked or petted (1-never, 5-always)?
2. Does your cat solicit physical contact from you such as petting, or sitting on your lap (1-never, 5-always)?
3. Does your cat sleep in the same room as you (1-never, 5-always)?
4. How affectionate do you perceive your cat to be towards you (1-not at all, 5-extremely)?

Questions 1-3 were derived from examples from the Fe BARQ questionnaire through a test on its effectiveness to test cat behavior, in which it was found valid and reliable (Duffy et al. 2017), as well as a study on social organization indicating affiliative behaviors (Crowell-Davis et al. 2004). The full survey is listed in the appendix.

Habituation

Before testing, cats were allowed up to an hour to habituate to the equipment, researchers, and any new furniture arrangement in the testing room. Cats that did not habituate

after an hour were excluded from the study. Cats were deemed habituated when they did not show signs of investigation or frustration. Investigation included behaviors such as sniffing, stalking, searching, or vocalizing towards the researchers or equipment (Bennett et al 2017). Frustration included behaviors such as flattened ears, hissing, raising the upper lip and nose wrinkling, hiding, or overt aggression (Bennett et al 2017). Cats were allowed to freely move about the space, though they were confined to one room.

Procedure

Data Collection

The study took place in a room in the owner's home which is familiar to the cats, to reduce stress and novel environmental variables. Two video cameras were used; one on a tripod set up in a spot where most of the room could be seen to record cat behavior during testing, the other held by the researcher or assistant to follow the cat's movements. The owner positioned themselves in a spot visible to the cat for the duration of the experiment.

Procedures were similar to those of Joly-Mascheroni and colleagues (2008) and Romero and colleagues (2013) to enable comparisons across studies. Cats participated in two conditions: a control condition in which the owner performed an open mouth gape in the presence of the cat, and the test condition, in which the owner performed a yawn or fake yawn to the best of their ability in the presence of the cat. The open mouth gape was adapted from Smith (1999)'s description involving the opening of the lower jaw, with no eye wrinkling, no noise, and no upper body movement or stretching. In Baenninger (1987), a gape was stated to be different from a yawn, lacking the respiratory element; results from Provine (1989) showed that the individual feature of an open mouth did not elicit contagious yawning. A normal or faked yawn includes the stretching of the mouth, wrinkling of the eyes, an inhalation followed by an exhalation, and/or

tilting the head back and stretching the upper body (Provine 2005, Smith 1999). Conditions were counterbalanced, with half of the owners starting with yawn condition (YC) and the other half starting with the control gape condition (GC).

Owners were instructed to call the attention of their cat in a way that was normal for them, which included but was not limited to calling the cat's name, making a noise, and using a toy before each yawn or gaping motion. Attention was determined by the cat looking at the owner. A study on attentional states suggests that the direct gaze of humans is not perceived as aggressive to cats (Ito et al. 2016) and the American Association of Feline Practitioners acknowledge that willingness to make eye contact is part of their normal visual communication (Overall et al. 2004). The owner was instructed to do as many yawns or gapes with the cat's attention as possible within the ten minutes. The researcher recorded the number of cat yawns per stimulus yawn or gape provided as a ratio to account for differences in the frequency of owner yawns across cats. Each condition was ten minutes long, with a three minute observation period immediately following the condition. Although in previous studies five minute testing conditions were used (Joly-Mascheroni et al. 2008; Romero et al. 2013), ten minutes was chosen to allow owners time to obtain attention from the cats. The observation period was used to see if cats yawned after all human yawning or gaping stopped. The ten minutes started at the first yawn or gape. A five minute break separated the conditions. Cats were video recorded for the duration of all conditions and observation periods. The number of times the cats yawned was measured during the condition and observation period for a total of thirteen minutes.

Data Analysis

Data were recorded in real time by the researcher, and then verified with video recordings. The number of times the cats yawned was measured for each cat for each condition.

A Wilcoxon signed rank test will be used to analyze the difference in number of yawns between the YC and the GC. McNemar's test was used to analyze the difference in the number of cats that yawn and do not yawn in the treatment and control conditions. The Spearman's correlation was used to test if there was an influence of affiliation score on yawns produced in the YC, and Cronback's alpha will test whether Likert-scale questions correlate with each other.

Ethics Approval

This study was reviewed and approved by the Hunter College Institutional Review Board (Approval # 2018-0688) and the Institutional Animal Care and Use Committee (Approval # JP-yawning-12/20).

Results

Thirteen of the twenty-six cats yawned during the experiment, with an average of 0.54 yawns in the yawn condition, and 0.58 yawns in the gape condition. A Wilcoxon Signed-Ranks Test indicated that yawns in the yawn condition were not significantly different from yawns in the gape condition ($W = 41$, $z = -1.54$, $p > 0.05$). To test for order effects of the first conditions on yawns performed, Wilcoxon Rank-Sum Tests were performed. We counterbalanced the number of cats that received the yawning and the gaping conditions first (N = 13 in each group), and found that the frequency of yawning was not affected by order (frequency of yawning in the gaping condition when it was presented first versus second: $W_s = 18$, $z = 0.77$, $p = 0.22$, frequency of yawning in the yawning condition when it was presented first versus second, $W_s = 13.5$, $z = -0.39$, $p = 0.65$). McNemar's Test was run to test if cats that yawned (N = 13 cats) were more likely to yawn in either the yawn condition, the gape condition, or both conditions equally. McNemar's Test showed no significant difference between cats that yawned in the yawn condition versus those that yawned in the gape condition ($\chi^2 = 0.125$, $p > 0.05$).

Survey results showed a mean affiliation score of 4.1 out of 5. To determine the internal consistency of the questions, Cronbach's Alpha was run on the affiliation questions. The four questions were not very reliable ($\alpha = 0.59$); however, when removing question 3, the only question to have reported 1 scores, the remaining questions were somewhat more reliable ($\alpha = .73$). Due to the inconsistency found within the questions, the correlation test between affiliation and yawns produced in the yawn condition used only the scores from question 4, which directly asked about the owner's reported perceived affection from their cats. To test this, a Spearman correlation was used, finding no correlation between affiliation and yawns elicited ($r_s = 0.2$, $p > 0.05$).

Discussion

The results of this study on contagious yawning in the domestic cat do not support the hypothesis that cats yawn contagiously with their owners. The results found, across all 26 subjects, no difference in yawning across conditions, suggesting that cats do not contagiously yawn when their owners yawn first. The results also show that when cats did yawn (13 subjects), they did not yawn significantly more often in the yawn versus the gape condition. The affiliation with the owner also had no impact on the yawns produced by the cats. All of the results in this study indicate that cats may not possess the ability to contagiously yawn with their owners, and further research is needed on cat-human bonding and empathy.

The differences in contagious yawning abilities in cats and dogs may be due to the differences in domestication, with cats having started the domestication process only about 9,000 years ago (Driscoll et al. 2007). Dogs, on the other hand, were domesticated much earlier; dogs are considered to have been the first species domesticated, and archaeological evidence suggests it happened as early as 14,000 years ago (Clutton-Brock 1995). Cats also lack some neotenous

characteristics that are found in other domesticated species (Driscoll et al. 2007). Some argue that cat domestication is incomplete, and a product more of natural selection rather than artificial selection (Driscoll et al. 2009). The differences in domestication are consistent with the differences in behavior and the relationships we have with cats and dogs. Dogs need humans, even free-ranging or feral dogs depend on human food waste to scavenge (Bonanni & Cafazzo 2014). Purebred dogs are also prone to breed related disorders, increasing their need for human interference for proper health care (Asher et al. 2009). These health problems arose from artificial selection for specific features, for example respiratory problems associated with flat muzzles (Asher et al. 2009). This differs from cats, who may affiliate with humans, but do not require human intervention for their survival. Feral colonies of cats thrive, some without ever being around humans, and often breed with wild cats (Driscoll et al. 2007). Cats are capable of hunting for their own food and surviving off of what they catch (Driscoll et al. 2009), as opposed to dogs, who scavenge through human garbage for sustenance (Bonanni & Cafazzo 2014). There are some breeds of cats, but there are far fewer compared to dogs, and purebred cats are relatively new compared to other domesticated species (Lipinski et al. 2008). In the future, artificial selection may play a more important role in further cat evolution.

The behavior in Strange Situation Tests (SST) is also indicative of the differences in dependence on humans. The original test was designed for infants and their mothers, a relationship rooted in dependence, with the secure base model being the healthiest form of attachment (Ainsworth & Bell 1970). Cats, who do not necessarily need humans to thrive, may not see humans as a necessity, but rather a companion, and don't use the relationship as a source of security (Potter & Mills 2015). Their independence is also demonstrated in the study by Miklosi and colleagues (2005) that tested visual communication signals in cats and dogs when

they were presented with an unsolvable task. In this study, dogs gazed at their owner, signaling a request for help, much earlier and for longer than cats (Miklosi et al. 2005). This directly compares how cats and dogs use humans in their lives, showing that cats are less likely to seek help from owners, specifically through gazing (Miklosi et al. 2005). The differences in dependence on humans may influence the kind of the social relationship cats and dogs have with us. Increased dependence on humans would support a need for more complex social relationships between humans and dogs, while less dependence might not. More complex forms of empathic perspective taking and its underlying mechanisms may be absent or more primitive in cats, as suggested by this study on contagious yawning.

The cat ancestor's more solitary lifestyle (Bradshaw 2016), may also impact the contagious yawning ability in cats. Domestic cats' closest relatives, European wildcats (*Felis silvestris silvestris*) and African wildcats (*Felis silvestris lybica*), and their shared ancestor are solitary in nature (Bradshaw 2016) and would not have needed complex social mechanisms that underlie contagious yawning. However, cats today are considered somewhat social with both conspecifics and humans (Bradshaw 2016; Crowell-Davis et al. 2004), so further research in this area is needed. The only other solitary species to be tested on contagious yawning, the red-footed tortoise, also did not show evidence for this capacity (Wilkinson et al. 2011). Yawning as a social stimulus may not be in cats' repertoires; some of their social signals have been carried over from interactions between kittens and their parents, such as the tail up signal (Cafazzo & Natoli 2009) and the meow towards humans (Turner & Bateson 2014), while others include scents and marking for communication (Natoli et al. 2001), suggesting the need of cats to repurpose signals to meet the needs of their new social lives. If this is the case, it may be necessary to investigate contagious yawning in cats with conspecifics. This would help

determine if cats are capable of contagious yawning within their species, or if they do not contagiously yawn at all.

It is also possible that the current study was affected by confounding variables and constraints in methodology. Noises and distractions from inside and outside the home may have impacted the cats' attentional states. For example, other people in the house not participating in the study making noise may have been distracting. Additionally, owners were asked to attract their cats' attention in a normal way, and some owners used toys or played with their cat as that was normal for them; however, this could have impacted what the cat was attending to, focusing on the toy instead of the owner's facial movements. Some constraints with the methodology included the need for eye contact to determine attention and the open mouth gape as a control. It was necessary to obtain eye contact to make sure cats saw the yawn, and while gaze is not necessarily linked to aggression (Ito et al. 2016), prolonged eye contact and gaze may not be best suited for cats. Additionally, the control open mouth gape is an unfamiliar stimulus that may not be neutral to the cats. While an open mouth gape has been effective as a control in dog and human studies, it may not be the best control for cats. The results in this study show that when cats yawn, they do not yawn significantly more often in one condition over the other; this could indicate that a gape and a yawn elicit yawning in cats in similar ways. The closed space may also have been a source of frustration to cats who are accustomed to uncontrolled roaming of the home.

Future studies on contagious yawning in cats should consider these confounding variables and stressors carefully. In this study, researchers went into cats' homes to eliminate the stress of being in a lab setting; however, it is possible that, even with the habituation period, researcher presence impacted stress levels. The present study focused on a natural environment

for the cat to attempt to eliminate stress, however the tradeoff is less control over confounding variables and distractions. Future studies may control for stress differently, possibly through increasing habituation time, moving to a controlled lab setting where stress levels can be measured physiologically, using self-reporting, or researchers directing the study remotely, via web communications. Future studies may consider the tradeoffs of conducting a contagious yawning study in a more controlled lab setting to avoid these types of confounding variables. Future studies should also consider changing the control open mouth gape, as it is unclear whether this stimulus is truly neutral to cats. Other contagious yawning studies do not collect baseline levels of yawning in their animal subjects, and we did not anticipate a reason for doing so in the current study. However, as this study found similar rates of yawning in the yawn and gape conditions, future research that measure these baseline levels could provide important insight into whether cats are responding to the experimenter's yawn and gape cues similarly, or are simply yawning at their normal rates. Finally, another method to discern attentional states may be necessary. Although eye contact with the owner is likely not an aggressive signal (Ito et al. 2016; Overall et al. 2004), it is possibly an unusual interaction between the cat and owner. Although no data were collected on owner comments regarding the experiment, a few owners mentioned that the act of getting the cat to make eye contact was unusual or extraordinary and that the cats typically don't respond to their name.

The methods used in previous studies on contagious yawning may not be the best methods for testing domestic cats. In order to compare across studies, it is necessary to use comparable methodology; however, as multiple researchers note, it is important to take into account the behaviors of the species being studied (Zasloff 1996), and to consider their specific sensory systems and perspectives (White 2013). For this initial study, it was important to use

familiar methods, controls, and attentional states to compare with past studies. However, going forward, it would be useful to consider the differences in cat behavior, their communicative signals, and how they interact with people. For example, in popular culture, cats are thought to be more independent than dogs; therefore, it may be too much to ask cats to attend to their owners for thirty uninterrupted minutes in this type of study. Different body parts, such as the ears and tail, are important in cat communication (Bennet et al. 2017), and so it is necessary for future studies to look specifically at signals that are salient to them. In addition, the novelty of the setup, potential stress from seeing strangers, and confining the cat to the room may have negatively affected the cats' performance or attention in this study. Thus, it may be necessary to look into emotional contagion in other ways than contagious yawning as has been done in dogs, similarly to how Palagi and colleagues (2015) looked at emotional contagion through rapid mimicry in play behavior, Sümegi et al. (2014) measured it by quantifying changes in stress and cognitive task performance, and Yong & Ruffman (2014) assessed physiological responses to crying in conspecifics. The social relationship domestic cats have with humans and other cats (Crowell-Davis et al. 2004) shows the need for more studies on the cat-human relationship.

References

Ainsworth, M. D. S., & Bell, S. M. (1970). Attachment, exploration, and separation: Illustrated by the behavior of one-year-olds in a strange situation. *Child development, 41*(1), 49-67.

Amici, F., Aureli, F., & Call, J. (2014). Response facilitation in the four great apes: Is there a role for empathy?. *Primates, 55,* 113-118. doi: 10.1007/s10329-013-0375-1.

Anderson, J. R., Myowa-Yamakoshi, M., & Matsuzawa, T. (2004). Contagious yawning in chimpanzees. *Proceedings of the Royal Society, 271,* s468-s470. doi:10.1098/rsbl.2004.0224.

Asher, L.,, Diesel, G., Summers, J. F., McGreevy, P. D., & Collins, L. M. (2009). Inherited defects in pedigree dogs. Part 1: Disorders related to breed standards. *The Veterinary Journal, 182,* 402-411. doi: 10.1016/j.tfjl.2009.08.033.

Baenninger, R. (1987). Some comparative aspects of yawning in *Betta splendens, Homo sapiens, Panthera leo,* and *Papio sphinx*. *Journal of Comparative Psychology, 101*(4), 349-354.

Baron-Cohen, S., Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*(2), 163-175.

Bartholomew, A. J., Cirulli, E. T. (2014). Individual variation in contagious yawning susceptibility is highly stable and largely unexplained by empathy or other known factors. *PLoS ONE, 9*(3). E91773. doi: 10.1371/journal.pone.0091773.

Bennet, V., Gourkow, N., & Mills, D. S. (2017). Facial correlates of emotional behavior in the domestic cat (*Felis catus*). *Behavioural Processes, 141,* 342-350.

Bonanni, R., & Cafazzo, S. (2014). The social organization of a population of free-ranging dogs in a suburban area of rome: A reassessment of the effects of domestication on dogs' behaviour. In Kaminski, J., Marshall-Pescini, S. (Eds.), *The Social Dog: Behaviour and Cognition* (65-104). Elsevier.

Bradshaw, J. W. S. (2016). Sociality in cats: A comparative review. *Journal of Veterinary Behavior, 11,* 113-124.

Buttner, A. P., Strasser, R. (2014). Contagious yawning, social cognition, and arousal: An investigation of the processes underlying shelter dogs' responses to human yawns. *Animal Cognition, 17,* 95-104. doi: 10.1007/s10071-013-0641-z.

Cafazzo, S., Natoli, E. (2009). The social function of tail up in the domestic cat (*Felis silvestris catus*). *Behavioural Processes, 80,* 60-66. doi: 10.1016/j.beproc.2008.09.008.

Campbell, M. W., Carter, J. D., Proctor, D., Eisenberg, M. L., & de Waal, F. B. M. (2009). Computer animations stimulate contagious yawning in chimpanzees. *Proceedings of the Royal Society, 276,* 4255-4259. doi: 10.1098/rspb.2009.1087.

Campbell, M. W., de Waal, F. B. M. (2011). Ingroup-outgroup bias in contagious yawning by chimpanzees supports link to empathy. *PLoS ONE*, *6*(4). e18283. doi: 10.1371/journal.pone.0018283.

Campbell, M. W., de Waal, F. B. M., (2014). Chimpanzees empathize with group mates and humans, but not with baboons or unfamiliar chimpanzees. *Proceedings of the Royal Society, 281*(1782). 20140013. doi:10.1098/rspb.2014.0013.

Clutton-Brock, J. (1995). Origins of the dog: domestication and early history. *The domestic dog: Its evolution, behaviour and interactions with people,* 7-20.

Crowell-Davis, S. L., Curtis, T. M., & Knowles, R. J., (2004). Social organization in the cat: A modern understanding. *Journal of Feline Medicine and Surgery, 6,* 19-28. doi: 10.1016/j.jfms.2003.09.013.

Custance, D., Mayer, J. (2012). Empathic-like responding by domestic dogs (*Canis familiaris*) to distress in humans: An exploratory study. *Animal Cognition*, *15*(5), 851-859. doi:10.1007/s10071-012-0510-1.

de Waal, F. B. M., & Preston, S. D. (2017). Mammalian empathy: Behavioural manifestations and neural basis. *Nature Reviews Neuroscience, 18*(8), 498-509. doi:10.1038/nrn.2017.72

Demuru, E., Palagi, E. (2012). In bonobos yawn contagion is higher among kin and friends. *PLoS ONE, 7*(11). e49613. doi:10.1371/journal.pone.0049613.

Driscoll, C. A., Menotti-Raymond, M., Roca, A. L., Hupe, K., Johnson, W. E., Geffen, E., Harley, E. H., Delibes, M., Pontier, D., Kitchener, A. C., Yamaguchi, N., O'Brien, S. J., & Macdonald, D. W. (2007). The near eastern origin of cat domestication. *Science, 317,* 519-523. doi: 10.1126/science.1139518.

Driscoll, C. A., Macdonald, D. W., & O'Brien, S. J. (2009). From wild animals to domestic pets, an evolutionary view of domestication. *Proceedings of the National Academy of Sciences, 106*(Supplement 1), 9971-9978.

Duffy, D. L., Diniz de Moura, R. T., & Serpell, J. A. (2017). Development and evaluation of the Fe-BARQ: A new survey instrument for measuring behavior in domestic cats (*Felis s. catus*). *Behavioural Processes, 141,* 329-341.

Edwards, C., Heiblum, M., Tejeda, A., & Galindo, F., (2007). Experimental evaluation of attachment behaviors in owned cats. *Journal of Veterinary Behavior: Clinical Applications Research, 2(4),*119-125.

Eriksson, M., Keeling, L. J., & Rehn, T. (2017). Cats and owners interact more with each other after a longer duration of separation. *PloS ONE, 12*(10): e0185599.

Gallup, A. C., Swartwood, L., Militello, J., & Sackett, S. (2015). Experimental evidence of contagious yawning in budgerigars (*Melopsittacus undulates*). *Animal Cognition, 18,* 1051-1058. doi: 10.1007/s10071-015-0873-1.

Galvan, M., Vonk, J. (2015). Man's other best friend: Domestic cats (*F. silvestris catus*) and their discrimination of human emotion cues. *Animal Cognition, 19,* 193-205. doi: 10.1007/s10071-015-0927-4.

Hare, B., Tomasello, M. (2005). Human-like social skills in dogs? *Trends in Cognitive Sciences, 9*(9), 439-444. doi: 10.1016/j.tics.2005.07.003.

Hare, B., Rosati, A., Kaminski, J., Bräuer, J., Call, J., & Tomasello, M. (2010). The domestication hypothesis for dogs' skills with human communication: A response to Udell et al. (2008) and Wynne et al. (2008). *Animal Behaviour, 79,* e1-e6. doi: 10.1016/j.anbehav.2009.06.031.

Harr, A. L., Gilbert, V. R., & Phillips, K. A. (2009). Do dogs (*Canis familiaris*) show contagious yawning?. *Animal Cognition*, *12*(6), 833-837. doi:10.1007/s10071-009-0233-0.

Helt, M. S., Eigsti, I. M., Snyder, P. J., & Fein, D. A. (2010). Contagious yawning in autistic and typical development. *Child development, 81*(5), 1620-1631.

Heusner, A. P. (1946). Yawning and associated phenomena. *Physiological Reviews, 26*(1), 156-168.

Ito, Y., Watanabe, A., Takagi, S., Arahori, M., & Saito, A. (2016). Cats beg for food from the human who looks at and calls to them: Ability to understand humans' attentional states. *Psychologia, 59,* 112-120.

Joly-Mascheroni, R. M., Senju, A., & Shepherd, A. J. (2008). Dogs catch human yawns. *Biology Letters, 4,* 446-448. doi:10.1098/rsbl.2008.0333.

Lipinski, M. J., Froenicke, L., Baysac, K. C., Billings, N. C., Leutenegger, C. M., Levy, A. M., Longeri, M., Niini, T., Ozpinar, H., Slater, M. R., Pedersen, N. C., Lyons, L. A. (2008). The ascent of cat breeds: Genetic evaluations of breeds and worldwide random-bred populations. *Genomics, 91*(1), 12-21. doi: 10.1016/j.ygeno.2007.10.009.

Madsen, E. A., & Persson, T. (2013). Contagious yawning in domestic dog puppies (*Canis lupus familiaris*): The effect of ontogeny and emotional closeness on low-level imitation in dogs. *Animal Cognition, 16*(2), 233-240. doi:10.1007/s10071-012-0568-9.

Marshall-Pescini, S., Passalacqua, C., Ferrario, A., Valsecchi, P., & Prato-Previde, E. (2011). Social eavesdropping in the domestic dog. *Animal Behaviour,* 1-7. doi: 10.1016/j.anbehav.2011.02.029.

Massen, J. J. M., Gallup, A. C. (2017). Why contagious yawning does not (yet) equate to empathy. *Neuroscience and Biobehavioral Reviews, 80,* 573-585. doi: 10.1016/j.neubiorev.2017.07.006.

Mayes, E. R. E., Wilkinson, A., Pike, T. W., & Mills, D. S. (2015). Individual differences in visual and olfactory cue preference and use by cats (*Felis catus*). *Applied Animal Behaviour Science, 173,* 52-59.

Merola, I., Lazzaroni, M., Marshall-Pescini, S., & Prato-Previde, E. (2015). Social referencing and cat-human communication. *Animal Cognition, 18,* 639-648. doi: 10.1007/s10071-014-0832-2.

Miklosi, A., Pongracz, P., Lakatos, G., Topal, J., & Csanyi, V. (2005). A comparative study of the use of visual communicative signals in interactions between dogs (*Canis familiaris*) and humans and cats (*Felis catus*) and humans. *Journal of Comparative Psychology, 116*(2), 179-186. doi: 10.1037/0735-7036.116.2.179.

Moyaho, A., Rivas-Zamudio, X., Ugarte, A., Eguibar, J. R., & Valencia, J. (2015). Smell facilitates auditory contagious yawning in stranger rats. *Animal Cognition, 18,* 279-290. doi: 10.1007/s10071-014-0798-0.

Müller, C. A., Schmitt, K., Barber, A. L. A., & Huber, L. (2015). Dogs can discriminate emotional expressions of human faces. *Current Biology, 25,* 601-605.

Natoli, E., Baggio, A., Pontier, D., (2001). Male and female agonistic and affiliative relationships in a social group of farm cats (*Felis catus* L.). *Behavioural Processes, 53,* 137-143.

Norscia, I., Palagi, E. (2011). Yawn contagion and empathy in *Homo sapiens*. *PLoS ONE, 6*(12), e28472. doi: 10.1371/journal.pone.0028472.

O'Hara, S. J., & Reeve, A. V. (2011). A test of the yawning contagion and emotional connectedness hypothesis in dogs, *Canis familiaris*. *Animal Behaviour*, *81*(1), 335-340. doi:10.1016/j.anbehav.2010.11.005.

Overall, K. L., Rodan, I., Beaver, B. V., Carney, H., Crowell-Davis, S., Hird, N., Kudrak, S., & Wexler-Mitchell, E. (2004). Feline behavior guidelines from the American association of feline practitioners. *American Association of Feline Practitioners.*1-44.

Palagi, E., Leone, A., Mancini, G., & Ferrari, P. F. (2009). Contagious yawning in gelada baboons as a possible expression of empathy. *PNAS, 106*(46). 19262-19267. doi:10.1079/pnas.0910891106.

Palagi, E., Norscia, I., & Demuru, E. (2014). Yawn contagion in humans and bonobos: Emotional affinity matters more than species. *PeerJ, 2.* e519. doi:10.7717/peerj.519.

Palagi E., Nicotra V., Cordoni G. (2015). Rapid mimicry and emotional contagion in domestic dogs. *R. Soc. Open sci. 2*: 150505.

Paukner, A., Anderson, J. R. (2006). Video-induced yawning in stumptail macaques (*Macaca arctoides*). *Biology Letters, 2.* 36-38. doi:10.1098/rsbl.2005.0411.

Platek, S. M., Critton, S. R., Myers, T. E., & Gallup Jr., G. G. (2003). Contagious yawning: The role of self-awareness and mental state attribution. *Cognitive Brain Research, 17,* 223-227. doi: 10.1016/S0926-6410(03)00109-5.

Platek, S. M., Mohamed, F. B., & Gallup Jr., G. G. (2005). Contagious yawning and the brain. *Cognitive Brain Research, 23,* 448-452. doi: 10.1016/j.cogbrainres.2004.11.011.

Potter, A., Mills, D.S., (2015). Domestic cats (*Felis silvestris catus*) do not show signs of secure attachment to their owners. *PloS ONE, 10*(9). E0135109. doi: 10.137/journal.pone.0135109.

Preston, S. D., de Waal, F. B. M. (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences, 25,* 1-72.

Provine, R. R. (1989). Faces as releasers of contagious yawning: An approach to face detection using normal human subjects. *Bulletin of the Psychonomic Society, 27*(3), 211-214.

Provine, R. R. (2005). Yawning: the yawn is primal, unstoppable and contagious, revealing the evolutionary and neural basis of empathy and unconscious behavior. *American Scientist, 93*(6), 532-539.

Reddy, R. B., Krupenye, C., MacLean, E. L., & Hare, B. (2016). No evidence for contagious yawning in lemurs. *Animal Cognition, 19*(5). 889-898. doi:10.1007/s10071-016-0986-1.

Romero, T., Konno, A., & Hasegawa, T. (2013). Familiarity bias and physiological responses in contagious yawning by dogs support link to empathy. *Plos ONE, 8*(8), doi:10.1371/journal.pone.0071365.

Romero, T., Ito, M., Saito, A., & Hasegawa, T. (2014). Social modulation of contagious yawning in wolves. *PLoS ONE, 9*(8), e105963. doi: 10.1371/journal.pone.0105963.

Rundle, B. K., Vaughn, V. R., & Stanford, M. S. (2015). Contagious yawning and psychopathy. *Personality and Individual Differences, 86*, 33-37. doi: 10.1016/j.paid.2015.05.025.

Saito, A., Shinozuka, K. (2013). Vocal recognition of owners by domestic cats (*Felis catus*). *Animal Cognition, 16*, 685-690. doi: 10.1007/s10071-013-0620-4.

Sanford, E. M., Burt, E. R., & Meyers-Manor, J. E. (2018). Timmy's in the well: Empathy and prosocial helping in dogs. *Learning and Behavior, 46*(4), 374-386.

Senju, A., Maeda, M., Kikuchi, Y., Hasegawa, T., Toto, Y., & Osanai, H. (2007). Absence of contagious yawning in children with autism spectrum disorder. *Biology Letters, 3*, 706-708. doi: 10.1098/rsbl.2007.0337.

Senju, A., Kikuchi, Y., Akechi, H., Hasegawa, T., Tojo, Y., & Osanai, H. (2009). Brief Report: Does eye contact induce contagious yawning in children with autism spectrum disorder? *Journal of Autism and Developmental Disorders, 39,* 1598-1602. doi: 10.1007/s10803-009-0785-5.

Senju, A. (2010). Contagious yawning: Developmental and comparative perspectives. In *The mystery of yawning in physiology and disease* (Vol. 28, pp. 113-119). Karger Publishers.

Shreve, K. R. V., Udell, M. A. R. (2015). What's inside your cat's head? A review of cat (*Felis silvestris catus*) cognition research past, present and future. *Animal Cognition, 18*, 1195-1206. doi: 10.1007/s10071-015-0897-6.

Shreve, K. R. V., Mehrkam, L. R., & Udell, M. A. R. (2017). Social interaction, food, scent or toys? A formal assessment of domestic pet and shelter cat (*Felis silvestris catus*) preferences. *Behavioural Processes, 141,* 322-328.

Silva, K., de Sousa, L. (2011). *'Canis empathicus'*? A proposal on dogs' capacity to empathize with humans. *Biology Letters. 7,* 489-492 doi: 10.1098/rsbl.2011.0083.

Silva, K., Bessa, J., & de Sousa, L. (2012). Auditory contagious yawning in domestic dogs (*Canis familiaris*): First evidence for social modulation. *Animal Cognition, 15*(4), 721-724. doi:10.1007/s10071-012-0473-2.

Smith, E. O. (1999). Yawning: An evolutionary perspective. *Human evolution, 14*(3), 191-198.

Sümegi, Z., Oláh, K., & Topál, J. (2014). Emotional contagion in dogs as measured by change in cognitive task performance. *Applied Animal Behaviour Science, 160*106-115. doi:10.1016/j.applanim.2014.09.001.

Turner, D. C., Bateson, P. (2014). *The domestic cat: The biology of its behavior.* (3rd ed.). Cambridge University Press.

Turner, D. C. (2017). A review of over three decades of research on cat-human and human-cat interactions and relationships. *Behavioural Processes, 141,* 297-304.

Udell, M. A. R., Dorey, N. R., & Wynne, C. D. L. (2011). Can your dog read your mind? Understanding the causes of canine perspective taking. *Learning & Behavior, 39*(4), 289-302. doi: 10.3758/s13420-011-0034-6.

Usui, S., Senju, A., Kikuchi, Y., Akechi, H., Tojo, Y., Osanai, H., & Hasegawa, T. (2013). Presence of contagious yawning in children with autism spectrum disorder. *Autism research and treatment, 2013*. doi: 10.1155/2013/971686.

Vogt, A. H., Rodan, I., Brown, M., Brown, S., Buffington, C. A. T., LaRue Forman, M. J., Neilson, J., & Sparks, A. (2010). AAFP-AAHA Feline life stage guidelines. *Journal of Feline Medicine and Surgery, 12,* 43-54. doi: 10.1016/j.jfms.2009.12.006.

White, K., (2013). And say the cat responded? Getting closer to the feline gaze. *Society & Animals, 21,* 93-104.

Wilkinson, A., Sebanz, N., Mandl, I., & Huber, L. (2011). No evidence of contagious yawning in the red-footed tortoise *Geochelone carbonaria*. *Current Zoology, 57*(4), 477-484.

Yonezawa, T., Sato, K., Uchida, M., Matsuki, N., & Yamazaki, A. (2017). Presence of contagious yawning in sheep. *Animal Science Journal, 88,* 195-200. doi: 10.1111/asj.12681.

Yong, M. H., Ruffman, T. (2014). Emotional contagion: Dogs and humans show a similar physiological response to human infant crying. *Behavioural Processes, 108*155-165. doi:10.1016/j.beproc.2014.10.006.

Yoon, J. D., & Tennie, C. (2010). Contagious yawning: A reflection of empathy, mimicry, or contagion?. *Animal Behaviour, 79*(5), e1-e3. doi:10.1016/j.anbehav.2010.02.011.

Zasloff, R. L. (1996). Measuring attachment to companion animals: a dog is not a cat is not a bird. *Applied Animal Behaviour Science, 47,* 43-48.

Appendix

Pet Survey Questions

Please answer the following questions to the best of your knowledge.

What is the sex of your cat? Male / Female

What breed is your cat:

Domestic longhair Domestic shorthair Purebred Unsure

If you selected Purebred, what is your cat's breed? _____

Are there other pets in your home? Yes / No

If yes, what kind? _____ How Many? _____

How old is your cat (in years)? _____

How long has your cat lived with you (in years)? _____

From where did you get your cat:

Pet store Shelter/Rescue Breeder Friend/Family Other

If you selected Other, please explain: _____

Please answer the following questions using the scale of 1 to 5, with 1 indicating never and 5 indicating always.

Does your cat purr when stroked or petted?

1	2	3	4	5
Never	Seldom	Sometimes	Usually	Always

Does your cat solicit physical contact from you such as petting, or sitting on your lap?

1	2	3	4	5
Never	Seldom	Sometimes	Usually	Always

Does your cat sleep in the same room as you?

1	2	3	4	5
Never	Seldom	Sometimes	Usually	Always

How affectionate do you perceive your cat to be towards you?

1	2	3	4	5
Not at all	Slightly	Average	Moderately	Extremely