

The effects of oxytocin on proximity – seeking behavior and vocalizations in shelter cats

by  
Naomi K. Sakaguchi

A THESIS

submitted to  
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degree of

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Abstract approved: \_\_\_\_\_  
Monique A. R. Udell

The aim of this study was to evaluate the effects of intranasally administered oxytocin on the sociability of adult, neutered, male and female shelter cats, as measured by proximity-seeking behavior and meow vocalizations. Two local Humane Societies were sampled in this study. The shelter cats were randomly assigned to one of two groups: a control group or an oxytocin (OT) group. The control group received intranasally administered saline and the OT group received intranasally administered OT. A Paired Attachment Test (PAT) conducted with each cat consisted of a 2 – minute phase in which each cat was allowed to freely explore the testing room. Each time the subject would fully enter either of the circles, they would be greeted with 2 pets from either the handler or administrator. Each session was analyzed and coded for specific behaviors/actions including frequency of contact with each tester, duration of time spent in the 1m half - circle to each tester, and frequency of meow vocalizations. Although an increase in pro-social behaviors such as meow vocalizations and proximity – seeking were expected, only the frequency of approaches by the shelter cats to the testers after given OT was statistically significant. These results may be applicable in increasing pro – social behaviors of cats in shelter settings seeking adoption.

Key Words: Shelter Cats, Oxytocin, Vocalizations, Paired Attachment Test, Cat Sociability

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I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

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## **Dedication**

This thesis is dedicated to all the animals that have taught me valuable lessons throughout my life and to the people that accompanied those animals along the way. To the horses that taught me patience and persistence, to the dogs that taught me understanding and loyalty, and to the cats that taught me independence and bravery. Knowingly or unknowingly, all of these people and animals have helped me along my journey to pursue a career in veterinary medicine, and I couldn't be more grateful.

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The effects of oxytocin on proximity-seeking behavior and vocalizations in shelter cats

## **Introduction**

### **Cat Social Behavior**

Although cats are thought to have been first domesticated 4,000 – 9,000 years ago, very little scientific research has explored feline social behavior in terms of interaction between humans and cats (Driscoll et al., 2007). A closer analysis of our pet cat's behavior may provide methods to better cat welfare based on creating an environment most suited to their preferred ways of living (Powell & Gartner, 2011).

Cats are often mistakenly thought to lead solitary, highly independent lives. However, cats can live both solitary and socially (Izawa & Doi, 1993). Many free – roaming domestic cats (feral, stray, etc.) not belonging to a human residence, live in colonies and engage in a variety of social behaviors (Crowell-Davis et al. 2004; Mertens and Turner 1988), including grooming, rubbing, and greeting each other as well as sleeping curled next to or even on top of each other (Crowell-Davis et al. 2004). Some social behaviors are observed between different feline species, as observed through the social structure and behavior seen in larger species of non – domesticated cats such as lions and cheetahs (i.e. heightened aggressive behavior and aversion to human proximity – seeking) are often absent in the domesticated cat (Bradshaw and Cameron-Beaumont 2000; Powell and Gartner 2011; Randi et al. 2001). While touch is a vital factor in the social structure of cat – cat and cat – human bonds, vocalization has been found to be primarily cat – human based after cats reach adulthood (Brown, 1993) with cats infrequently vocalizing to one another at the same frequency as with a human.

Vocalizations play a key role in the social structure of many animals, with domestic cats having a more elaborately developed vocal range than other non – domesticated cat breeds as well as other Carnivora species (Schötz et al. 2017; Bradshaw et al. 2012). Between cats and humans, cats are believed to have developed the ability to change prosodic patterns depending on the desired reaction from a human from a conditioned response to each vocalization from their cat (Schötz & van de Weijer, 2014). Much is still unknown regarding human directed vocalizations and the manipulation of vocalizations from cats in order to elicit desired responses from humans.

### **Shelter Cat Behavior**

Approximately 3.2 million cats enter the shelter system each year but only 1.5 million cats are adopted from those shelters in the same timespan (ASPCA 2019). An animal's outward personality whilst under pressure is what potential adopters see. The excitability and curiosity seen in their canine shelter counterparts is often not seen in a cat's subtler behavioral features, regardless, playfulness and friendliness are key characteristics sought after in a potential new pet. (Weiss, Miller, Mohan-Gibbons, & Vela, 2012). However, the strain of the shelter setting can lead to suppression of these behaviors and potentially negatively affect their adoptability (D'Arpino, 2007).

### **Influence of Handlers**

Despite the stress induced by the shelter setting, on average, when given the opportunity to spend time within proximity to humans or not, shelter cats will spend more time in proximity (Vitale & Udell, 2019). The reasoning behind animals eliciting increased levels of social

behavior in the presence of a human is known as the “social catalyst effect” (Beetz, Uvnäs-Moberg, Julius, & Kotrschal, 2012).

## **Oxytocin**

Oxytocin (OT) is a neuromodulator produced in the brain’s hypothalamic paraventricular and supraoptic nuclei and is released through the posterior pituitary gland in response to sexual stimulation, uterine dilation, nursing, and stress (Insel, 2010). Often associated with viviparous labor, milk let-down and maternal behavior, OT’s effects on social modifications are a more recent area of study (Carter et al. 2008). Affectionately coined the “love hormone” (Stix 2014), OT has been the focus of many human studies, outlining the possibility for stress reduction and empathy reactivity (Rodrigues, Saslow, Garcia, John, & Keltner, 2009), fear extinction (Acheson et al., 2013), expression of pro – social dispositions (Kogan et al., 2011), and as a treatment for anxiety disorders (Guastella et al. 2009; Olf et al. 2010). OT has also been shown to reduce attachment avoidance and increase the experience of attachment in humans (Bernaerts et al., 2017). Studies on non-human animals have shown that OT can affect both humans and animals by promoting “pro-social” behaviors such as reduction of offensive aggression and increased social exploration towards an unfamiliar animal of the same species (Calcagnoli et al., 2015).

Recently, studies have explored the effects of administration of exogenous OT on a variety of contexts in several species, including affiliative behavior in dogs (Nagasawa et al., 2015; Romero et al. 2014), and social behavior in macaques and domestic pigs (Camerlink et al. 2016; Simpson et al. 2014). To date, no studies have explored the effects of OT on social behavior in cats. This study seeks to explore the potential for OT promote pro - social behavior, as well as increase the current knowledge regarding socialization and behavior in order to promote improved adoption practices and increase adoptability. Additionally, OT may be used to

target recently surrendered cats as mentioned above, in an attempt to decrease stress and minimize the trauma associated with losing the attachment formed between the cat and its caretaker, immediately after entering the shelter. Cats searching for a human – cat connection or looking to reestablish a bond may exhibit this effect more in settings such as a shelter, but does OT further increase the likelihood of seeking close proximity to the humans in the room? A study analyzing the effects of OT on dogs found that in certain types of dogs, OT increased human – directed social behavior (Persson, Trotter, Bélteky, Roth, & Jensen, 2017). A variety of factors determine the levels of stress exhibited by shelter cats, with recently surrendered cats showing more signs of stress than stray cats (Dybdall et al. 2007). Due to the nature of OT to reduce stress, if given to surrendered cats upon their immediate arrival into a shelter, paired with human interaction in order to stimulate the “social catalyst effect”, shelters could attempt to decrease the severity of caretaker bond loss.

We hypothesize that the administration of intranasal oxytocin will increase sociability, of shelter cats, as measured by proximity-seeking behavior, as well as increase meow vocalizations, as a result of decreased levels of anxiety, stress and fear due to the neurological effects of oxytocin.

## **Methods**

### **Subjects:**

Forty shelter cats, 22 female and 18 male, between the ages of 1 – 14 (mean age, 5.85 years) were selected from SafeHaven Humane Society in Tangent, Oregon, and Willamette Humane Society in Salem, Oregon. Selection was limited to cats > 1 year of age, due to differences in behavior between juveniles and adults. Cats exhibiting aggressive or fearful behavior, were pregnant, nursing or had other health concerns, were excluded from the study. Four cats were excluded from the study due to fearful/aggressive behavior either before or after solution administration. Breed was not a variable in selection of subjects. The Paired Attachment Test, as described below, was conducted with all subjects.

### **OT/Saline Preparation and Administration Protocol:**

The number and order of solution types (OT vs. saline) administered to each subject was counterbalanced. Seventy micrograms (30 IU) of OT were diluted in 0.1 ml of a 0.65% saline solution. All solutions were prepared within 48 hours of use at each shelter. Each solution type was given a letter code (either “C” or “D”) and prepared by an assistant not associated with the study in order to keep experimenters blind during testing. Two different experimenters, alternated positions (handler vs. administrator) between subjects to control for and evaluate possible associations formed between the role of an experimenter and proximity seeking during the PAT. Solutions were administered in each subject’s home cage (See Figure 1). Experimenters in the role of either “handler” or “administrator” alternated between each subject. The “handler” would wrap each cat in a blanket/towel in order to restrain the cat in the kennel in the safest, least stressful/stimulating way possible. The “administrator” would inject the 0.1mL

of either OT or saline, equally into each nostril, based on predetermined solution type determination for each cat.

**Figure 1:** Experimenters administering solution to test cat at SafeHaven Humane Society.



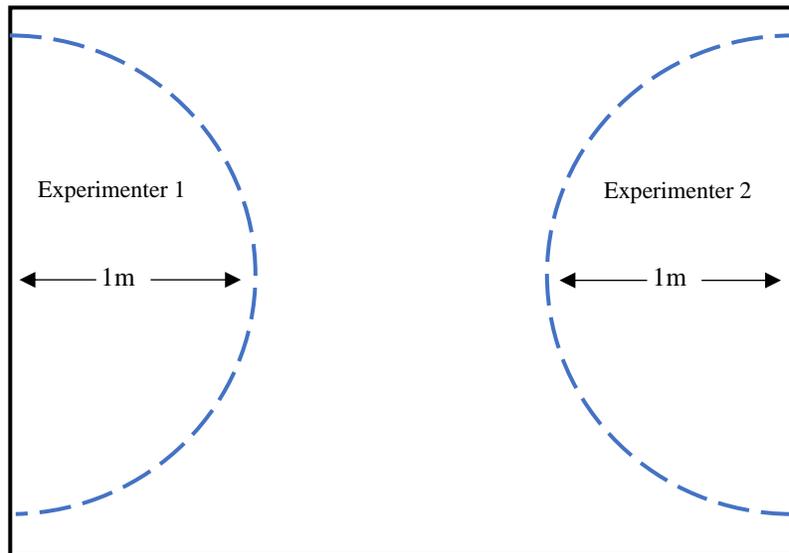
After administration, the cats were left alone for a 45-minute waiting period due to previous research indicating that this time-span is necessary for intranasally administered neuropeptides to interact with the brain (Born et al., 2002; MacDonald et al., 2011; Rault et al., 2013). After the 45 – minute waiting period, the experimenter who had administered the solution carried the cat into the testing room.

### **Paired Attachment Test:**

Paired Attachment Tests (PAT) were carried out and videotaped in animal shelter visiting rooms which were approximately 1 – meter x 2 meters. Exact room size varied due to the differences in testing facilities. Two half-circles, each with a radius of 1 meter, were marked on the floor at opposite ends of the testing room using tape and were used to determine “proximity” to each experimenter (See Figure 2). A video camera was attached to a tripod and was placed in

the corner of the testing room to record cat behavior. Each video was coded for: duration of time spent in each experimenter's circle, frequency of approach with each experimenter's circle, and frequency of vocalizations. Each cat was tested only once.

**Figure 2: PAT Room Layout**



The PAT consisted of a 2-minute trial in which the cat under test was allowed to freely explore the testing room. Two experimenters, the handler and the administrator, sat within the circles at opposite ends of the room. Each time the subject would place at least two legs (or half their body) either of the circles, they were greeted with 2 pets from the experimenter who was sitting within that circle. Upon re-entry into the circles the cats could receive another 2 pets. This method was modeled after the “passive experimenter” phase in (Barrera et al., 2010; Vitale & Udell, 2019). Experimenters were instructed to maintain a neutral demeanor; no vocalizations and minimization of facial expressions.

## Data Analysis

From the videos recorded in each testing session, behaviors were coded using the program *Countee*. Each video was coded for frequency of approach with each experimenter, duration of time spent in each 1m radius circle, and frequency of meow vocalizations (See Table 1). Twelve shelter videos (30% of all videos) were double – coded by an independent research assistant to evaluate inter-rater reliability. A 92% agreement in proximity seeking coded data for either of the experimenter was determined with an 8% tolerance. An 97% agreement in cat approaches to experimenters was determined based on exact agreement in coder data.

**Table 1:**

*Coded Behavior Classifications (adapted from (Vitale & Udell, 2019))*

<b>Behavior</b>	<b>Description</b>
Proximity Seeking	Proportion of the trial in which the cat had at least 2 legs (or half their body) within the 1m radius half – circle the experimenter was sitting in.
Frequency of Approaches	Frequency at which the cat had physical contact with the experimenter. Contact must be inside the half – circle.
Vocalization	Frequency of meow vocalization occurrences in the trial.

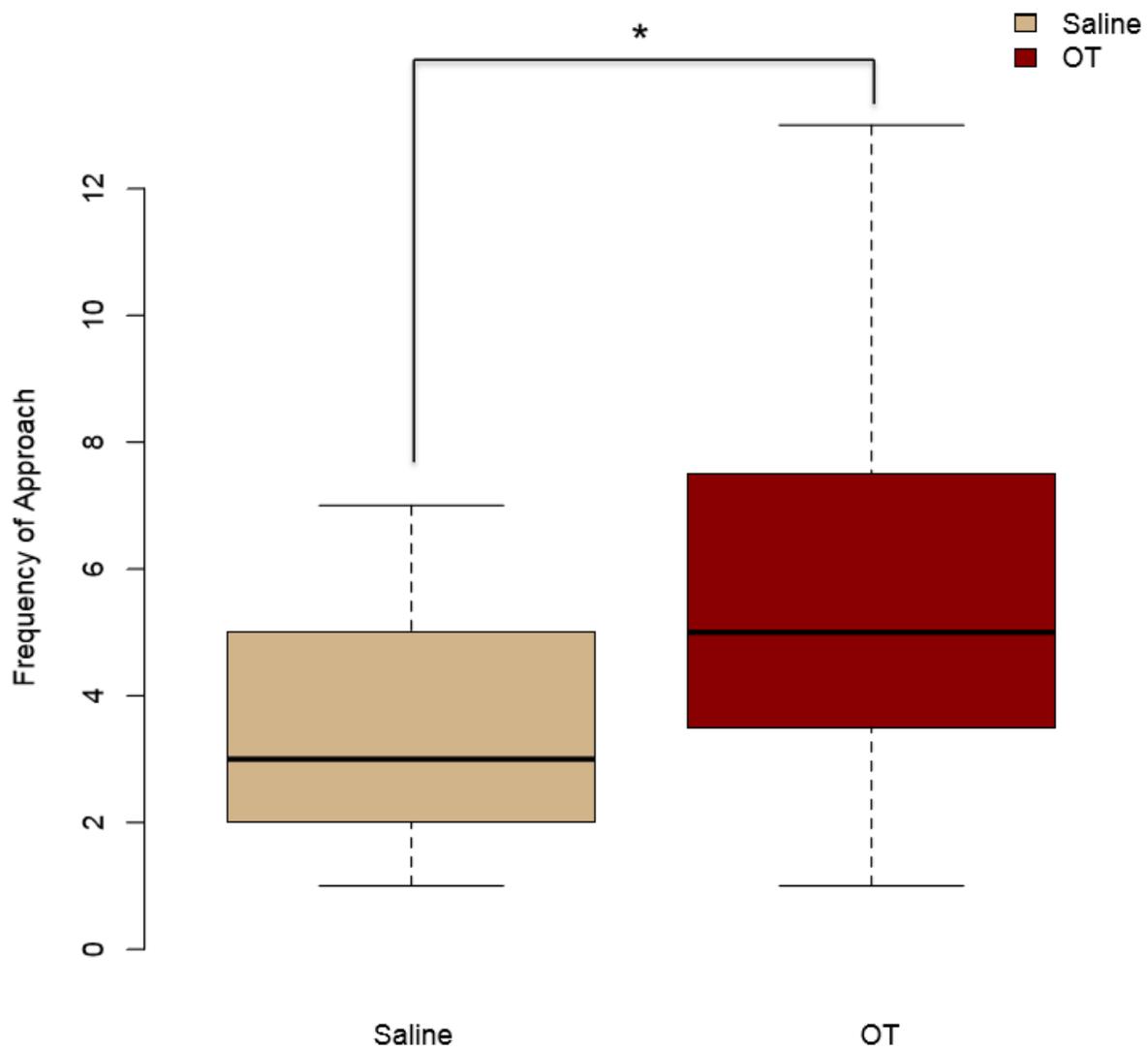
All data were determined to be non – normal using a Shapiro – Wilk normality test (all  $P < 0.05$ ) in R (R Development Core Team, 2013). Therefore, non – parametric

two tailed Mann – Whitney U tests, run in the Vassar – Stats program, were used to analyze all data.

## Results

### Effects of Oxytocin Administration on Proximity Seeking

Solution type influenced the number of times cats approached the experimenters. (Mann – Whitney,  $U(40) = 280$ ,  $z = -2.15$ , and  $p = 0.03$ ). As shown in Figure 3.1, cats given the OT solution approached experimenters significantly more often than cats given the placebo saline solution.



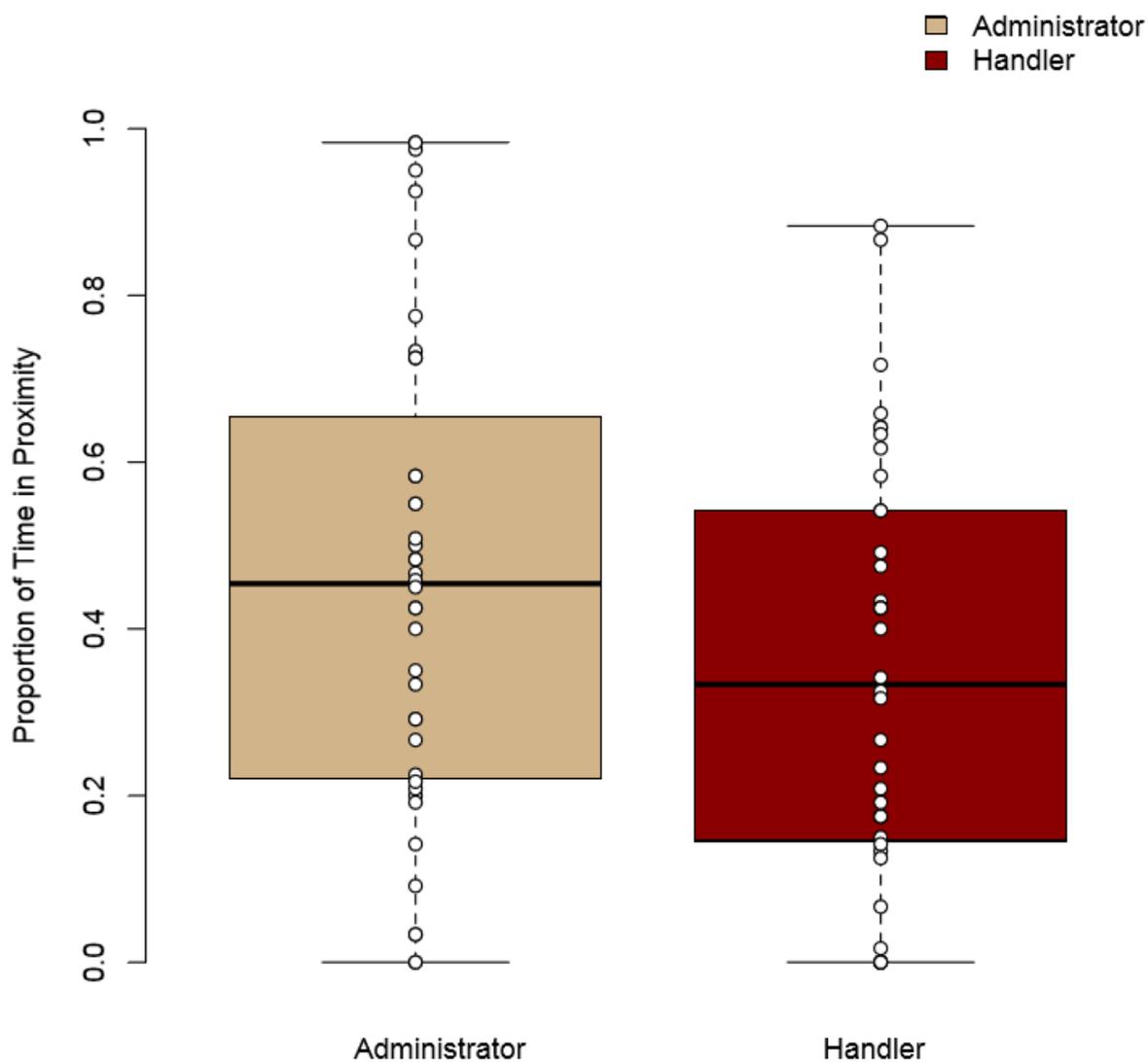
**Figure 3.1** Frequency of instances each cat approached either experimenter (handler or administrator) based on solution type (Saline or OT).

There was no significance in the total amount of time cats receiving OT vs saline spent proximity to the experimenters (measured by time in both 1m half – circles combined). ( $U(40) = 204.5$ ,  $z = -0.11$ , and  $p = 0.91$ ). Nor was there a significant difference between solution administration groups and the frequency of meow vocalizations. ( $U(40) = 183$ ,  $z = 0.45$ , and  $p = 0.65$ ).

### **Handler Type**

There was not a significant difference in the handler/administrator and number of approaches made by cats under test. (Mann – Whitney,  $U(40) = 183$ ,  $z = 0.45$ ,  $p = 0.65$ ).

There was a trend towards significance between handler/administrator and time spent in proximity to experimenters, with cats spending slightly more time in proximity to administrator. ( $U(40) = 1001$ ,  $z = -1.93$ ,  $p = 0.05$ , see Figure 3.2). Cats spent an average of 13.55 seconds more in the administrator's circle than in the handler's circle - with an average of 55.15 seconds with the administrator and 41.60 seconds with the handler, giving a 32.6% increase in time spent in proximity to the administrator.



**Figure 3.2** Total amount of time (as a proportion of the 120 second test) each cat spent in proximity (within the 1m half circle) to experimenters. Each circle indicates an individual cat (40 total circles on both “Administrator” and “Handler” graph).

### Male vs. Female Subject Comparison

No comparison was significant regarding behavioral modifications due to OT in male or female subjects.

There was not a significance difference between vocalizations after receiving saline (Mann – Whitney U,  $w = 32$ ,  $p = 0.17$ ), and vocalizations after receiving OT (Mann – Whitney U,  $w = 58.5$ ,  $p = 0.38$ ). Nor was there a significant difference between handler approaches by the cats after receiving saline (Mann – Whitney U,  $w = 63.5$ ,  $p = 0.23$ ), and the cats receiving OT (Mann – Whitney U,  $w = 41.5$ ,  $p = 0.52$ ).

There was no significant difference between proximity seeking towards the handler between cats receiving saline (Mann – Whitney U,  $w = 62$ ,  $p = 0.30$ ) and cats receiving OT (Mann – Whitney U,  $w = 58.5$ ,  $p = 0.54$ ). Nor was there a significant difference between proximity seeking towards the administrator between cats receiving saline (Mann – Whitney U,  $w = 26$ ,  $p = 0.98$ ) and cats receiving OT (Mann – Whitney U,  $w = 42$ ,  $p = 0.57$ ).

## Discussion

Solution type influenced the number of approaches the cats made towards the experimenters, showing that the cats were more likely to increase the frequency of their approaches when given the OT solution. The cats that were given the OT solution approached the experimenters, regardless of handler/administrator type, at an average of 5.45 times per 2 – minute session, while the cats that were given the saline solution approached the experimenters at an average of 3.45 times per 2 – minute session. Cats given the OT solution showed a 57.97% increase in number of approaches compared with those given saline. This result was predicted given prior research that has suggested that OT promotes “pro-social” behavior, as well as signs of trust and attachment (Bernaerts et al., 2017; Calcagnoli et al., 2015).

Upon continued examination of the effects of solution type (OT or saline) cats were more likely to approach the experimenters during the 2 – minute session but were not as likely to necessarily spend more time in the 1 – meter proximity of either experimenter. This may be a result of having two experimenters in the room. Previous research (examining feline behavior with only 1 person in the testing room at a time), found that cats in shelter environments elicited significantly more proximity – seeking behavior towards strangers who are inattentive to them than pet cats (Vitale & Udell, 2019). This may mean that like shelter dogs, shelter cats display exaggerated proximity – seeking behavior which may have led to the observed increased frequency of approach to both experimenters but not duration to one experimenter overall (Barrera et al., 2010; Gficsi & Mikl, 2001).

The same study also found that the proximity – seeking behavior of both pet and shelter cats increases when humans are attentive to them compared to inattentive. In the current study, the duration of time each cat spent in close proximity to the two experimenters may not have been

significant because cats are more likely to display longer durations of social behavior when experimenters are attentive. Each cat in this study only received attention from the experimenters upon each entrance (at least two legs, or half their body) to the marked 1 – meter half – circle, after the two pets they received the experimenter was inattentive until the cat’s exit and reentry. These actions from the experimenter may have increased the likelihood that the cats under test alternated between experimenters, thus increasing the frequency of approach and attentive responses from experimenters. The cat’s social behaviors may also be associated with a decreased sense of fear induced by the OT - as discovered in previous studies, intranasal OT can facilitate reductions in neural activity in the areas of the brain associated with fear processing (Baumgartner, Heinrichs, Vonlanthen, Fischbacher, & Fehr, 2008). With decreased senses of fear, the cats may be less timid thus more social and interactive. This observation may be advantageous for applied use in shelter settings. When a prospective adopter comes to see the cats, they will presumably play an attentive role during the cat – adopter interaction. If the adopter’s behavior, at minimum, mimics the attentive phase of the current trials (2 pets per entrance into the half – circle), the pro – social behavior exhibited (i.e. approaching experimenters more frequently) would be present in these cats. This along with OT use can facilitate pro – social behaviors seen in non – fearful, attention seeking cats. In shelter settings, increasing pro – social behaviors such as frequency of approach by the cat as a result of increased levels of OT could facilitate a stronger perceived connection that the adopter feels towards the cat. The more approachable and social the cat behaves, the more likely it is that the cat should be to be adopted.

As seen by the data analyzed for time spent in the circle in relation to handler type, there seemed to be a slight preference for spending more time in proximity to the OT administrator. A

precaution we had taken when formatting the study was to have the job of handler/administrator alternate between the two experimenters for each cat in order to balance out possible negative associations with the individual administering the solution. The result of a slight increase in proximity seeking behavior towards the administrator was unexpected. We had predicted that the cats would be more likely to form a negative association towards the administrator due to the intranasal solution administration, and thus we predicted that cats would be more likely to show lower amounts of proximity seeking behavior towards this individual (frequent approaches/time spent in the administrators circle). As mentioned above, a 32.6% increase in time spent in the time cats were in proximity to the administrator was observed. This result may be useful for situational application: could giving your cat OT help it bond with you if the administration process and the direct visualization of the administrator causes increased proximity seeking behavior in cats? If so, individuals with new, stressed or shy cats could take advantage of chronically administered OT to encourage and normalize pro-social behaviors from their pets by evoking the positive correlation made by the connection between visual association and feelings of attachment and trust.

No significant correlation was found between frequency of meow vocalizations and type of solution given. No solidified prediction of the outcome of this test was determined prior to testing due to the lack of research done in the field of OT effects on feline behavior. However, we had hypothesized that cats may show similar reactions to dogs with regards to vocalization after receiving OT. In a study conducted to analyze the effects of OT on canines, the results showed a trend of an increase in vocalizations from dogs given an OT solution (Thielke, Rosenlicht, Saturn, & Udell, 2017). In many species, vocal signaling is fundamental aspect in social communication. As applicable for the present study, vocalizations could be an important

indicator of distress and/or social solicitation. Further research should be conducted with a larger population sample in order to fully determine the effects on feline behavior and vocalization.

Further research can also re – assess the different effects of OT behavior modification in male subjects in comparison to female subjects. All the above tests (frequency of approach, vocalizations, and time spent in proximity to experimenters) could all be re-analyzed to look for differences in significance between these tests, OT vs. saline administration and sex of the cats. Although we tried to balance our test subjects to be equal numbers of males and females, the population should be larger in a future study so that more than 18 males and 22 females are tested. If a significant effect is declared on either male or female cats, these results may be important for applicational use in shelters who could target a specific sex of cats in the shelter who show positive behavioral modifications when given OT, therefore possibly increasing adoptability.

Further research should also delve deeper into different attachment styles seen in cats and assess the effects of OT administration on cats with varying attachment styles. The attachment styles as outlined by Schöberl et al. 2016, would be: secure, insecure – avoidant, insecure – ambivalent, insecure – disorganized, and unclassifiable, and could be adapted for cat behavior. With the addition of attachment style determination before conducting the same PAT as the current study, researchers may be able to determine if certain types of personalities would benefit more from OT administration.

Further research may also evaluate the effects of alternative OT dosing and administration timing in comparison to pro – social behavior. Studies may evaluate the effects of administering OT multiple times before testing, split up either into days leading up to testing, or hours leading up to testing. However, chronic OT administration may not be advised due to

studies showing a resulting decrease in OT receptors in the brain and selective social behavior reduction after long- term usage (Bales et al., 2013; Huang et al., 2014; Peters et al., 2014).

A deeper understanding of how oxytocin can be utilized to encourage pro – social behavior could be useful in shelter/adoption settings and help prospective adopters get to know their potential pets before taking them home.

## **Conclusion**

The aim of this study was to evaluate the effects of intranasally administered oxytocin on the sociability of adult, neutered, male and female shelter cats, as measured by proximity-seeking behavior and meow vocalizations.

Results derived from the Paired Attachment Test identified a significant increase in proximity – seeking behaviors such as frequency at which cats approached experimenters after being given OT. There was a trend towards significance between handler/administrator and time spent in proximity to experimenters, with cats spending slightly more time in proximity to administrator. These results may be applicable in reducing stress induced by the changing of environments and caretakers, as well as increasing pro – social behaviors of cats in shelter settings seeking adoption. Further research should re – examine male vs. female behavioral comparisons, examine the effects of OT administration on cats with varying attachment styles in order to evaluate which types of cats would benefit the most from receiving OT, and determine the effects of adjusting OT dosage and administration time variation.

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