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Comparing the Effect of Human-Dog Interactions and Progressive Muscle Relaxation on Self-Report and Physiological Measures of Stress

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This study compares the effects of human-dog interactions and progressive muscle relaxation on stress in college students during the week of their final exams using self-report and physiological measures of stress. Students often cope with stress during the final exams period using various strategies such as spending time with a therapy dog. While students often report that their stress is reduced after visiting with a therapy dog, some studies find physiological evidence for a reduction in stress while others do not. During the first day of finals week, students (N = 53) in an introductory psychology or a research methods course were randomly assigned to spend 15 minutes with a therapy dog or to spend 15 minutes doing a progressive muscle relaxation task. Heart rate variability, a physiological measure of stress, and two self-report measures of stress (the PSS-10 which is a 10 item questionnaire on the participants' stress level and the SVAS on which the participants mark a visual scale to indicate their current stress level) were measured both before and after the treatments. Compared to the pre-treatment measures, stress was lower after the treatment. Spending time with a therapy dog can reduce stress associated with final exams. However, the intercorrelations between heart rate variability and the self-report measures were not statistically significant suggesting that the measures might correspond to different dimensions of the stress response, as explained in some theories of stress response and emotion. Future research regarding the effects of therapy dogs on stress should include at least one physiological measure of stress and ideally multiple measures. This inclusion might help clarify the underlying psychological and physiological mechanisms leading to stress reduction.

Keywords: therapy dogs, stress reduction, physiological measurement, self-report measurements

Author Note

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There are few occurrences during the academic semester that generate as much stress and anxiety among students as exams (Gilbert et al., 1996). In response to stress from final exams, some academic institutions offer stress mitigation strategies such as allowing students to visit with therapy dogs (Trammell, 2017). These students' intuition that interacting with dogs may reduce stress is supported by research that finds such interactions may activate the oxytocin system (Beetz, Unväs-Moberg et al., 2012; Handlin et al., 2012). The impact of therapy dogs on students' stress has been the focus of multiple studies. Some studies fail to find physiological evidence of a reduction in stress after visiting with a therapy dog (Barker et al., 2016; Crump & Derting, 2015; Gee et al., 2014; Grossberg et al. 1988; Lass-Hennemann et al., 2014; Schöberl et al., 2012) while others do find physiological evidence of stress reduction (Barker et al., 2005; Beetz, Julius et al., 2012; Tsai et al. 2010).

Barker et al. (2016) is one study that failed to find a difference in stress reduction when measured physiologically, but which did find a difference in stress reduction using self-report scales. Self-reported stress was measured with the Perceived Stress Scale (PSS) and the Stress Visual Analog Scale (SVAS) while physiological markers of stress included salivary nerve growth factor and alpha amylase. Barker et al. randomly assigned students to either an attention-control condition (no interaction with therapy dogs) or a therapy dog intervention. Afterwards students provided a second set of saliva samples and responded to the PSS and SVAS. Barker et al. found a reduction in self-reported stress, but no reduction in the physiological markers of stress for students who had interacted with the therapy dogs.

At first glance, the studies that fail to find a reduction in stress via physiological measures after interacting with dogs seem to indicate that this is a robust finding, but this may be a premature conclusion as explained later. This finding appears across multiple studies with different physiological measures of stress -- salivary alpha amylase (Barker et al. 2016), heart rate and blood pressure (Crump & Derting, 2015; Grossberg et al., 1988; Lass-Hennemann et al., 2016), and heart rate variability (Gee et al., 2014). The null finding appears with different stressors, both acute (stress induced by the study: Gee et al., 2014; Grossberg et al., 1988; Lass-Hennemann et al, 2014) and chronic (stress induced by exams in the following week: Barker et al., 2016; Crump & Derting, 2015). It appears with different populations -- students (Barker et al., 2016; Crump & Derting, 2015; Gee et al. 2014), and for some measures, healthcare workers (Barker et al. 2005). It also appears with therapy dogs and with pet dogs (Grossberg et al. 1988). Therapy dogs are trained to remain calm in most situations and are accompanied by their handlers who may be sympathetic, good listeners, and/or calming. These traits may or may not be present in pet dogs and their guardians, and it is possible that these traits contribute to the reduction in stress above and beyond whatever reduction is stress is caused by the therapy dog per se.

There are several possible reasons, ranging from the practical to theoretical, why a study might find a pre- to post-test difference in stress when measured with a self-report and not when measured with a physiological marker. A researcher might have selected an insensitive physiological marker of stress or there might have been some technical difficulty with the measurement per se. This may have been part of the reason that Barker et al. (2016) failed to find a difference with one of their physiological markers – most levels of salivary nerve growth factor were undetectable in their study.

Similarly, the researcher may not have used a sufficiently stressful event. For example, Grossberg et al. (1988) used the Thematic Apperception Test (TAT) (which involves looking at an ambiguous picture and creating a story about it) as one of their stressors. The TAT is not usually considered to be a stressful test. The duration of a laboratory stressor might have been too short (e.g. Lass-Hennemann et al.'s, 2014, stressful event was an 11 minute film clip depicting physical and sexual violence). Weaker manipulations might produce weaker results – results small enough that the researcher's statistical tests might not be powerful enough to detect.

Another possible explanation is that self-reports may be more prone to subject-expectancy effects than are physiological measures. When participating in a study with therapy dogs in which there are pre- and post-test measures of stress, participants may believe that they have figured out the purpose of the study and respond with lower levels of self-reported stress in the post-test, whether the intervention actually reduced stress or not.

A possible theoretical explanation comes from Lang's (1979) tripartite model of emotional responses. This model claims that there are three components to an emotional response – physiological arousal, cognitive distress, and behavioral avoidance. During strong emotions, such as an intense fear associated with a phobia, these components tend to be concordant – tending to vary together. However, with less strong emotions, such as many students might experience during finals week, these components may be discordant – tending to vary independently (Ollendick et al., 2011). Thus, if the stress is not sufficiently severe, it is not surprising that some researchers find stress reduction with one measure, but not with all measures.

Other studies suggest that therapy dogs can reduce physiological markers of stress. This too seems to be a robust finding which occurs with different measures – cortisol (Barker et al. 2005; Beetz, Julius et al., 2012) and systolic blood pressure (Tsai et al., 2010). This finding occurs in different populations – healthcare workers (at least with some physiological markers, Barker et al., 2005), children with insecure attachment (Beetz, Julius et al., 2012), and hospitalized children (Tsai et al. 2010). For example, Barker et al. (2005) measured serum cortisol, epinephrine, norepinephrine, salivary cortisol, salivary IgA, and lymphocytes in blood both before and after spending 5 or 20 minutes with a therapy dog or 20 minutes of quiet rest. Results indicate that both serum and salivary cortisol were reduced, especially when measured 45 minutes after the interaction with the therapy dog.

One physiological measure of stress is heart rate variability – the variance of the time between heart beats, (technically the variance of the RR intervals). It is thought that heart rate variability is controlled by the interactions of the sympathetic and parasympathetic branches of the autonomic nervous system. The sympathetic nervous system activates the "flight vs. fight" response while the complementary parasympathetic nervous system activates the "rest and digest" responses. During times of stress, the sympathetic nervous system becomes more active and this leads to a decrease in heart rate variability – the period of time between heart beats becomes more regular. In a meta-analysis, Kim et al. (2018) reviewed 37 studies that examined whether heart rate variability is a valid physiological measure of stress or not. The meta-analysis concludes that heart rate variability is a valid measure of stress.

Traditionally, heart rate variability has been measured with an electrocardiogram (ECG or EKG) which involves attaching numerous (often 12) electrodes to a person's limbs and chest. The ECG equipment can be expensive, the electrodes are often discarded after a single use, and placing electrodes on a participant's chest can be intrusive, and perhaps stressful, to some participants. Fortunately, alternatives now exist that are less expensive, less wasteful, and less stressful. Photoplethysmography (PPG), a non-invasive method used in this study to collect heart rate variability, shines a light through a participant's fingertip to a photosensor. The change in volume of blood in the fingertip that naturally occurs during the beating of the heart can be detected and from this, the heart rate variability can be determined. In a review of PPG and its applications in clinical physiological measurement, Allen (2007, p. R27) states that heart rate variability can be "easily extracted from PPG pulse signals."

The present study examines self-report and physiological measures of stress taken from college students on the first day of final exams week both before and after interacting with a therapy dog or participating in a progressive muscle relaxation control condition. It is predicted that stress, measured both with self-reports and physiological markers, will be reduced (heart rate variability will increase) after interacting with therapy dogs or participating in a progressive muscle relaxation control condition.

Method

Sample

The sample consisted of 53 college students (36 female and 17 male) with a mean age of 19.2 years (SD = 1.0 years). Data from one additional participant was discarded due to the loss of the pre-treatment heart rate variability reading. Twenty-six participants (18 females and 8 males) were randomly assigned to the therapy dog with handler condition and the remaining 27 participants (18 females and 9 males) were assigned to the progressive muscle relaxation condition. Human-animal interactions and progressive muscle relaxation are not covered in detail in the courses from which the participants volunteered. The participants were students in an introductory psychology class or a research methods class at a private university in the United States. They participated in partial fulfillment of a research requirement for the introductory psychology class or for extra credit in the research methods class. Students who disliked dogs, were nervous about dogs, were unsure of their ability to interact with dogs, were allergic to dogs, or were very anxious were not allowed to participate. The study was approved by the Institutional Animal Care and Use Committee and a subcommittee of the Institutional Review Board.

The six therapy dogs and handlers were recruited from the Miami Valley Pet Therapy Association (MVPTA). Each dog had passed a seven-week course during which the dogs were trained and verified by MVPTA as appropriate as a therapy animal.

Instruments

Two self-report measures of stress were used – the ten item Perceived Stress Scale (PSS-10) modified to ask about stress during the last week instead of the last month and the Stress Visual Analog Scale (SVAS). The PSS-10 consists of 10 questions (e.g. In the last week, how often have you felt nervous and stressed?) with five point Likert scale responses (0 = never, 4 = very often). The responses to the 10 questions are summed after reverse scaling appropriate responses. Cohen et al. (1983) report that Cronbach's α for the PSS-10 is .84 and that the PSS-10 has mild to moderate correlations with negative life events. In the current study, the pre- and post-test PSS-10 Cronbach's α are .76 and .79.

The SVAS asks participants to indicate their level of stress that they are currently feeling by placing a mark on a 15 cm long line with anchors of "none" on the left end and "most severe imaginable" on the right end of the line. The distance in millimeters of the mark from the left end of the scale is recorded. Barker et al. (2016) report good test-retest reliability (.79) for the SVAS and good concurrent validity (.68) between patient ratings and nurse ratings of stress responses in patients.

The physiological measure of stress was heart rate variability. A CorSense PPG sensor from Elite HRV was used. According to the manufacturer's web site, accuracy is comparable to 5-lead ECG/EKG (Elite HRV, 2019). Plews et al. (2017) compared PPG as measured by a smart phone, a heart rate sensor (Polar H7) and ECG and found almost perfect correlations (R = 1.00 with 90% confidence interval of [.99 to 1.00]) between the PPG and ECG and between the heart rate sensor and ECG. The CorSense PPG sensor has been informally compared to the Polar H7 heart rate sensory used in the previous study by a company (not affiliated with Elite HRV) that writes smart phone software for measuring HRV. The review concludes that the Elite HRV sensor is "very accurate in detecting RR intervals and can therefore be used reliably for HRV analysis." (Altini, 2018).

Participants inserted the index finger of their right hand into the sensor and sat still for two minutes while heart rate variability was measured. The CorSense software captures the equivalent of the R-R intervals, calculates the root mean square of successive differences (RMSSD) of these intervals, takes the natural logarithm of the RMSSD, and normalizes the result to a value between 0 and 100.

Design

Participants were tested in groups of one to six participants depending on how many people signed-up and attended a given session. After getting consent to participate, participants reported their age, sex, the date and time of their next exam, and what, if any, sources of stress they were currently experiencing. Next, they answered the SVAS and PSS-10. Heart rate variability was then measured for two minutes. A randomly selected half of the group was then escorted to a nearby room where a therapy dog and handler were waiting.

Participants in the therapy dog with handler condition were told to initially hold out their hand for the dog to sniff and then they could pet, talk to, or play (but not vigorously) with the dog. All but one of the participants petted the dog and/or talked to the dog. No one played with the dog. Participants spent 15 minutes interacting with the dog and handler. The handlers of the therapy dogs were instructed to behave as they would in any other therapy dog session. All handlers talked to the participants in a friendly way – asking about their finals, if they had pets at home, and answered questions about their therapy dog. Heart rate variability, SVAS, and PSS-10 were then re-administered while the participants remained in the same room as the therapy dog and handler.

The other participants stayed in the original room and did a 15-minute-long progressive muscle relaxation task. Instructions were pre-recorded and told participants to progressively contract, hold, and relax various muscle groups while they sat. Progressive muscle relaxation was first introduced in 1934 and is a commonly used procedure for reducing stress-related anxiety (McCallie et al. 2006). Dolbier and Rush (2012) found reductions in self-reports and physiologically measured stress with 20 minute sessions of progressive muscle relaxation. Heart rate variability, SVAS and PSS-10 were then re-administered.

All participants were debriefed and had their questions answered.

Results

Table 1 shows the frequencies of stressors that the participants reported experiencing. Many participants reported more than one stressor. All but three participants reported that they were experiencing stress related to exams or studying for exams.

To help reduce the likelihood of making Type-I errors, univariate tests were only performed if the corresponding multivariate test was statistically significant. Likewise, follow-up tests of simple main effects were only performed if the univariate interaction was statistically significant.

To test if the participants in the therapy dog with handler and progressive muscle relaxation groups were equally stressed initially, a MANOVA with treatment condition as the independent variable and the three stress measures as the dependent variables was performed on the pre-treatment data. The MANOVA failed to find a significant effect of treatment, $F(3, 49) = 1.933$, $p = .137$, $\alpha = .05$, $\eta_p^2 = .106$.

To test if the treatments reduced stress, a 2 (treatment: therapy dog with handler vs. progressive muscle relaxation) X 2 (time of measurement: pre- vs. post-treatment) MANOVA was performed with the three stress measures as the dependent variables. The MANOVA revealed effects of treatment, $F(3, 49) = 3.107$, $p = .035$, $\eta_p^2 = .160$, time of measurement, $F(3, 49) = 33.769$, $p < .001$, $\eta_p^2 = .674$, and their interaction, $F(3, 49) = 6.847$, $p = .001$, $\eta_p^2 = .295$.

Shapiro-Wilk tests were used to test ANOVA's assumption of normality. All Shapiro-Wilk tests with the exception of the pre-test SVAS had *p* values that were $\geq .077$. An inspection of the Q-Q plot for the pre-test SVAS revealed no systematic departure from normality. ANOVA is robust to violations of the assumption of normality when sample sizes are greater than approximately 20.

Thus, this assumption is likely sufficiently satisfied. Bartlett's tests for homogeneity of variance were performed for each dependent variable. All *p* values were ≥ .233, satisfying this assumption.

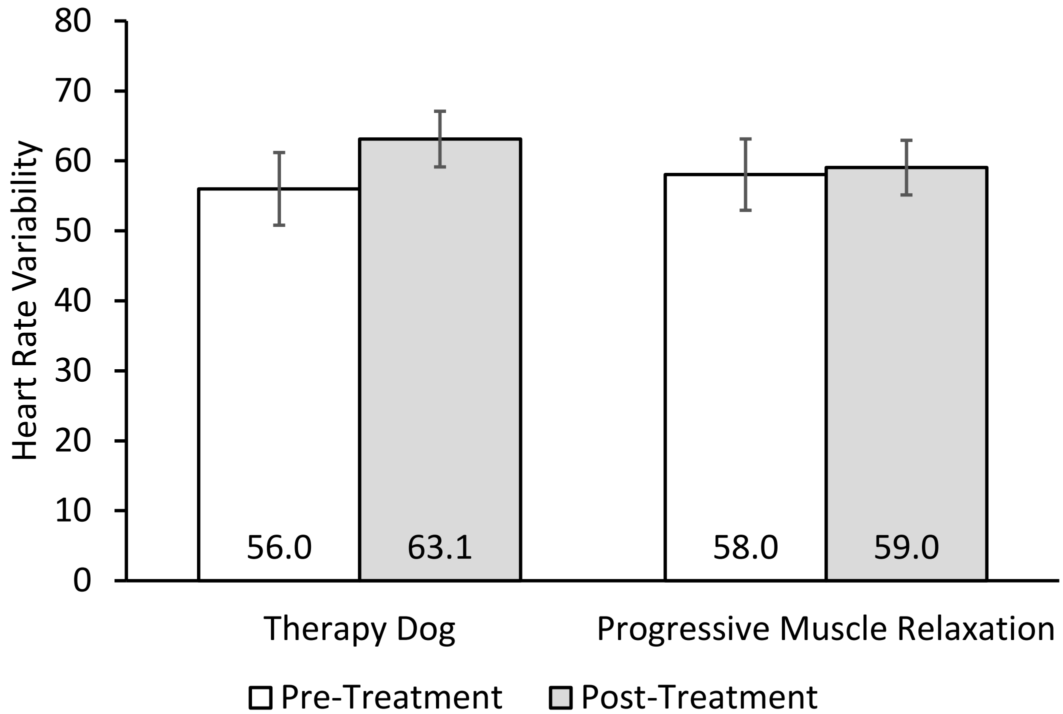
Table 1
Participant's Self-Reported Stressors and Their Frequencies

Stressor	*N*
Finals / studying for finals	50
Moving out / packing	11
Getting work done	5
Jobs	3
Family issues	2
Grades	2
Papers	2
Presentations	2
Friends	1
Future goals	1
Going on a study abroad	1
Graduation	1
Heat	1
Living arrangements	1
Nothing	1
Relationship problems	1
School related topics	1
Switching majors	1
This study	1

Follow-up 2 (treatment: therapy dog with handler vs. progressive muscle relaxation) X 2 (time of measurement: pre- vs. post-treatment) ANOVAs were performed for each dependent variable. Figure 1 shows the means and 95% confidence intervals for the heart rate variability data. The ANOVA for heart rate variability revealed a reliable difference between the pre-treatment (*M* = 57.0, SE = 1.8) and post-treatment (*M* = 61.1, *SE* = 1.4) stress measurements, $F(1, 51) = 5.145$, $MS_{error} = 84.771$, $p = .028$, $\eta_p^2 = .092$. The ANOVA failed to reveal a reliable difference between the therapy dog with handler (*M* = 59.6, *SE* = 1.9) and progressive muscle relaxation (*M* = 58.5, *SE* = 1.9) conditions, $F(1, 51) = 0.144$, $MS_{error} = 191.397$, $p = .706$, $\eta_p^2 = .003$. The ANOVA also failed to reveal a reliable interaction of treatment condition and time of measurement, $F(1, 51) = 2.922$, $MS_{error} = 84.771$, $p = .093$, $\eta_p^2 = .054$.

Figure 1

Pre- and Post-Treatment Heart Rate Variabilities for Visiting With Therapy Dogs and Handlers and Progressive Muscle Relaxation



Note. The error bars represent the 95% confidence intervals. Higher values imply *less* stress.

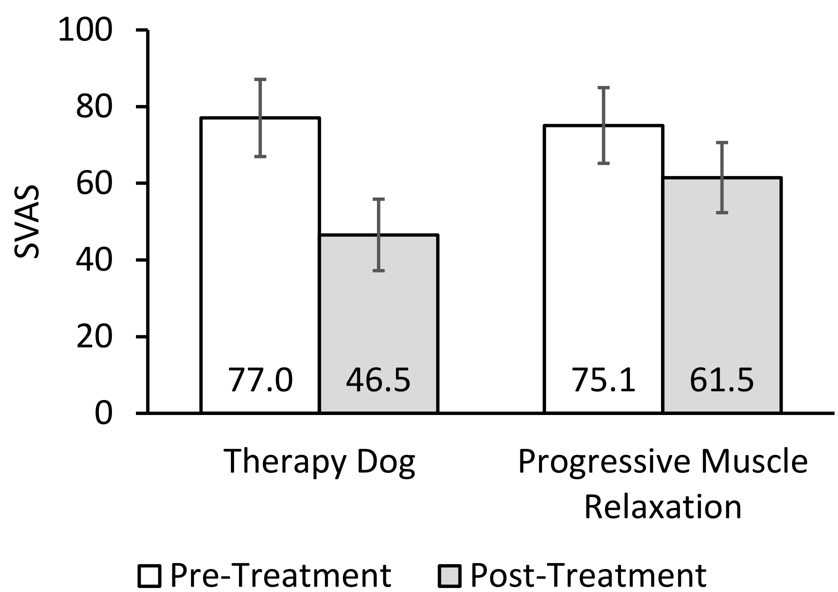
Consistent with the philosophy of the *new statistics* (Cumming, 2012), the effect size of visiting with the therapy dog and handler was calculated with a repeated measures *t*-test and revealed a large effect for the pre- ($M = 56.0$, $SE = 2.6$) vs. post-treatment ($M = 63.1$, $SE = 2.0$) heart rate variability data, $t(25) = -4.052$, $p < .001$, $r^2 = .396$. A repeated measures *t*-test failed to reveal even a small effect for the pre- ($M = 58.0$, $SE = 2.5$) vs. post-treatment ($M = 59.0$, $SE = 1.9$) heart rate variability for participants in the PMR condition, $t(26) = -0.325$, $p = .748$, $r^2 = .004$.

Figure 2 shows the means and 95% confidence intervals for the SVAS data. The ANOVA for SVAS revealed a reliable difference between the pre-treatment ($M = 76.1$ mm, $SE = 3.5$) and post-treatment ($M = 54.0$ mm, $SE = 3.3$) stress measurements, $F(1, 51) = 94.967$, $MS_{error} = 135.579$, $p < .001$, $\eta_p^2 = .651$. The ANOVA failed to reveal a reliable difference between the therapy dog with handler ($M = 61.8$ mm, $SE = 4.6$) and progressive muscle relaxation ($M = 68.3$ mm, $SE =$

4.5) conditions, $F(1, 51) = 1.034$, $MS_{error} = 1078.618$, $p = .314$, $\eta_p^2 = .020$. The ANOVA revealed a reliable interaction of treatment condition and pre- to post-test measurements, $F(1, 51) = 13.963$, $MS_{error} = 135.579$, $p < .001$, $\eta_p^2 = .215$. Repeated measures *t*-tests were used as follow-up analyses of simple main effects of time of measurement for the therapy dogs with handler ($t(25) = 9.622$, $p < .001$, $r^2 = .787$) and for progressive muscle relaxation ($t(26) = 4.216$, $p < .001$, $r^2 = .406$). For SVAS, interacting with therapy dogs and handler reduced perceived stress more than doing a progressive muscle relaxation task did as indicated by the differences in the effect sizes.

Figure 2

Pre- and Post-Treatment Stress Visual Analog Scale (SVAS) Ratings for Visiting With Therapy Dogs and Handlers and Progressive Muscle Relaxation

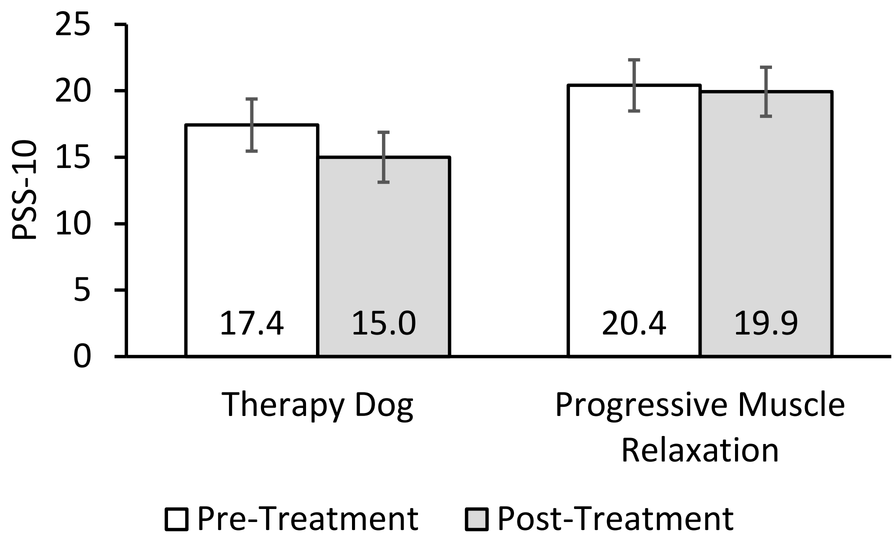


Note. The error bars represent the 95% confidence intervals. Higher values imply more stress.

Figure 3 shows the means and 95% confidence intervals for the PSS-10 data. The ANOVA for PSS-10 revealed a reliable difference between the pre-treatment ($M = 18.9$, SE= 0.7) and post-treatment ($M = 17.5$, SE = 0.7) stress measurements, $F(1, 51) = 15.860$, $MS_{error} = 3.513$, $p < .001$, $\eta_p^2 = .237$. The ANOVA revealed a reliable difference between the therapy dog with handler ($M = 16.2$, SE = 0.9) and progressive muscle relaxation ($M = 21.2$, SE = 0.9) conditions, $F(1, 51) = 9.403$, $MS_{error} = 44.114$, $p = .003$, $\eta_p^2 = .156$. The ANOVA revealed a reliable interaction of treatment condition and time of measurement, $F(1, 51) = 7.137$, $MS_{error} = 3.513$, $p = .010$, $\eta_p^2 = .123$. Repeated measures *t*-tests were used as follow-up analyses of simple main effects of time of measurement for the therapy dogs with handler ($t(25) = 4.848$, $p < .001$, $r^2 = .485$) and for progressive muscle relaxation ($t(26) = 0.903$, $p = .375$, $r^2 = .030$). For PSS-10, interacting with therapy dogs and handler decreased perceived stress while doing a progressive muscle relaxation task did not reliably reduce perceived stress.

Figure 3

Pre- and Post-Treatment Perceived Stress Scale (PSS-10) Ratings for Visiting With Therapy Dogs and Handlers and Progressive Muscle Relaxation



Note. The error bars represent the 95% confidence intervals. Higher values imply more stress.

If heart rate variability, SVAS, and PSS-10 measure are at least partially overlapping dimensions of stress, one would expect the three variables to be intercorrelated if the stress level was high according to Lang's (1979) theory. Correlations among the three pre-test measures and the three post-test measures are shown in Table 2. None of the correlations are statistically reliable. Variability in heart rate variability explains less than 1% of the variability of the PSS-10 and SVAS. Variability in the SVAS score explains less than 7% of the variability in the PSS-10 score.

Table 2
Intercorrelations Among the Three Measures of Stress

Pre-Test

	PSS-10	SVAS
Heart rate variability	$r = -.088$ $p = .529$ $r^2 = .008$	$r = .030$ $p = .830$ $r^2 = .001$
SVAS	$r = .181$ $p = .196$ $r^2 = .033$	

Post-Test

	PSS-10	SVAS
Heart rate variability	$r = -.092$ $p = .516$ $r^2 = .008$	$r = .002$ $p = .988$ $r^2 < .001$
SVAS	$r = .250$ $p = .074$ $r^2 = .063$	

Discussion

The results suggest that visiting with therapy dogs and their handlers for 15 minutes reduces stress in college students during final exams week when measured with heart rate variability using a commercially available and relatively inexpensive sensor. Furthermore, interacting with the therapy dog and their handlers yields a relatively large effect size from pre- to post-test, explaining almost 40% of the variability in the heart rate variability data. The PSS-10 and SVAS also had large effect sizes pre- to post-test for interacting with a therapy dog and handler. Making therapy dogs and their handlers available to students during final exams week may be a valuable service that colleges and universities can provide to their students.

Students in the progressive muscle relaxation group did not show an increase in heart rate variability with the effect size explaining less than 1% of the variability in the data. The PMR group did have large effect sizes pre- to post-test when measured with the PSS-10 and SVAS. PMR may be an inexpensive and easy way for students to reduce stress as measured with the PSS-10 and SVAS during final exams week. An empirical question is whether students would be at least as likely to engage in PMR as they are in a therapy dog session. Students who are missing their own pets may, or may not, be more willing to attend a therapy dog session than to engage in PMR. If students are not sufficiently interested in PMR as a way to reduce stress, then it would not be a viable option no matter how beneficial and cost effective it is. The relative interest in participating in a PMR session (or other stress-management sessions) versus a therapy dog session during final exam week is an interesting empirical question for future research.

The studies which found reductions in physiological evidence of stress after visiting with a therapy dog and handler (Barker et al., 2005, Beetz, Julius et al., 2012, Tsai et al., 2010) used serum and/or salivary cortisol and/or systolic blood pressure as their measures of stress. Barker et al.'s and Beetz, Julius et al.'s results suggest that cortisol levels might lag changes in stress. Barker et al. found the largest change in cortisol when it was measured 45 minutes after the interaction, and Beetz, Julius et al. found a reliable difference in cortisol levels only between the first of two pre-treatment and the last of two post-treatment measurements. While such delays might be acceptable in a laboratory setting, they are probably less practical in field studies where the participants might be less willing to wait up to 45 minutes after interacting with a therapy dog or undergoing PMR. If other researchers can replicate the finding that heart rate variability is a reliable and valid measure of physiological stress reactivity before and after interacting with therapy dogs or PMR, it might eliminate the delay that appears to be necessary with salivary cortisol measurements. Measuring heart rate variability is likely cheaper and safer than collecting bodily fluids (saliva for salivary cortisol and blood for serum cortisol), storing them appropriately, and having them analyzed.

Because the correlations between heart rate variability and the PSS-10 and SVAS are quite low, the physiological and self-report measures of stress might be assessing different components – Lang's (1979) physiological, cognitive, or behavioral components -- of the emotional response associated with stress. During strong emotions, such as an intense fear associated with a phobia, these components tend to be concordant – tending to vary together; with less strong emotions, such as moderate generalized anxiety, these components tend to be discordant – tending to vary independently (Ollendick et al., 2011). The low intercorrelations among the measures are consistent with their exam stress being moderate instead of strong. Future research might study participants who are experiencing higher levels of exam stress, such as those seeking help from the campus counseling center for stress, to see if the physiological and self-report measures from those individuals might be more concordant and more strongly correlated with each other.

Lazarus and Folkman's (1984) transactional model of stress and coping categorizes coping strategies as problem-focused or emotion-focused. Problem-focused coping strategies tend to be more effective when dealing with a stressor that is under one's control, while emotion-focused coping strategies tend to be more effective when dealing with a stressor that is not under one's control. Many stressors, such as exam stress, have some components that are controllable (e.g. how much a student studies and when they start studying) while having other components that are not controllable by the individual (e.g. how difficult the exam will be, how many exams are scheduled in the same day). Therapy dog sessions and PMR are more consistent with emotion-focused coping – the individual is not learning about a particular stressor, but rather is learning pragmatic skills to regulate their emotions as they encounter stressors, which may not be under their control.

In connection with Lazarus and Folkman's (1984) model, researchers have categorized people – including adults (Cohen & Lazarus, 1973; Goldstein, 1973) and children (Peterson & Toler, 1986) -- as information-seekers who prefer problem-focused coping strategies or information-avoiders who prefer emotion-focused coping strategies. Thus, therapy dog sessions may be most beneficial for individuals who are information-avoiders, but may also be appropriate for information-seekers if paired with another intervention that is problem-focused. This may also be helpful for information-seekers when forced to face uncontrollable stressors or if paired with another intervention component that is problem-focused in nature. That is, emotion-focused strategies such as visiting with a therapy dog, may allow a person to feel less overwhelmed and more relaxed. Then, a problem-focused strategy, such as teaching a study strategy, could be introduced. Future research might look at the effects of therapy dogs on exam stress for students with various coping dispositions as identified by the aforementioned researchers and whether adding a problem-focused coping strategy, such as a study skill, further reduces stress.

The possibility that part of the reduction in stress is due to “subject-expectancy effects” is worth noting. That is, if a participant successfully perceived the purpose of the study, some may be motivated to respond to self-report measure items in ways that are consistent with their perceptions of the hypothesis, regardless of their physiological reactions, which may or may not be noticeable to them. However, given past research showing decreases in self-reported stress in response to sessions with therapy dogs, accompanied by the evidence of concurrent validity for the self-report measures selected for use in this study, there is reason to believe that participants legitimately experienced a decrease in stress in response to the interventions. In a future study, perhaps the use of a post-experimental inquiry or interview may allow a better understanding of the subjective experience of participants following a therapy dog session.

In order to fully understand the effects of therapy dogs and their handlers on stress, it is recommended that researchers continue to include physiological indicators of stress. According to the concept of individual response stereotypy (Lacey & Lacey, 1958), different people have different autonomic responses to the same stressor and thus no single measure of autonomic response will capture the stress response of all participants. Levenson (1983) recommends a minimum of three measures of the autonomic response – a cardiovascular measure, an electrodermal measure, and a somatic muscle measure. Levenson also recommends, when possible, that a cortical measure be included to measure central nervous system arousal. Individual response-stereotypy accompanied with a failure to measure the three different dimensions of the autonomic response might explain why some of the previous research failed to find an effect of therapy dogs on physiological indicators of stress.

In an ideal experiment, the number of people with the therapy dog and handler in each session should have been controlled. In practice, the number of participants who signed-up for a given session with the therapy dog and handler and the number of participants who came to the session prevented this variable from being controlled. While the number of students with a therapy dog and handler in a session could influence how the students interacted with the dog and therefore influence the results, it would likely influence the results in a way that would work against the hypothesis. That is, if one-on-one is optimal for reducing stress, the larger group sizes would reduce the size of the effect. Likewise, if many-on-one is optimal for reducing stress, the smaller group sizes would reduce the size of the effect. Whatever the optimal group size is, having other group sizes would tend to reduce the size of the effect across the sessions. Variation in group size might also be more similar to what happens in therapy dog sessions outside the laboratory. Future research should systematically vary group size and other factors to see how much, if at all, they contribute to the reduction of stress observed when students interact with therapy dogs.

Future research might attempt to determine the reason that visiting a therapy dog and handler reduces stress. While it may be possible that there is something unique about interacting with a therapy dog that reduces stress, such as the activation of the oxytocin system (Beetz, Uvnäs-Moberg et al., 2012), there are other potential reasons. At least in this study, the therapy dog session was in a calm environment and simply spending time in such an environment might reduce stress. While the interaction between treatment (therapy dog and progressive muscle relaxation) and time of measurement (pre- and post-treatment) was not statistically significant for heart rate variability in this study, progressive muscle relaxation, which was also in a calm environment, had an effect size that was less than the cutoff for a small effect while the therapy dog with handler condition had a large effect size. The handlers of the therapy dogs also interacted with the participants in a friendly manner. Perhaps interacting with another person in a friendly way contributes to the reduction of stress (but see Lass-Hennemann et al., 2014). Future research, for example, could have handlers follow scripts while interacting with the participants. In some scripts, the handler might be friendly while in other scripts the handler might act in a more formal manner.

Interacting with a friendly dog might have reminded some of the participants of pleasant times with their own dog, and this might contribute to the reduction of stress. Future researchers could explore this possible explanation by assessing and statistically controlling for such variables as past experience with dogs or emotional memories of family interactions involving a dog.

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