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Examining the impact of a brief human-canine interaction on stress and attention

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The interaction between humans and canines has been linked to a variety of benefits including reductions in ADHD symptoms in children, depression symptoms in nursing home patients, and PTSD symptoms in veterans returning from war. Although the inclusion of therapy dogs on college campuses has increased over the last few years, little evidence exists demonstrating the effect of canine interaction in these settings. The current study examined the effects of college student's interactions with therapy dogs during an exam period. Fifty-six students interacted with therapy dogs before or after completing measures of sustained attention, mind wandering, perceived stress, cognitive test anxiety, and state anxiety. Interacting with the therapy dogs reduced state anxiety and resulted in lower perceived stress but did not alter sustained attention task performance or mind wandering. The results suggest that interaction with therapy dogs may help reduce perception of stress and anxiety but may not alter the cognitive functions measured in the current study. Due to the levels of stress that college students experience during exam periods, on-campus therapy dog programs may provide a low, cost effective intervention that universities could implement to benefit their students.

Keywords: Stress, Sustained attention, Human-canine interaction

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Interactions between humans and canines have shaped the evolution of canines in a mutually beneficial manner (Range & Viranyi, 2014). The benefits of the human-canine interaction have been demonstrated across a variety of human outcomes. Interaction with therapy dogs reduces depression symptoms and increases well-being in nursing home patients (Gammonley & Yates, 1991), decreases PTSD, depression, and anxiety symptoms in soldiers returning from war (Beck, Gonzales, Sells, Jones, Reer, & Zhu, 2012), decreases ADHD symptoms in children (Schuck, Emmerson, Fine & Lakes, 2015), reduces physiological arousal but not state anxiety or medical fear in hospitalized children (Tsai, Friedmann, & Thomas, 2010), reduces physiological response to a stressful mental arithmetic task (Allen, Blascovich, Tomaka, & Kelsey, 1991), and increases comfort and stress relief during therapy sessions (Walsh, 2009). Interactions with dogs in long-term settings as pets demonstrate similar benefits including, lower systolic and diastolic blood pressure in older adults with a mildly elevated blood pressure (Friedmann, Thomas, Son, Chapa, & McCune, 2013), increased 1 year survival rate following a cardiac event (Friedmann, Katcher, Lynch, & Thomas, 1980), faster

recovery from both psychological and physiological stress manipulations in married couples, (Allen, Blascovich, & Mendes, 2002) and better cardiovascular health (Friedmann, Thomas, Stein, & Kleiger, 2003). Building on these and other findings, the purpose of the current study is to examine the impact of the interaction between college students and dogs on several measures of cognitive functioning and perceived stress.

It is important to note that not all of the studies examining the impact of interactions with dogs or other pets have shown beneficial effects (see Barker & Wolen, 2008). In fact, some recent studies have shown no difference in the frequency of pet owners and non-pet owners who rate themselves as very happy (Herzog, 2010) and no differences in blood pressure between owners and non-owners (Wright, Kritz-Silverstein, Morton, Wingard, & Barrett-Connor, 2007). In contrast to prior work demonstrating better health in pet owners (Headey, 1999), dog ownership in older adults is associated with poorer physical health and depression (Parslow, Jorm, Christensen, & Rodgers, 2005). Overall, the evidence supporting the benefits of pet ownership and animal interaction on human health and well-being is still mixed (Herzog, 2011).

Of specific interest to the current study, the benefits of interaction with therapy dogs has been examined in a variety of educational settings including preschool, elementary school, and at the collegiate level. The presence of a therapy dog in preschool classes increases speed and accuracy on an object recognition task, possibly due to increased focus or motivation resulting from the canine interaction (Gee, Belcher, Grabski, DeJesus, & Riley, 2012). At the elementary school level, the inclusion of a therapy dog in classroom reading programs results in higher reading scores and increased enthusiasm for reading for kindergarten through fourth graders (Kirnan, Siminerio, & Wong, 2015). College students report high levels of interest in and enjoyment of therapy dog sessions (Adamle, Riley, & Carlson, 2009). However, research examining impact of the canine interaction among college students has resulted in mixed findings.

Among college samples, the impact of canine interaction on stress and cognitive performance is important. Stress has a significant negative impact on college student's academic achievement (Pritchard & Wilson, 2003; Struthers, Perry & Menec, 2000). Interactions with a dog are associated with reductions in subjective but not physiological stress following viewing a traumatic film (Lass-Hennemann, Peyk, Streb, Holz, & Michael, 2014). A brief unstructured interaction with a dog, but not viewing a dog, results in decreases in negative affect, state anxiety, and increases in positive affect in medical school residents and students (Crossman, Kazdin, & Knudson, 2015). Further, college students that interact with a therapy dog during a week prior to final exams report lower levels of stress following the interaction than following a control manipulation (Barker, Barker, McCain, & Schubert, 2016). Canine interaction did not result in changes in salivary alpha amylase, suggesting that interacting with therapy dogs does not alter physiological stress.

Despite the benefits of interaction with a dog on perceived stress, the effects do not appear to extend to physiological or cognitive benefits. The presence of a dog does not buffer the effect of a difficult cognitive task on heart rate variability (Gee, Friedmann, Stendahl, Fisk, & Coglitore, 2014) or reduce arousal while preparing for a delivering a speech (Straatman, Hanson, Endenburg, & Mol, 1997). Further, the presence of a dog during a working memory task does not improve task performance (Gee, Friedmann, Coglitore, Fisk, &

Stendahl, 2015). The lack of a clear effect of interaction with a dog on cognitive task performance may be a result of a methodological flaw. In prior studies, participants were required to remain in physical contact with the dog during the tasks. Requiring participants to remain in contact with a dog while completing a cognitive task may be problematic. First, requiring the participants to remain in contact gives the participants a second task to complete (e.g., remain touching the dog) while completing the cognitive task. This second task places an extra load on limited cognitive resources (Kane & Engle, 2000). Second, any movement the dog makes during the task may result in additional distraction for the participant, thereby reducing task performance. Therefore, this methodological flaw may be responsible for the lack of evidence for a benefit of canine interaction on cognitive performance.

The reductions in stress that occur as a result of canine interaction may play a role in possible cognitive changes as a result of the interaction. Stress results in increases in mind wandering, or Task-Unrelated Thoughts (TUTs; Banks & Boals, 2016). Mind wandering is a common experience, occurring in approximately 50% of all waking hours (Killingsworth & Gilbert, 2010). Despite the frequency of these thoughts, when individuals experience mind wandering, their ongoing task performance is impaired (McVay & Kane, 2009; Randall, Oswald, & Beier, 2014). Impaired performance as a result of mind wandering has been demonstrated on a variety of tasks, including working memory (Banks & Boals, 2016; Banks, Tartar, & Tamayo, 2015), sustained attention (Banks, Tartar, & Welhaf, 2014; McVay & Kane, 2009), and academic performance (Wammes, Seli, Cheyne, Boucher, & Smilek, 2016). This is especially problematic for college students during exam periods, as exam periods are stressful (Bosch, Ring, de Geus, & Amerongen, 2004) and require the ability to sustain attention to goal directed tasks, such as taking an exam or studying. Given the benefits of canine interaction on stress reduction, the use of therapy dogs during periods of stress may have a variety of benefits, including reducing mind wandering and increasing sustained attention. Despite prior work demonstrating changes in stress following an interaction with a therapy dog (Barker et al., 2016), no prior work has examined the impact of this interaction on mind wandering. Since mind wandering is a mediator for the impact of stress on cognitive task performance – specifically tasks requiring working memory (Banks & Boals, 2016) – then reductions in stress that result from interacting with therapy dogs may also result in the downstream effects of reducing mind wandering and increasing some cognitive task performance. The current study examined the impact of college students interacting with therapy dogs during an examination week—a period examined as a time of mild chronic stress (Bosch et al., 2004). Increased levels of cortisol, a stress hormone, have been observed during examination periods, providing supporting evidence for the stressful nature of examination periods (Viena, Banks, Barbu, Schulman, & Tartar, 2012). Unlike other studies that have examined the impact of the interaction between people and dogs on cognitive tasks in a laboratory setting (Gee et al., 2014; 2015), the interaction between people and dogs in the current study occurred in a university-wide Canine Therapy event, consistent with events that occur on university campuses across the U.S. Therefore, any effects observed in the current study will mirror effects that might be observed in the real world. It was hypothesized that college students who interact with therapy dogs during examination periods will have lower levels of

perceived stress than those who do not interact with the therapy dogs. Secondly, it was hypothesized that college students who interact with therapy dogs during examination periods would experience higher performance on several cognitive tasks, including higher levels of sustained attention, increased speed of processing, and lower levels of mind wandering compared to those who do not interact with the therapy dogs. Finally, based on prior work demonstrating the beneficial effect of owning a dog (Friedmann et al., 1980; 2003; 2013), we controlled for dog ownership in examining the impact of the brief on-campus intervention.

Methods

Participants

Fifty-six students (43= Females, 13= Males; *M* age years = 20.05, *SD* = 3.38) from a university in the southeastern United States participated in the current study in exchange for a gift card or course credit. Students were randomly assigned to a control (*n* = 27) or brief on-campus canine interaction condition (*n* = 29). Participants were recruited via flyers posted on campus and online advertisements for the psychology department research pool. Participants that reported a fear of dogs or any allergic reaction to dogs were excluded from participation.

The study was approved by the Nova Southeastern University Institutional Review Board and the Nova Southeastern University Institutional Animal Care and Use Committee. Sample size was determined based on effect sizes reported in prior work examining the impact of canine interaction on reports of perceived stress, which demonstrated large effect of interaction on changes in reported perceived stress (d= 1.63-1.87; Barker et al., 2016; d=1.11-1.48; Crossman et al., 2015). A power analysis suggested a required sample size of 46 to achieve an alpha = .05 with an effect size of d= 1.11.

Materials

***Cognitive Outcome Measures Letter and Pattern Comparison*.** The letter and pattern comparison tasks are established measures of speed of information processing (Salthouse & Babcock, 1991). The letter comparison consists of two trials, each with a row of consonants presented on a page of paper, with a line in between each of the rows (i.e., XLD____XLD). Participants are asked to classify whether the letters in the rows are the same or are different for each pair of letters, by writing either an "s" or a "d" on the line between the pairs. The pattern comparison task is analogous to the letter comparison task although in this task the participant is asked to compare two patterns of lines. For both tasks the participant completes two 30-second trials. The score on each task is the combined number of correct responses on the two trials minus the number of incorrect responses. Scores on each task were converted to z-scores and a composite speed of processing score was created by averaging the z-scores for each task.

Sustained Attention to Response Task (SART). The SART is a go/no-go task in which participants must respond rapidly to all frequent non-target stimuli while withholding a respond to infrequent target stimuli (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). In this version of the SART, the infrequent target stimuli was the number 3 and the frequent non-target stimuli were any number between 1 and 9, excluding 3. The SART consisted of 180 trials, made of 160 non-target trials and 20 target trials. Participants were instructed to complete the task as accurately and quickly as possible. Accuracy on the SART was

measured as the number of correctly withheld responses to the target stimuli (TACC).

Thought Probes. Thought probes were inserted into the SART task to measure frequency of mind wandering. Consistent with prior work (McVay & Kane, 2009) with the SART, participants were interrupted at random intervals and asked, "What were you thinking about" just prior to the probe. Participants selected one of the following response options: "a. Task related thought, exclusively", "b. Task performance/evaluative thoughts", "c. Task-unrelated, neutral content", "d. Task-unrelated, positive content"," e. Task-unrelated, negative content". The percent of task-unrelated thoughts was calculated by summing the number of off-task response choices, options c though e, endorsed and dividing by number of probes presented during the task (12 total probes). Due to the intermediate nature of task-related intrusions being between on- and off- task thoughts, the percentage of task-related intrusions, option b, was not included in any analysis.

Self- report Outcome Measures

Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). The PSS measures the degree to which an individual perceives a situation as stressful. Participants responded to a series of items examining perceived stress a scale of 0 (*never*) to 4 (*very often*). The PSS was scored by summing the items, such that the higher the PSS score, the greater the level of perceived stress (Cohen et al., 1983). The PSS has been shown to correlate well with other measures of stress (Cohen et al., 1983). Internal consistency in the current data set was high (α = .85).

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is a 20-item measure of positive and negative affect. Participants rated their current mood in relation to items on a five-point Likert–type scale, ranging from 1 (*very slight or not at all*) to 5 (*extremely*). The PANAS was scored by summing the positive and negative items for each individual participant to create a positive and negative affect score. The PANAS has been shown to be reasonably related to other measures of depression, anxiety, and stress (*r'*s= .30-.67; Crawford & Henry, 2004). Reasonable internal consistency was found in the current sample at both time points for positive affect (α =.82-.86) and negative affect (α =.75-.81).

Mind Wandering Questionnaire (MWQ). The MWQ is a five-item questionnaire that measures mind wandering (Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). Participants respond on a 6-point scale from 1 "almost never" to 6 "almost always" to a series of items such as "I have difficulty maintaining focus on simple or repetitive work." Scores on the MWQ are related to other well-known measures of mind wandering including, probe-caught mind wandering during a working memory task (r = 0.299) and during a self- report stress scale, the PSS, or perceived stress scale, (r = 0.303; Mrazek et al., 2013). Internal consistency in the current sample was reasonable (α = .80).

Cognitive Test Anxiety Scale (Cassady & Johnson, 2002). The cognitive test anxiety scale is a 27-item questionnaire measuring the amount of anxiety individuals experience in evaluative situations such as exams (Cassady & Johnson, 2002). Participants respond to items on a scale from 1 "Not at all typical of me" to 4 "Very typical of me" in response to questions such as "I lost sleep worrying about examinations". The cognitive test anxiety scale is highly related to other measures of test anxiety (*r's* = .61-.81; Cassady & Johnson, 2002). Internal consistency in the current sample was high (α = .93).

State-Trait Anxiety Inventory (STAI-S; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI-S was

used to measure state anxiety. The STAI-S is a 20-item measure that evaluates subjective emotional states like nervousness, restlessness, tension, and worrying. Higher scores indicate higher state anxiety. The STAI-S has demonstrated adequate convergent validity with other measures of state anxiety (Spielberger et al., 1983). Internal consistency was high in the current sample for state ($\alpha = .89$) and trait ($\alpha = .89$) anxiety.

Animal History Questionnaire. Participants were asked a series of questions designed to determine their level of prior interaction with animals and their current number of pets, including "Do the dog(s) currently reside with you (do you see them daily)?", "Do you have an overall positive experience with animals?" and "Do you enjoy interacting with dogs?". Participants responded to these questions with a "yes" or "no" response. This measure was included to control for any effects attributable to owning a dog.

Demographics. Participants completed a demographics form to indicate age, ethnicity, and gender.

Procedure

Data collection occurred as part of a university-wide Canine Therapy event for all students on campus during a midterm exam week. Study participants were recruited prior to the day of the event and reported to a location near the canine therapy event. No participants interacted with the therapy dogs prior to participation in the study. All participants completed an informed consent form, a baseline measure of the PANAS, and an Animal History Questionnaire. Participants were randomly assigned to a control or canine interaction condition. Control condition participants proceeded directly to the laboratory to complete subsequent measures. The control condition was designed to control for the effects of repeated testing and to provide a comparison group experiencing similar amounts of examination period stress. Canine interaction condition participants interacted with a dog for 10 minutes. Prior work has used similar durations for canine interaction, ranging from 7 minutes (Crossman et al., 2015) to 15 minutes (Barker et al., 2016). Participants were allowed to choose the dog they interacted with from several possible dog breeds including Beagles, Golden Retrievers, and German Shepherds. Participants were permitted to interact with as many of the dogs as they wished. Most participants sat on the ground next to one of the dogs and petted the dog for the interaction period. While petting the dogs, participants were also seen talking with the dogs, talking with the handlers, and taking pictures with the dogs. The dog handlers had the dogs on a leash and were asked to behave as they normally would during a campus visitation event, including allowing the college students to pet the dog, having the dogs do tricks, and answering questions about the dogs or the therapy dog program. The dogs were all certified therapy dogs with Canine Assisted Therapy, and all dogs had experience visiting individuals in a variety of settings, including academic settings. The dog handlers were also certified handlers with Canine Assisted Therapy that had been certified independently of their dogs. To ensure minimal fatigue on the dogs, the event was limited to two hours and handlers could remove their dogs during the event for a break if they felt the dogs were fatigued. Following the 10-minute interaction period, canine interaction participants proceeded to the laboratory. Upon arrival at the lab all participants completed the SART on a computer in a semi-private room. Participants completed the Letter and Pattern comparison tasks in a group led by a research assistant and then were given the self-report questionnaires to complete in a room with a

trained research assistant. Participants completed the MWQ, PSS, PANAS, and demographics to determine if the canine interaction altered mind wandering, perceived stress, or mood. Completing these measures took approximately 35 minutes. All participants were thanked for their participation, awarded a gift card, and debriefed as to the purpose of the study. Following completing the study, participants in the control condition were then given the option of interacting with the dogs in the same setting as the experimental participants.

Data analysis

A series of independent samples t-tests were conducted to ensure that participants in the brief on-campus canine interaction and control conditions did not differ on baseline levels of positive or negative affect prior to interacting with the canines or on the number of dogs they currently own, have owned in the past, number the currently reside with, or whether they enjoy interacting with dogs. A chi-square analysis was conducted to compare participants in the brief on-campus canine interaction and control conditions in terms of the current presence or absence of a dog at home.

A series of linear regression analyses were conducted predicting the dependent variables of perceived stress, positive and negative affect, state anxiety, cognitive test anxiety, SART performance, speed of processing, and mind wandering. Pet ownership was entered as a covariate in all analyses, with condition entered as the primary predictor of interest. Condition was dummy coded for the purpose of the regression analyses; brief on-campus canine interaction condition dummy coded as 1 and control dummy coded as 0. Pet ownership was also dummy coded for entry into the regression analyses; pet owners dummy coded as 1 and non-pet owners dummy coded as 0.

A series of mixed model ANOVA's were conducted to determine if scores on the PANAS positive or PANAS negative changed over time and if this change was moderated by condition. All analyses were conducted using SAS 9.4 software. Significance threshold was $p = 0.05$.

Results

Descriptive statistics for all dependent variables can be found in Table 1. No differences were found between participants in the canine interaction and control conditions on baseline levels of positive or negative affect prior to interacting with the canines. Additionally, no differences were found between participants in either condition in regard to the number of dogs they currently own, have owned in the past, number they currently reside with, or whether they enjoy interacting with dogs, all p's > .05. Further, the presence or absence of a dog at home did not differ significantly by condition, χ^2 (1) = 2.08, p = .15.

Condition did not serve as a significant predictor for positive and negative affect, cognitive test anxiety, SART performance, speed of processing, or mind wandering, all p's > .05. As can be seen in Table 2, significant regression models were found for predicting perceived stress and state anxiety. For both models condition served as a significant predictor; participants in the brief on-campus canine interaction condition evidenced lower levels of perceived stress and state anxiety. To determine if the effect of the intervention on perceived stress and state anxiety was altered by pet ownership, an interaction term was added to the two regression models. The interaction terms were not significant in either regression, p's > .05, and did not improve model fit. To visualize the effect of

the canine interaction condition, perceived stress and state anxiety are plotted in Figure 1, by condition.

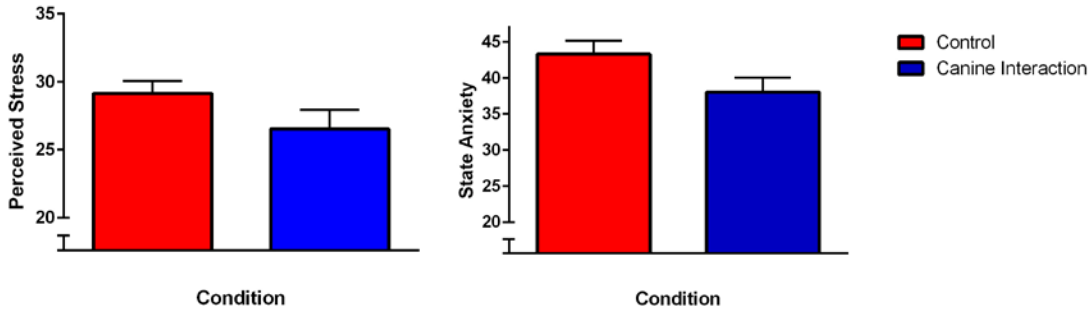
A significant effect of time was discovered on the PANAS positive, $F(1, 53) = 10.86$, $p < .01$, *partial* $\eta^2 = .17$, such that participants reported lower levels of positive affect at the end of the study than at the beginning of the study (as seen in Table 1). Importantly, there was no effect of condition or time x condition interaction, all *p*'s > .05. No effect of time, condition, or time x condition interaction was observed for scores on the PANAS negative, all *p*'s > .05.

Table 1. Descriptive Statistics by Condition

	Brief Canine Interaction Condition		Control Condition	
	M	(SD)	*M*	*(SD)*
PSS	26.54	(7.44)	29.15	(4.68)
STAI -S	38.04	(10.05)	43.28	(9.28)
STAI-T	42.07	(9.55)	44.21	(8.90)
Cognitive Test Anxiety	66.59	(14.92)	65.31	(17.74)
MWQ	19.41	(4.66)	17.89	(5.56)
SART-TACC	6.79	(3.64)	7.11	(3.36)
Speed of Processing Composite	0.17	(0.84)	-0.18	(0.86)
PANAS Positive T1	30.41	(6.82)	30.15	(6.84)
PANAS Positive T2	25.90	(7.35)	26.67	(7.25)
PANAS Negative T1	13.48	(3.40)	14.56	(4.48)
PANAS Negative T2	13.69	(4.48)	13.74	(4.37)
Percentage of TUTs	33.33	(30.29)	21.30	(23.92)

Note: PSS= Perceived Stress Scale, STAI-S= State Anxiety Inventory-State, STAI-T- State Anxiety Inventory-Trait, MWQ= Mind Wandering Questionnaire, SART-TACC= Target accuracy on the Sustained Attention to Response Task, TUTs- Percentage of Off-Task thoughts

Figure 1. The impact of canine interaction on perceived stress and state anxiety.



Note: error bars represent standard error of the mean.

Table 2. Regression analysis

	B	*SE*	β	*t*	*p*	*F*	*df*	*p*	Adjusted R^2
Predicting PSS									
Dog at home	-5.06	1.99	-.33	-2.54	.014	4.53	2,51	.015	.117
Condition	-3.45	1.66	-.27	-2.09	.042				
Predicting STAI									
Dog at home	-6.33	3.16	-.27	-2.00	.051	3.98	2,48	.025	.107
Condition	-6.29	2.69	-.32	-2.34	.023				
Predicting PANAS Positive T2									
Dog at home	4.42	2.37	.25	1.86	.07	1.82	2,53	.17	.029
Condition	-0.07	1.95	-.01	-0.04	.97				
Predicting PANAS Negative T2									
Dog at home	-1.18	1.47	-.11	-0.80	.43	0.32	2,53	.73	-.025
Condition	-0.24	1.21	-.03	-0.20	.84				
Predicting CAT									
Dog at home	5.58	5.44	.14	1.03	.31	0.57	2,52	.57	-.016
Condition	2.23	4.50	.07	0.50	.62				
Predicting SART									
Dog at home	-0.77	1.17	-0.09	-0.67	.51	0.28	2,53	.76	-.027
Condition	-0.44	0.96	-0.06	-0.46	.65				
Predicting Speed of Processing									
Dog at home	-0.46	0.28	-.22	-1.67	.10	2.76	2,53	.08	.057
Condition	0.28	0.23	.17	1.24	.22				
Predicting TUTs									
Dog at home	0.04	0.06	.06	0.46	.64	1.48	2,53	.24	.017
Condition	0.13	0.04	.23	1.71	.09				
Predicting MWQ									
Dog at home	-1.74	1.70	-.14	-1.02	.31	1.15	2,53	.33	.005
Condition	1.25	1.40	.12	0.90	.37				

Note: PSS= Perceived Stress Scale, STAI-S= State Anxiety Inventory-State, STAI-T- State Anxiety Inventory-Trait, MWQ= Mind Wandering Questionnaire, SART = Target accuracy on the Sustained Attention to Response Task, CAT= Cognitive Test Anxiety, TUTs= Percentage of off-task thoughts.

Discussion

The current study examined the impact of interaction between dogs and college students during an exam period on perceived stress and cognitive functioning. We hypothesized that a brief ten-minute interaction with a therapy dog would reduce levels of state anxiety, perceived stress, mind wandering, and increase sustained attention. Our results suggest that interacting with a dog during the intervention was related to lower levels of perceived stress and state anxiety. Decreased perceived stress and state anxiety could have a positive impact on scholastic achievement since higher levels of stress in college students have negative impacts scholastically (Pritchard & Wilson, 2003;

Struthers et al., 2000). Although the covariate—presence of a dog at home—was a significant predictor of both perceived stress and state anxiety, the presence of a dog at home was related to lower levels of each measure, the variable was included for the purposes of a covariate and not a main effect. The perceived stress scale asks participants to report their level of perceived stress over the last month, however, the interaction with the canines appears to have been sufficient to alter perception of recent stress.

Interestingly, no benefit of the interaction with dogs was observed on the PANAS. In fact, a main effect of time was found: participants decreased in level of positive affect over the course of the study. This finding may be due to the timing of participants completing the PANAS. Since the second PANAS was completed after the SART and speed of processing tasks, it is possible that any effect of interacting with the dogs on positive affect was counter acted by the cognitive tasks.

Consistent with prior findings in college students (Gee et al., 2015), we did not find any changes on either cognitive measure. One strength of the current study is the inclusion of multiple cognitive measures examining two different cognitive functions; sustained attention and speed of processing. The lack of an effect of the interaction on either sustained attention or speed of processing is consistent with prior findings demonstrating no effect on cognition (Gee et al., 2015). The current findings do suggest that the methodological flaws in prior studies—requiring participants to touch the dog during the cognitive tasks—may not be responsible for the lack of an improvement in cognitive functioning.

Although prior work has shown cognitive benefits in children as a result of interactions with canines (Gee et al., 2012; Gee, Church, & Altobelli, 2010; Kirnan et al., 2015), the lack of effect on cognitive functioning in college students may not be surprising. Since college students are approaching peak levels of cognitive functioning (Alloway & Alloway, 2013), interventions such as the one in the current study may have minimal impacts. The changes in levels of perceived stress and state anxiety as a result of canine interaction may have downstream effects on academic performance—one of the main reasons that canine intervention programs are held on college campuses. Consistent with the idea that cognitive changes may occur as a downstream result of changes in state anxiety and perceived stress, the lack of a change in rates of mind wandering may explain the lack of changes in the cognitive tasks. As mind wandering mediates the relationship between stress and cognitive performance (Banks & Boals, 2016), the lack of a change in mind wandering may suggest the intervention was not strong enough to influence mind wandering and cognitive task performance.

There are several limitations in the current study. It is possible that a longer interaction with the dogs would have resulted in a greater effect and possibly changes in cognitive functioning. It is also possible that canine interaction would alter cognitive tasks that require greater attentional demands, such as working memory tasks, as these tasks are more difficult. Further, the setting of the interaction in the current study differed from prior work. Participants in the current study interacted with the dogs in a group setting and then completed the rest of the tasks in the laboratory without the dogs present. In prior studies, the dog was present in the lab as the participants were completing the studies, even to the point of touching the dogs while completing the cognitive tasks (Gee et al., 2015). However, since the methodology in the current study matches the type of interaction that occurs on college campuses across the country, these results may match the effects that are seen in the real world.

Additionally, the current study did not examine the impact of the canine interaction on academic performance. It is possible the reduction in perceived stress and state anxiety had downstream consequences on academic performance. Prior work has demonstrated a relationship between state anxiety and academic performance (Pritchard & Wilson, 2003; Struthers et al., 2000). Future work should examine the impact of canine interaction on academic performance in the classroom. Additionally, since the control group used in the current study was a non-treatment control group, it is not possible to determine if the effects seen in the canine interaction condition occurred due to the passage of time. Finally, given the smaller sample used in the current study, it is possible that the current study did not have sufficient power to detect smaller effects that may have occurred on the other constructs examined.

The current study provides evidence for the efficacy of a group canine interaction experience on college student's perceived stress and state anxiety. Caution must be taken in interpreting our results since the benefits seen in the canine interaction group may have been due to them taking a break while they played with the dogs rather than something about the interaction itself. However, despite this possible alternative explanation our results are consistent with prior work demonstrating the beneficial effect of having a dog at home (Allen et al., 2002; Headey, 1999; Siegel, 1990) and of reduced self-reported stress in college students (Barker et al., 2016; Crossman et al., 2015). Importantly, the current results did not provide any evidence for changes on either of the cognitive measures. The lack of changes in rates of mind wandering provide a possible explanation for the lack of changes on the cognitive tasks and a direction for future work. Changes in cognitive task performance may only occur following interaction with a dog when the interaction results in changes in reductions in stress related mind wandering. This is the first study, to the authors' knowledge, to test for an effect of interaction with dogs on measures of sustained attention, speed of processing, and mind wandering. Interaction with dogs, in a group setting on campus, may serve as a beneficial intervention to reduce stress in a college student population. Given the level of stress during examination periods and the importance of strong academic performance during this time, the inclusion of canine interaction periods on college campus may be beneficial for students.

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