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The Influence of Interactions with Pet Dogs on Psychological Distress

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Abstract

Many people, including nearly half of American households, own a pet dog. Previous work has found that therapy dog interactions reduce distress, but little work to date has empirically established the mood-enhancing effects of interaction with one's own pet dog. In this study, dog owners (N = 73; 86.3% female, 13.7% male; age 25-77 years) underwent a stress-inducing task followed by random assignment to either 1) interacting with their dog (n = 24), 2) an expectancy control (n = 25) ("stress-reducing" coloring books), or 3) a waiting control (n = 24). We compared the effects of each condition on affect and state anxiety. Participants assigned to the dog interaction showed greater increases in positive affect, as well as greater reductions in anxiety compared to both expectancy and waiting controls (*ds* > 0.72, *ps* < 0.018). No significant reductions in negative affect were detected. Second, we found that self-reported experiences with animals, attitudes towards animals, or bondedness with their dog did not differentially predict the condition's impact on the owner's mood. Finally, we coded participants' degree of engagement (e.g., time spent playing) with the dog and found that higher engagement predicted reduced negative affect. Overall, interacting with one's own pet dog reduced owners' distress. Such interactions, which occur commonly in daily life, may have the potential to alleviate distress at a large scale. Precisely how this works and for whom it is especially well-suited remain intriguing open questions.

Keywords: human animal interaction, distress, dog, pets, stress

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The Influence of Interaction with Pet Dogs on Psychological Distress

Does spending time with our pet dogs cheer us up? Around half of American households own a pet dog (American Pet Products Association [APPA], 2021; US Census Bureau, 2019), and owners vary widely in terms of age, ethnicity, gender, and location (Applebaum et al., 2020). For many owners, one of the most appealing aspects of owning a dog is the expectation that they will boost our mood and decrease stress (Powell et al., 2018). If pet dogs can indeed reduce distress or improve affect, this finding would have important implications for many people. Interactions with one's own pet could potentially provide owners respite from psychological distress, a widespread problem with consequences ranging from increased risk for mortality (Robinson et al., 2004; Russ et al., 2012) to increased absenteeism from work (Hardy et al., 2003). Despite the considerable impact of psychological distress, the majority of people suffering do not receive help (Kessler et al., 2005; Merikangas et al., 2010; Pearson et al., 2009). Simple, scalable approaches to reducing psychological distress are sorely needed.

We intuit that pet dogs improve mood, and media outlets, some researchers, and even medical professionals commonly suggest adopting or buying animals in order to alleviate distress and improve mental health (sometimes referred to as the "pet prescription"; e.g., Fischman, 2005, Wright et al., 2015). The assumption that pets alleviate distress is also at the heart of ongoing recommendations about emotional support animals (i.e., pets that mental health professionals have certified are necessary for providing comfort and support; Brulliard, 2018; Hsu, 2018; Younggren et al., 2016).

The Benefit of Pet Dogs Remains Unclear

Despite the intuition that pet dogs reduce distress, we lack sufficient evidence that this is empirically true, and recommendations that people get pet dogs to improve their mental health

are well ahead of the available evidence. There is evidence that the media is biased in reporting only positive outcomes, while ignoring negative or null effects (Herzog, 2011). This contributes to the general public and even healthcare professionals incorrectly lumping pet animals into evidence-based medicine (Silva & Lima, 2020).

We cannot draw conclusions about the emotional benefits of a pet dog in part because existing pet ownership studies have methodological weaknesses and inconsistent results. Weaknesses include correlational study designs, a lack of random assignment, and uncontrolled confounds. Studies have found associations between pet ownership and wellbeing (Bao & Schreer, 2016; Janssens et al., 2020; Knight & Edwards, 2008) and benefits when comparing pet owners to non-pet owners (e.g., Headey et al., 2008; Pruchno et al., 2018). However, it remains unclear if time with these dogs is driving such associations, or if there are other explanations (e.g., happy people are simply more likely to own a dog, higher socioeconomic status among pet owners). This makes it difficult to tease out if any observed effects are due directly to the pet ownership, or to other variables. Randomized controlled experiments would help evaluate whether spending time with a pet dog benefits affect. In addition to methodological weaknesses, there are also inconsistent results – with some studies finding pet ownership associated with positive outcomes (Bao & Schreer, 2016; Janssens et al., 2020; Wheeler & Faulkner, 2015) and others with negative outcomes or null results (Eshbaugh et al., 2011; Fraser et al., 2020; Gilbey et al., 2007; Jorm et al., 1997; Miltiades & Shearer, 2011; Parslow et al., 2005; Peacock et al., 2012; Rijken & Beek, 2011).

Early experiments suggest interactions with pet dogs can alleviate interpersonal distress (e.g., the Trier social stress task; Aydin et al., 2012), particularly for children (Kerns et al., 2018; Kertes et al., 2017; Wheeler & Faulkner, 2015), when subjectively measured, but it is unclear if

they relieve more general types of subjective distress. Studies that have looked at non-interpersonal stressors have found reductions in some physiological outcomes relevant to distress (e.g., heartrate recovery; Allen et al., 1991; Allen et al., 2002; Odendaal & Meintjez, 2003; Zilcha-Mano et al., 2012) but to our knowledge, subjective affective outcomes of non-interpersonal stressors have yet to be assessed in the lab (for measurement in participants' homes see Campo & Uchino, 2013).

These existing experiments on interactions with pet dogs could be strengthened by the presence of an expectancy control. Otherwise, it is possible that interaction with a pet dog conveys benefits primarily because people expect it to. Any intervention or activity that is purported to reduce distress, and thus produces expectations of improvement, is likely to produce actual improvement (Price et al., 2008). Of course, this is why researchers often include placebo controls in pharmaceutical trials: to ensure that novel treatments exceed the effects produced by patient expectations alone (Gupta & Verma, 2013). Participant expectations are undoubtedly a contributing factor to the effects of pet interactions on distress. However, as with new pharmaceutical treatments, an important question is whether there are additional benefits beyond those due to expectations alone. This is a particularly important question in light of the fact that pet ownership is perceived as a credible and appealing strategy for improving mental health (Rabbitt et al., 2014). Among people with positive attitudes towards animals, in particular, animal-assisted interventions are perceived as more credible and appealing than other interventions presented with identical levels of empirical support (Crossman & Kazdin, 2018).

Assumptions about the benefits of pet dogs may exist in part because they fall under the broader umbrella of human-animal interaction (HAI), a promising strategy to alleviate distress (Crossman, 2017; Crossman & Kazdin, 2015b). HAI includes a range of activities, from animal-

assisted interventions to therapy animal visits (International Association of Human-Animal Interaction Organizations, 2013), and dogs are the species most frequently involved (APPA, 2021; Hare & Tomasello, 2005). The argument that both HAI (broadly) and pet ownership (specifically) reduce distress is predicated on the notion that an interaction with an animal benefits mental health. Notably, however, we cannot assume that benefits of some kinds of HAI – such as animal-assisted therapies – will extend to pet ownership as well. Pet ownership lacks many factors unique to such therapies (e.g., scheduled time with a human handler) but comes with additional stressors (e.g., time and financial costs; Wesley, 2015). Plus, HAI studies are frequently confounded by including social interactions such as experimenter presence (e.g. Allen et al., 1991; Aydin et al., 2012; Handlin et al., 2012; Powell et al., 2020; Zilcha-Mano et al., 2012) or group formats (Binfet, 2017); this is important to consider as the benefits of such social interactions are well documented (Clark, 1993; Cohen, 2004). Thus, conclusions about emotional benefits of the animals themselves, without additional human interaction, are lacking.

Overall, it is not yet possible to conclude that a pet dog interaction *per se* provides emotional relief from general distress. The state of the evidence is far from clear, and multiple review articles have highlighted the need for more research before we can draw conclusions about the emotional benefits of a pet (Chur-Hansesn et al., 2010; Friedmann & Krause-Parello, 2018; Herzog, 2011; Silva & Lima, 2020). Carefully controlled studies are needed in order to test this, and we aim to contribute to these efforts. We provide a starting point for establishing pet dog interactions, with implications for other kinds of HAI, as a strategy for affect improvement.

Present Study

The present study aimed to isolate the effects of a brief, unstructured interaction with a pet dog. We evaluated the effects of this dog interaction independently of other intervention

components with which it is frequently confounded. Specifically, we evaluated only the circumscribed interaction (rather than evaluating one in the context of an animal-assisted therapy); conducted the interaction on an individual basis rather than in a group format; and eliminated the involvement from human handlers. In order to disentangle the effects of change over time from the effects of the interaction, a waiting (i.e., no- treatment) control condition was included. We also included an additional control condition, an expectancy control, to establish whether the interaction benefits pet owners beyond another activity that is purported to reduce stress (i.e., that the interaction's benefits do not simply exist because people expect them to). We predicted that, following exposure to a stressful task, interaction with a pet dog would 1) increase self-reported positive affect, 2) reduce self-reported negative affect, and 3) reduce self-reported anxiety, compared to both the expectancy control condition and the waiting control condition. To our knowledge, this is the first study on interactions with pet dogs to use an expectancy control.

We elected to use a community sample of pet owners, rather than selecting for any particular diagnosis or any special category of pet owner (e.g., those with emotional support animals or psychiatric service animals), because of the need for methods reducing distress that can be applied across the population. In addition, the interest was in providing a proof-of-concept demonstration of the effects of interactions with pets, rather than establishing the benefits of interactions with pets for any particular disorder.

A secondary goal of this study was to evaluate whether the benefits of interactions with unfamiliar dogs that have been observed in prior studies (e.g., with support animals; Aydin et al., 2012; Crossman et al. 2017; Crossman et al. 2018; Wheeler & Faulkner, 2015) extend to interactions between people and their *own* pet dogs. The prevalence and long-term nature of pet ownership suggests that the vast majority of interactions between people and dogs probably

occur in the context of pet ownership. As a result, any benefits of interactions between people and their own pets might be leveraged to improve affect on a large scale.

This study also had several supplementary aims. One proposed explanation for the effects of HAI on distress is that HAI may serve as a powerful pleasurable activity (Crossman & Kazdin, 2015b), the implication being that people who enjoy animals are most likely to benefit. Casual observations from practitioners and animal handlers also suggest that individuals with little or no prior experience with animals are less likely to benefit. In the case of interactions between individuals and their own pets, many researchers have suggested that the degree of bonding between the person and the animal may influence the extent to which the interactions alleviate distress (see Crawford et al., 2006 for a review). Evaluating interactions between people and their own dogs allowed for exploration of the roles of participants' attachment to the dogs with whom they participated and the characteristics of the particular dogs (e.g., breed, type). These ideas about the impacts of animal-related attitudes and experiences are important because they have implications for efforts to identify the people who are most likely to benefit from HAI. Therefore, we explored the roles of participants' experiences with animals, their attitudes towards animals, and their bondedness with their specific pet dog. For details, see supplementary material.

As an additional supplementary aim, we were interested in whether the specific behaviors that occurred during the interaction (e.g., petting the dog) could predict the effect of the interaction on mood. Previous studies have found that some specific behaviors during an interaction with a dog can lead to more emotional benefits: physical contact (Beetz et al. 2011; Beetz et al. 2012; Handlin et al., 2012; Jenkins, 1986; Kerns et al., 2018; Kertes et al., 2017; Nagasawa et al. 2009; Vormbrock & Grossberg, 1988; Wheeler & Faulkner, 2015), eye contact

(Friedmann et al., 2019; Nagasawa et al., 2009; Nagasawa et al., 2015), and talking to the dog (Beetz et al., 2011; Kerns et al., 2018). Identifying specific aspects of HAI that can produce the most benefit may contribute to increasing the efficacy of HAI, and thus we also tested whether different interaction behaviors with one's pet dog were associated with more emotional benefit.

Method

Human Participants

Participants were 73 adult dog owners (86.3% female, 13.7% male), age 25-77 years (M = 50.59, SD = 14.86). Participants were drawn from the local community surrounding a university in the Northeast United States, and were eligible to participate if they were 18 years of age or older and had a dog in their household. In terms of race and ethnicity, 60 participants (82.2%) reported that they were White, Non-Hispanic; six (8.2%) were Asian; two each (2.7%) were Black, Hispanic/Latino, and Native-American/Alaska Native; and one (1.4%) declined to report race/ethnicity. For employment status, 37 participants (50.7%) reported full time paid employment, 18 (24.7%) were not engaged in or seeking employment, 14 (19.2%) had part-time paid employment, and four (5.5%) were unemployed but seeking paid employment. For highest level of education attained, 32 (43.8%) had a graduate degree from a university, 25 (34.2%) graduated college, 14 (19.2%) completed some college or technical school, one (1.4%) graduated high school, and one (1.4%) completed some high school.

Of the 73 human participants, 67 (91.8%) reported being the primary caregiver for the dog with whom they participated, five (6.8%) reported that they shared the caregiving responsibilities equally with their partner or spouse, and one (1.4%) indicated that their partner was the dog's primary caregiver. An additional five participants began the procedure but were not included in the analyses. In two of these cases, the procedure was stopped early because the

dogs showed signs of stress and/or separation anxiety while the human participant was completing other aspects of the procedure. In one case, the procedure was stopped early because the participant needed to take a phone call part-way through the procedure. The remaining two participants completed the procedure but were excluded from the analyses because one was administered the surveys in the wrong order, and the other reported that she was upset because she had found a rash on her dog during the interaction and was concerned about her dog's health.

Participants provided informed consent for themselves and for their dogs before participating. Each participant received a $20 gift certificate in exchange for their participation. In cases where dogs did not meet all veterinary requirements (see Canine Participants section for details of requirements), and participants reported that their veterinarian did not have the same requirements and the cost of obtaining them would be prohibitive (i.e., they would not participate because of the cost of the additional veterinary requirements), reimbursement was provided for those costs at the time of participation. This study was reviewed and approved by both the Institutional Review Board and the Institutional Animal Care and Use Committee of Yale University.

Canine Participants

Details of the characteristics of the canine participants, including age and breed class, are presented in Table 1. To participate, dogs had to be at least 16 weeks old, and owners had to provide proof of a negative stool sample from the last six months (negative for Giardia), and proof of vaccinations for rabies, Bordetella, and DHLPP (Distemper, Hepatitis, Leptospirosis, Parvovirus, and Parainfluenza). Per the Institutional Animal Care and Use Committee protocol, exemptions were granted for the Bordetella vaccine and the 6-month stool sample requirement under particular circumstances (e.g., a history of allergic reactions to the Bordetella vaccine), and

in those instances special precautions (beyond the standard operating procedure) were taken in sanitizing the facility at the end of the sessions. All members of the research team were trained to recognize signs of stress and discomfort in dogs, and to supervise human-dog interactions. In case of signs of stress or discomfort from the dogs, the procedure was stopped. Over the course of the study, on only two occasions was the overall study procedure stopped early because of concerns about separation anxiety in the dog while the human participant was completing other aspects of the procedure. In no cases did the study interactions between the human participants and their dogs have to be stopped early due to concerns about human or canine safety or wellbeing.

Procedure

After completing informed consent and acclimating the dog to the facility, height and weight measurements, and background information relevant to the assessment of heart rate and heart rate variability, were collected from human participants. Participants were then escorted to another room for heart rate measurements. Due to study staff changes after the study began, heart rate data was not analyzed and therefore not included as an outcome measure in the present study; this is a study limitation. In addition, the 10-minute relaxation period used to obtain heart rate measurements helped ensure that participants acclimated to the facility and had consistent experiences prior to beginning the study procedure. Participants were asked to sit comfortably in an armchair and read provided magazines for the duration of the relaxation period.

While the participant completed activities prior to the interaction with their dog, a family member or friend stayed with the dog in the canine waiting area to prevent the stress associated with separation from familiar individuals. In cases where a friend or family member was not available and the participant reported that their dog was comfortable with strangers and in

unfamiliar settings, a member of the research team stayed with the dog in the canine waiting area. In all cases, dogs were closely monitored for signs of stress and discomfort, and in cases where dogs showed signs of stress, the procedure was stopped and the participants were reunited with their dogs. As noted above, the procedure was stopped early due to these concerns in only two instances over the course of the study.

After completing this baseline procedure, participants next completed a background and demographic survey, including background information about their dog, the CABS (for details, see supplementary material), the Dog-Person Scale (for details, see supplementary material), and basic demographic information. They then completed the pre-stress Dysphoria Scale. Participants then completed a stress induction (the PASAT-C), followed by a second survey that included the post-stress Dysphoria Scale and the first (i.e., pretest) PANAS and STAI.

After the stress-induction and this survey, participants were escorted to a separate room and provided instructions for their respective conditions: experimental (i.e., dog), expectancy control (i.e., coloring), or waiting control. Assignment to condition was made using a random number generator, with males and females randomized separately to ensure equivalence across conditions. Participants were left alone to complete their assigned conditions, while an experimenter monitored these activities via a closed-circuit camera system. After completing their respective conditions, they completed the final survey that included the second (i.e., posttest) PANAS and STAI. Then, participants from both control conditions completed the interactions with their dogs. At the conclusion of the procedure, participants were debriefed, thanked, and given a $20 gift certificate. The debriefing included information about the purpose of the PASAT-C, as well as the different conditions and their general purposes.

Measures

Both subscales of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), along with the State portion of the State/Trait Anxiety Inventory (STAI; Spielberger et al.,1983) were used to assess positive affect, negative affect, and anxiety, respectively. The PANAS has established internal consistency, test-retest reliability, and construct validity and the STAI has established internal consistency and discriminant validity (Crawford & Henry, 2004; Julian, 2011; Metzger, 1976; Watson et al., 1988). Cronbach's alphas were .91 for the PANAS PA scale, .81 for the PANAS NA scale, and .92 for the STAI at pretest in the present study.

To confirm that the stress induction procedure (described below) produced the intended increases in the subjective experience of stress, we included the four-item Dysphoria Scale, typically used for this purpose (Lejuez et al., 2003). The Dysphoria Scale asks participants to rate their current levels of anxiety, difficulty concentrating, irritability, and frustration, each on a 100-point scale. The four items yield a single sum score, which has demonstrated internal consistency, and has been shown to increase following the stress induction procedure used in this study and other stress-inductions tasks, as well as in response to non-lab stressors (Daughters et al., 2005; Daughters et al., 2008; McHugh et al., 2011). Cronbach's alpha for the Dysphoria Scale at baseline (prior to the stress induction) was .80.

For details on the measures collected to assess participants' experiences with and attitudes towards dogs, and relationships with and characteristics of their particular dogs, please refer to the supplementary material. Missing items for all measures were prorated, so long as the total number of items missing from a given measure constituted less than one quarter of the total items in that measure. We excluded measures that were missing more than one quarter of the items. To prorate missing items, we computed a mean score using the completed items from that measure.

We then substituted missing items using that mean score and computed the sum score using completed and prorated items.

Stress Induction

The computerized version of the Paced Auditory Serial Addition Task (PASAT-C) was used to induce stress (Lejuez et al., 2003). In this task, numbers are sequentially flashed on a screen, and participants are asked to sum the two most recently displayed numbers. The numbers range from 0 to 20, and never sum to more than 20, in order to minimize the degree to which differences in math ability affect the experience of the task. Participants are awarded one point for each correct answer. No points are deducted for incorrect answers or skips, but an explosion sound is played in response to each incorrect. There are three levels of increasing difficulty. Level one lasts three minutes, and levels two and three last five minutes each. Typically, participants are given the option to terminate level three early, so that latency to quit can be used as an index of tolerance for frustration, in addition to using the task to induce distress. However, to reduce the influence of variability in task duration on post-task distress, participants in the present study were not given the option to terminate.

The PASAT-C has been repeatedly shown to increase the subjective experience of distress (Brown et al., 2002; Daughters et al., 2008; Daughters et al., 2009; Lejuez et al., 2003). It also produces increases in physiological arousal (Lejuez et al., 2003; Mathias et al., 2004). The computerized version provides a high level of consistency of administration across participants and across studies – an important advantage relative to other methods of inducing stress in the laboratory, which are susceptible to variation across participants and experimenters (Lejuez et al., 2003). Participants in this study were told that the PASAT-C assesses math skills and

attention and were asked to do their best. Participants were not told that the task was intended to induce stress, but were provided this information following the conclusion of their participation.

Three Study Conditions

Participants were randomly assigned to one of three conditions that occurred after the PASAT-C stress induction: experimental (n = 24), expectancy control (n = 25), or waiting control (n = 24). In the experimental condition, each participant engaged in a ten-minute interaction with their pet dog. Dogs were permitted to be off leash during the interactions, and participants were informed that they could play or interact with the dog however they liked but were encouraged to pet and play with the dog as much as possible. To ensure consistency across participants and to isolate the effects of the dogs, participants were not given any toys or treats to use.

Interactions in the experimental condition were video recorded and coded for seven behaviors that occurred during the interaction with the dog. Verbal Positive included audible speech that was positive or neutral (e.g., "Good boy"). Verbal Negative included audible speech that was negative (e.g., scolding the dog). Verbal Unknown included indistinguishable speech. Sounds included non-speech noises to get the dog's attention (e.g. kissing sounds, clicking tongue, clapping hands). Verbal Total included the sum of Verbal Positive, Verbal Negative, Verbal Unknown, and Sounds. Play included playing with the dog (e.g. wrestling or chasing), and Physical Touch included physical contact with the dog (e.g. petting the dog). When behaviors occurred at the same time, such as petting the dog and positive talk, the time was counted for both behaviors.

A trained video coder used the behavioral video analysis software BORIS to code the duration of each behavior in seconds, rounded to the one thousandth decimal. To assess interrater

reliability, a second researcher independently used BORIS to code a subset of the recorded interactions. Both researchers were trained together via several training sessions, which consisted of watching, coding, and discussing these videos with a supervising researcher. Interrater reliability, calculated with an intraclass correlation coefficient (ICC) between raters for each behavioral measure, was as follows: Physical Touch (.99), Sounds (.16), Verbal Negative (-.09), Verbal Unknown (.68), Verbal Positive (.73), Verbal Total (.76), Play (.89). Because reliability for Sounds and Verbal Negative was low, these two behavioral measures were not considered and will not be discussed further. A new Verbal Total was calculated by summing Verbal Positive and Verbal Unknown and showed good reliability (.88). To capture the overall degree of interaction with the dog, a final compilation of behaviors, Interaction Total, included a sum of the new Verbal Total, Play, and Physical Touch. Interaction Total showed good reliability (.97).

In the expectancy control condition, participants were given an adult coloring book, labeled for stress relief, and asked to use it for 10 minutes. The script used to introduce the expectancy control condition was matched to that used to introduce the experimental condition (with references to interaction with the dog replaced with references to coloring). In the years preceding this study, adult coloring books occupied numerous spots on best-seller lists and received extensive media attention for their purported ability to reduce distress, as well as their widespread use (e.g., Dovey, 2015; Gladstone, 2016; Marsh, 2015). However, there is little empirical evidence that these coloring books have specific effects on distress. In fact, although creative art production such as free drawing, or drawing to express a particular emotion has been shown to reduce distress, activities such as tracing or copying, which do not involve production, have been shown to be less effective at reducing distress (e.g., Petrillo & Winner, 2005; Smolarski et al., 2015). As described above, the goal of including this control condition was to

evaluate whether the distress-reducing effects of a pet dog interaction exceed those of merely receiving any intervention that claims to effectively reduce stress.

In the waiting control condition, participants were asked to wait quietly for 10 minutes (i.e., the same duration as participants in the other two conditions). This condition was included for the effects of change over time, participants' own independent coping abilities, and completing the measures multiple times. Participants were told that this waiting period was needed as a buffer between the PASAT-C and the interactions with their dogs.

Transparency and Openness

Rationale for all data exclusions, manipulations, and measures are reported above. Sample size was modeled off of a similar study on HAI (Crossman et al., 2015) because it was a similar design in terms of number of conditions and type of effect. The study was not pre-registered. Data, analysis code, and research materials are available upon request.

Results

Preliminary Analyses

First, we conducted a manipulation check to evaluate whether the PASAT-C had the intended stress-inducing effect. There was a technicality of the scale (the cursor began at a 0 for each item, and leaving it there without moving it was coded as “missing”), and so we have looked at these data in several ways. First, we looked only at sum scores of participants who had confirmed responses to all items on the entire scale at both baseline and post-PASAT-C. Results of a paired samples t-test indicated that these participants did report an increase on the Dysphoria Scale from before (M = 63.11, SD = 47.89) to after (M = 129.33, SD = 76.04) the stress induction, $t(26) = 3.81$, $p = .001$, $d = 0.76$. Second, we looked at mean scores (rather than sum scores) of participants’ confirmed responses for all participants who completed at least one item,

and the pattern of results was the same, $t(60) = 5.82$, $p < .001$, $d = 0.78$. Third, we made the reasonable assumption that each response coded as "missing" was intended to be a zero (i.e., was intentionally left in its starting place by the participant). The pattern of results again remains the same, with a significant increase on the Dysphoria Scale from before ($M = 31.44$, $SD = 40.30$) to after ($M = 104.24$, $SD = 88.78$) the stress induction, $t(72) = 6.81$, $p < .001$, $d = 0.80$. Thus, across several ways of analyzing this, the manipulation check indicates that the PASAT-C had the intended effect, similar to previous studies (e.g., Lejuez et al., 2003).

We assessed the relations between response to the PASAT-C, as indicated by change in mean scores on the Dysphoria Scale, and pretest STAI, PANAS NA, and PANAS PA scores. Change on the Dysphoria Scale (from before to after completion of the PASAT- C) was moderately correlated with pretest scores on the STAI (administered after participants completed the PASAT-C), $r(59) = .40$, $p = .001$. There was also a large, significant correlation between change on the Dysphoria Scale and pretest PANAS NA scores, $r(59) = .55$, $p < .001$. The correlation between change in Dysphoria Scale scores and pretest PANAS PA scores was not significant, $r(59) = -.11$, $p = .395$.

We used Pearson Product-Moment Correlations and a threshold of .71 to evaluate the relations among the dependent variables at pretest, and to check for redundancy of measures. Consistent with current theory on the structure of affect, the PANAS NA and PANAS PA scales were not significantly correlated, $r(71) = -.22$, $p = .062$. PANAS PA scores were negatively correlated, but not redundant with STAI scores, $r(71) = -.47$, $p < .001$, and were not significantly correlated with scores on the Dysphoria Scale at the same time point, $r(42) = -.11$, $p = .484$. There was a large, positive correlation between PANAS NA scores and STAI scores at pretest, indicating possible redundancy of measures, $r(71) = .76$, $p < .001$. However, based on the

correlation between STAI and PANAS NA change scores, we elected to retain them as separate measures, $r(71) = .70$, $p < .001$. There was a large positive correlation between PANAS NA and Dysphoria Scale scores assessed at the same time point, $r(42) = .55$, $p < .001$. STAI scores were additionally positively correlated with Dysphoria Scale scores assessed at the same time point, $r(42) = .51$, $p < .001$.

The sample size was insufficient to evaluate whether the three conditions differed significantly in terms of categorical demographic and background variables including sex, race/ethnicity, marital status, birthplace, education level, and employment status. However, one-way ANOVAs demonstrated that participants in the different conditions did not differ in terms of age; Dog-Person Scales scores; pretest PANAS PA, PANAS NA, or STAI scores; or Dysphoria Scale scores before or after the stress induction.

Primary Analyses: Effects of the Interactions

To compare affect across conditions, we used a two-way (Condition x Time) repeated measures ANOVA for each of the three outcome measures. To probe significant interactions, we used planned pairwise comparisons with a Bonferroni correction (Bonferroni corrected threshold = .025) to evaluate whether change scores for participants in the experimental condition differed significantly from those of participants in each of the two control conditions.

The two-way ANOVA for PANAS PA scores revealed a significant main effect of Time, $F(1, 70) = 12.96$, $p = .001$, $\eta_p^2 = 0.16$. This was qualified by the predicted Condition x Time interaction, $F(2, 70) = 4.67$, $p = .012$, $\eta_p^2 = 0.12$. See Figure 1 for a graph of this interaction. Participants in the experimental condition ($M = 5.71$, $SD = 6.87$) showed significantly greater increases in PANAS PA scores than participants in the waiting control condition ($M = 0.63$, $SD = 6.48$), $t(46) = 2.64$, $p = .011$, $d = 0.78$, as well as participants in the expectancy control

condition (M = 1.48, SD = 5.09), $t(47) = 2.46$, $p = .018$, $d = 0.72$. As predicted, participants who interacted with their dogs following exposure to the stressor showed greater increases in positive affect than those who waited quietly or who engaged in another activity claimed to alleviate distress.

The two-way ANOVA for PANAS NA scores also revealed a significant main effect of Time, $F(1, 70) = 63.50$, $p < .001$, $\eta_p^2 = 0.48$. However, the Condition x Time interaction for PANAS NA scores was not significant, $F(2, 70) = 1.24$, $p = .297$, $\eta_p^2 = 0.03$. See Figure 2 for a graph of this interaction. Contrary to our prediction, participants who interacted with their dogs did not show significantly greater reductions in negative affect than participants in the control conditions.

The two-way ANOVA for STAI scores revealed a significant main effect of Time, $F(1, 70) = 37.56$, $p < .001$, $\eta_p^2 = 0.35$. This was qualified by the predicted Condition x Time interaction, $F(2, 70) = 4.84$, $p = .011$, $\eta_p^2 = 0.12$. See Figure 3 for a graph of this interaction. Participants in the experimental condition (M = -10.42, SD = 8.22) showed significantly greater reductions in STAI scores than participants in the waiting control condition (M = -3.75, SD = 8.97), $t(46) = -2.68$, $p = .010$, $d = 0.79$, as well as participants in the expectancy control condition (M = -4.00, SD = 8.12), $t(47) = 2.75$, $p = .008$, $d = 0.80$. As predicted, participants who interacted with their dogs following exposure to the stressor showed greater reductions in anxiety than those who waited or engaged in another activity claimed to alleviate distress.

Supplementary Analyses

For details on results exploring the role of participants' experiences with and attitudes towards dogs, and relationships with and characteristics of their particular dogs, see supplementary material.

Behaviors During the Dog Interaction. We were interested in whether specific behaviors during the dog interaction predicted change on the outcome measures. One participant was omitted because we did not get a video recording for their interaction. On average, during the 10-minute interaction, participants engaged in Verbal Positive behavior with their dog for 218.65 s (*SD* = 95.42), Verbal Unknown for 5.83 s (*SD* = 12.81), Verbal Total for 224.48 s (*SD* = 94.13), Play for 123.92 s (*SD* = 126.54), Physical Touch for 281.03 s (*SD* = 142.83), and Interaction Total for 635.26 s (*SD* = 167.20).

To determine if participants' behaviors when interacting with their dog predicted the emotional outcomes of the interaction, we conducted partial correlations between each observed behavior and posttest PANAS scores (PA and NA, separately) and STAI scores, while controlling for pretest PANAS scores (PA and NA, separately) and STAI. Individual behaviors were not significantly correlated, *p*s > .053, *r*s < .43. However, Interaction Total was correlated with PANAS NA, $r(20) = -.45$, $p = .036$, and with STAI, $r(20) = -.57$, $p = .006$, such that more total interaction with one's dog predicted a greater decrease in negative affect. See Table 2.

Discussion

Primary Findings

We found that participants who interacted with their dogs, following exposure to a stressful task, showed greater increases in positive affect and reductions in anxiety than participants who waited for the same amount of time or those who used a stress-reducing coloring book. This finding extends those of prior research on interaction with unfamiliar dogs (e.g., therapy dogs; Beetz et al., 2011; Crossman et al., 2015; Crossman et al., 2018) to interaction with participants' own pet dogs. This study also complements prior research on

interactions with own pet dogs (Handlin et al., 2012; Jenkins, 1986; Kerns et al., 2018; Kertes et al., 2017; Nagasawa et al., 2009; Nagasawa et al., 2015) but now controls for several confounds in these earlier studies, including experimenter presence and an uncontrolled location. The use of an expectancy control is particularly novel and shows that results cannot be attributed merely to engaging in an activity (e.g., coloring) that is purported to reduce distress. Additionally, measuring subjective affect with a non-interpersonal stressor in the lab allows for conclusions to be drawn about more general types of distress, not just social based stressors as prior studies have found.

The current study did not detect stronger effects of the dog interaction on general negative affect (beyond anxiety, specifically) following exposure to the stressor, compared to control conditions. Consistent with a previous study in which interaction with a dog reduced negative affect relative to waiting, but *not* relative to viewing images of the dog (Crossman et al. 2015), this finding raises questions about whether interaction with a dog reduces negative affect more than other distracting activities, or more than the simple passage of time and an individual's own coping abilities (Kazdin, 2003). At the same time, the lack of an effect on negative affect may simply be due to a floor effect at posttest; this is observable in Figure 2. The lower limit may have interfered with the ability to capture differences between groups. The PASAT-C may evoke a high enough degree of anxiety, specifically, that anxiety varies across participants after the 10-minute condition, but it may not evoke other negative emotions (e.g., sadness) enough for the same to happen for general negative affect.

Emotional contagion (Hatfield et al., 1993) may explain the particular impact of dogs on owners' positive emotions. If the dog is excited to see its owner, which is plausible after the brief period of separation in the study, the dog's positive emotion may elicit increased positive

emotion in the owner. Human-to-animal emotional contagion has been documented (Huber et al., 2017; O'Hara & Reeve, 2011; Sümegi et al., 2014), but evidence of dog-to-human emotional contagion is unclear (see Adriaenese et al., 2020, for review). However, humans process dog and human expressions of affect similarly (Schemer et al., 2013), and some studies have shown hormonal synchronicity between dogs and their owners (Handlin et al., 2012; Nagasaki et al., 2015; Odendall & Meintjes, 2003), so this mechanism is deserving of further investigation. If the emotional benefits of dog interactions are relegated to anxiety and positive affect, this is still of substantial importance given their relevance to well-being, physical health, and other important outcomes (Lyubomirsky et al., 2005; Russ et al., 2012).

Supplementary Findings

Because the following analyses were exploratory, they should be interpreted with caution. We found that participants' degree of improvement from the pet dog interaction did not vary based on their previous experiences with dogs or attitudes towards dogs. This result, while exploratory, is consistent with those of previous studies (Crossman et al., 2015; Crossman et al. 2018) that showed no evidence that interaction benefits were limited to people who like dogs or had extensive experience with dogs. Because all participants in this study owned dogs, this finding may not hold among populations who have highly negative views towards dogs, or no experience at all with dogs. The degree of improvement also did not vary based on characteristics of the dogs themselves or of the participants' relationships with their pets – including the duration of the owner-dog relationship, the age of the dog, and the breed group (see supplementary material for details).

We found that time spent doing *specific* behaviors during the interaction (e.g., physical touch) was not associated with mood outcomes. Previous studies conducted in the participants'

and dogs' own homes have contradicted this finding and shown emotional benefits of physical touch (e.g. Kerns et al., 2018; Kertes et al., 2017), which suggests that a familiar environment may be necessary for physical touch and perhaps other specific behaviors to have positive effects. For example, physical touch with one's dog in a lab environment may be different from that which occurs while in the home.

However, total time spent behaviorally engaging with the dog predicted a greater decrease in both negative affect and anxiety. Future studies may evaluate causality of this relationship by manipulating the degree and type of behavioral engagement. It is important, however, to emphasize the supplementary nature of our analyses given the small sample size and potential for confounds. Many studies that have assessed the effect of specific HAI behaviors on mood are also preliminary, with modest sample sizes analyzing specific populations (Beetz et al., 2011; Beetz et al., 2012; Kerns et al., 2018; Nagasawa et al., 2009; Nagasawa et al., 2015). If specific behaviors have the ability to amplify the effects of HAI, these behaviors should be incorporated into current HAI approaches and future research.

Pet Ownership and Distress Debate

Our finding that interacting with one's pet dog can lead to greater increases in positive affect and reductions in anxiety, relative to control activities, is important in light of the enormous prevalence of pet ownership. Our results provide a starting point to understanding the cumulative effects that day-to-day interactions between people and their pets have on owners' affect, which has preliminary implications for the overall effects of pet ownership. Today, 70% of American homes have pets, and around 50% have dogs (APPA, 2021). Therefore, the benefits of interactions with pet dogs illustrated here may be able to be leveraged to reduce psychological distress and improve affect for a large portion of the population. More research is needed

however to determine precisely how this can be leveraged and for who it would provide the most benefit.

The present findings additionally relate to a long-standing debate about the benefits of pet ownership – specifically, whether pet ownership conveys benefits for psychological distress, and mental health more broadly. This debate is at the heart of discussions about emotional support animals. These animals are currently not protected by the Americans with Disabilities Act, or as of recently the Air Carrier Access Act (which previously allowed people to bring them on flights; U.S. Department of Transportation, 2020), but they are covered under the Fair Housing Act (Fair Housing Act of 1968). The question of whether or not to support such protections rests on the actual emotional benefit that these animals may provide. Emotional support animals have become increasingly prevalent, and thus far, delineating their roles has proceeded without conclusive evidence that they yield the intended effects on distress (Younggren et al., 2016). Recommendations to obtain a pet or emotional support animal for stress reduction are based on the assumptions that pets provide a real distress-reducing contribution. Without well-controlled studies with random assignment and an expectancy control, we cannot know if that is actually true. If a pet provided the same amount of stress relief as a coloring book labeled for stress reduction (our expectancy control), then perhaps mental health professionals should not promote pets for mood enhancement nor make policies protecting emotional support animals. This study provides evidence that pet dogs improve affect in an experimental setting and more than an expectancy control - thereby lending support for the psychological benefits of pet dogs, and relatedly, emotional support animals.

While the current findings can contribute to our understanding of the effects of pet dogs and the related category of emotional support animals, the present study found only that an

abbreviated interaction with one's pet dog can improve affect. It did *not* evaluate the global effects of pet ownership. Future research on such global effects is needed in order to inform policies around pets and emotional support animals.

Limitations

This study has several limitations. First, our study has the potential for selection effects, such that participants without an affinity for dogs would not volunteer to participate in a study that involves interaction with a dog. This selection effect issue is exacerbated because all participants already owned dogs. Research has shown that some traits associated with dog ownership are also associated with better mental and physical health (Saunders et al., 2017), and because our study's sample involved dog owners, those traits may be present. As a result, the observed effects of interactions with pets on affect may not apply equally to people who do not own dogs, actively dislike dogs, or have had especially negative experiences or no experience with dogs. At the same time, people who participate in animal-assisted interventions or keep pet dogs in their homes are also likely to have positive attitudes towards and experiences with dogs, so the present study may capture a common experience. Relatedly, the predominantly white and female sample limits external validity. Our sample was demographically not very representative of the general population, and caution should thus be taken before applying these interpretations to people with identities that were not well represented in our sample, as these results may not be found in different demographic populations. Results should also be interpreted with caution due to the relatively small sample size.

Second, our study measured affect only by self-report, which raises concerns about demand characteristics. Overall, this issue highlights the need for future investigations to evaluate the effects of pet dog interactions on physiological and behavioral indicators of distress

and affect. At the same time, self-report measures are well suited to evaluating the subjective experience of psychological distress. Indeed, the surveys that identify distress as a national problem rely precisely on such reports (e.g., Substance Abuse and Mental Health Services Administration [SAMHSA], 2014). We aimed to reduce demand characteristics in our recruitment advertisements. The consent process mentioned potential benefits of pets; this may have led participants to respond more favorably on their self-report measures in an attempt to help the researchers find benefits of pets. Future studies may wish to reduce demand characteristics further, for example through a sham reason for the study.

Third, attitudes towards and beliefs about the expectancy control were not assessed out of concern that this would increase the obtrusiveness and potentially reduce the effect itself. The purpose of this control was to assess the effects of engaging in something purported to reduce distress. Using an intervention that has been pretested to confirm that participants have the assumed expectation of improvement, as well as measuring participants' degree of engagement with the control activity, would be an important next step.

Finally, our study evaluated only immediate changes in anxiety and affect and did not include follow-ups to examine whether the interactions had any lasting impact on affect. HAI interventions commonly aim to bring momentary respite, highlighting the importance of these immediate changes (Bell, 2013). Nevertheless, it is important to note that conclusions cannot be drawn from this study about whether dogs would improve people's mental health overall; our findings (in combination with other studies) merely show that interactions with pet dogs may be beneficial to psychological health – at least in the short term. To draw definitive conclusions about HAI more broadly, these interactions need to be examined in more contexts and in longitudinal studies.

Future Research

In addition to studies that address the above-noted limitations, our findings suggest multiple important avenues for future research. First, research is needed to establish *how* (i.e., through which processes) interactions with pet dogs improve affect. Put another way, what is the active ingredient in these interactions that boosts mood? Historically, researchers have successfully used many interventions without understanding the mechanisms by which they work (e.g. penicillin; Soares et al., 2012). Nonetheless, understanding mechanisms can be helpful for maximizing the intervention's impact, convincing skeptics of its utility, and informing future research and policies. Establishing mechanisms requires a number of steps (see Kazdin, 2007 for a review). There are several possible mechanisms through which pet dog interactions may improve mood, such as nonjudgmental social support (Bowen et al., 2021; Polheber & Matchock, 2014), emotional contagion (O'Hara & Reeve, 2011), enjoyable experiences (Aydin et al., 2012; Marr et al., 2000), and direct stress relief, supported by the data in this study.

Second, more research is needed to establish the *circumstances* under which interactions with animals are most effective at improving affect, including what types of interactions are most effective. The current study looked at a brief 10-minute interaction, which only provides a glimpse into what occurs across the changing circumstances of pet ownership. Studies looking beyond brief interactions have shown a wide range of circumstances tied to the owner's mood: exercise and shared activities with the dog are associated with positive mood and wellbeing (Bennet et al., 2015; Knight & Edwards, 2008), while unwanted behaviors from the dog and dog's aging are associated with negative mood (Barcelos et al., 2020). Some moderators that may influence the benefits of interactions with pet dogs include their frequency and duration and the

presence of specific behaviors such as play (Crossman, 2017). Identified moderator variables could then be used to guide interactions with pet dogs in order to leverage maximal benefit.

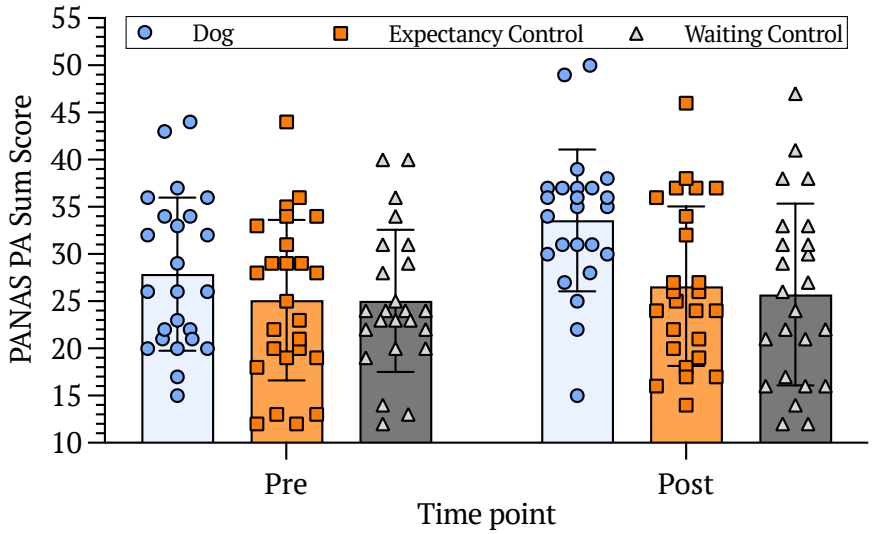
Third, more research is needed to identify *who* is most likely to benefit from interacting with pet dogs (or other types of HAI), as it may indeed be more effective for some people than for others. There is evidence that several owner-dependent moderators may predict differential response to a pet dog interaction. Sex assigned at birth predicts differential hormonal responses to interacting with one's pet dog (Amiot et al., 2015; Miller et al., 2009), higher compatibility between owner and dog is associated with better mental health (George et al., 1998), and attachment to one's pet is associated with greater psychological wellbeing (e.g., Garrity et al., 1989; Krause-Parello, 2012; Namekata & Yamamoto, 2021; Zilcha-Mano et al., 2012). Future research should aim to prioritize diversity in sampling to help determine who precisely stands to benefit from interactions with pet dogs.

Finally, more research is needed on the effects that such interactions have on the pets themselves. To date, the vast majority of research on pet ownership, including the current study, has focused on the human perspective. However, HAI is inherently interactive. Increasing attention to the influence of interactions on the animals is important to ensure animal wellbeing for ethical reasons, and perhaps to enhance HAI, as researchers and practitioners have repeatedly suggested that distressed animals do not effectively reduce human distress. Utilizing video data to code dog behaviors (such as affiliative behaviors or stress responses), as well as other biomarkers of stress could aid in understanding how dogs respond in these settings. Additionally, future studies may wish to leverage video data to code for quality or intensity of human-dog behaviors in addition to their duration or frequency.

Overall, our study demonstrates that there are some emotional benefits to interacting with one's own pet dog. Following stressful events, pet dogs may help reduce anxiety and improve positive affect. These findings may extend to other types of HAI. More research is still needed to figure out how to best leverage these effects to help as many people as possible.

Figure 1

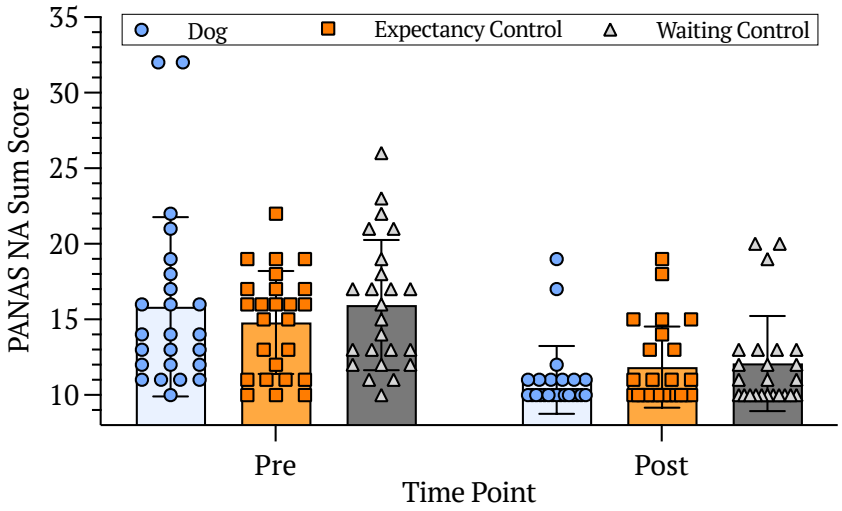
PANAS PA at Pretest and Posttest by Condition



Note. PANAS PA sum scores at pretest and posttest by study condition indicate greater increase in positive affect in the dog condition. Columns capture group averages and points capture individual subject scores. Error bars represent standard error.

Figure 2

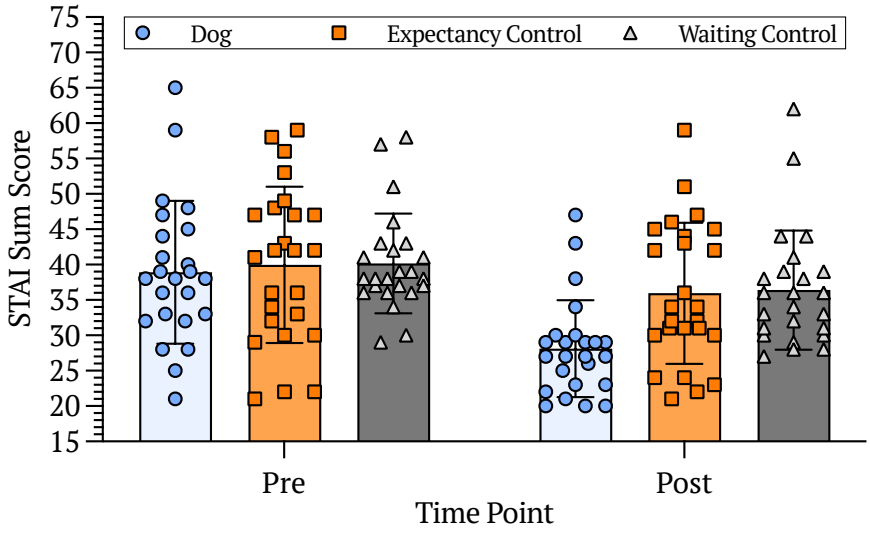
PANAS NA at Pretest and Posttest by Condition



Note. PANAS NA sum scores at pretest and posttest by study condition indicate no significant difference between conditions. Columns capture group averages and points capture individual subject scores. Error bars represent standard error.

Figure 3

STAI at Pretest and Posttest by Condition



Note. STAI scores at pretest and posttest by study condition indicate greater decrease in STAI in the dog condition. Columns capture group averages and points capture individual subject scores. Error bars represent standard error.

Table 1

Canine Characteristics

Characteristic	Full Sample N = 73	Dog n = 24	Expectancy Control n = 25	Waiting Control n = 24
Age				
Range	1-16	1-10	1-16	1-12
M (SD)	5.18 (3.46)	3.92 (2.57)	6.00 (3.84)	5.58 (3.60)
Participant Knows Dog's Exact Age (%)	52 (71.20)	19 (79.20)	17 (68.00)	16 (66.70)
Years Dog has Been with Participant: M (SD)	4.83 (4.97)	4.77 (7.09)	5.05 (3.86)	4.65 (3.37)
Dog's Primary Caregiver				
Participant	67 (91.80)	21 (87.50)	23 (92.00)	23 (95.80)
Participant's Partner	1 (1.40)	0 (0.00)	1 (4.00)	0 (0.00)
Both Participant and Participant's Partner	5 (6.80)	3 (12.50)	1 (4.00)	1 (4.20)
Breed Class (%)				
Sporting	13 (17.80)	2 (8.30)	4 (16.00)	7 (29.20)
Herding	9 (12.30)	5 (20.80)	3 (12.00)	1 (4.20)
Hound	7 (9.60)	2 (8.30)	3 (12.00)	2 (8.30)
Non-Sporting	4 (5.50)	1 (4.20)	3 (12.00)	0 (0.00)
Terrier	5 (6.80)	1 (4.20)	3 (12.00)	1 (4.20)
Toy	6 (8.20)	3 (12.50)	2 (8.00)	1 (4.20)
Working	5 (6.80)	2 (8.30)	1 (4.00)	2 (8.30)
Mixed-Breed	24 (32.90)	8 (33.30)	6 (24.00)	10 (41.70)

Table 2

Behavior and Mood Correlations

Behavior		PANAS PA	PANAS NA	STAI
Verbal Positive	*r*	.23	-.38	-.33
	p	.295	.083	.131
Verbal Unknown	*r*	-.33	.10	.10
	p	.138	.667	.669
Verbal Total	*r*	.19	-.37	-.32
	p	.395	.093	.146
Play	*r*	.41	-.42	-.23
	p	.061	.054	.308
Physical Touch	*r*	-.36	.05	-.30
	p	.096	.837	.170
Interaction Total	*r*	.10	**-.45***	**-.57***
	p	.660	**.036**	**.006**

** p<.05*

Note. Partial correlations between behaviors and posttest PANAS PA, PANAS NA and STAI scores, while controlling for pretest PANAS PA, PANAS NA and STAI scores respectively.

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