Exploring Whether Household Pets Buffer Responses to a Remote Stress Induction

By

Helen M. K. Harvie

A Thesis Submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements of the degree of

MASTER OF ARTS

Department of Psychology

University of Manitoba

Abstract

Within the field of research examining stress reactivity, there have been recent strides to modify the Trier Social Stress Test (TSST) to be administered remotely, with user-friendly and accessible means of collecting physiological measures of an acute stress response. Research regarding stress reactivity often examines stress buffering, the phenomena wherein the experience of an acute stressor is dulled or recovery is assisted by environmental factors. Within the home environment, a household pet may be considered a source of stress buffering. This study examined whether interactions with a household pet before and after a novel, internet-delivered adaptation of the TSST (iTSST) may result in a blunted acute stress response, collected through photoplethysmography via Smartphone, and self-reported stress and anxiety (390 recruited, $n = 291$). As well, this study examined if pet attachment, species of pet, and pre-existing mental health and environmental factors influence the extent to which stress buffering may occur ($n = 66$). Results indicated that individuals who interacted with a pet cat, but not a pet dog, demonstrated a blunted response to the iTSST. As well, occurrences of behaviours that were observed during an owner's interaction with their pet dog or cat were similar before and after the iTSST, suggesting that these behaviours may be an expression of trait-like characteristics. Finally, owner gender and timepoint during the experiment best accounted for variance in data between participants. Results support the idea that pets may be beneficial in attenuating acute stress responses.

Keywords: heart rate, household pet, photoplethysmography, stress buffering, Trier Social Stress Test

Acknowledgements

It's been a wild ride. Completing a Master's Degree, let alone during a global pandemic, has been one of the biggest challenges of my life. I could not have done it without the support of my mentors, my friends, and my family.

To my advisor, Dr. Ryan Giuliano, thank you for taking an interest in my research ideas, helping me develop this project, and your guidance throughout the past two years.

To my committee members, Dr. Leslie Roos and Dr. Debbie Kelly, thank you for devoting your time to provide feedback for this thesis.

To the WASABI team (Allie Conway Barbie Jain, Caelan Budhoo, Edgar Delbert, Gillian Zinko, Heidi Del Castro Lima, Lexie Tencha, Louise Torre, Nicole Tongol, Michael Newman, and Thomas Rawliuk) and to the video coding team (Allie Conway, Caelan Budhoo, Thomas Rawliuk, Rachel Cluett, and Justine Gillert), thank you for volunteering your time to this project and making this all possible.

Thank you to my friends and colleagues: Alejandro Rodrigo, thank you for your invaluable assistance in conquering the mysterious land of R; and thank you Kevin Leonard and Dr. Alizée Vernouillet, for devoting your time to providing feedback to previous drafts of this thesis, as well as your emotional support throughout this degree.

To my family - my mother, father, sister, and partner Brad, thank you believing in me and for keeping me sane and giving me strength to get to this point.

To my friends and lab mates, thank you for donating much needed laughs, I will always be grateful.

And, of course, to my pets: Sam (1992-2007), Guy (2005-2018), Ruby, Haze, and BunBun, thank you for inspiring this thesis

Table of Contents

List of Tables

List of Figures

Exploring Whether Household Pets Buffer Responses to a Remote Stress Induction

As the global population recovers from the unprecedented conditions created by the SARS-CoV-2 pandemic, the necessity to adjust to a socially distanced life has resulted in an assortment of practical and psychological challenges. Not only was there a sudden and drastic change to the way individuals conducted their work and social lives, but the stress resulting from this shift to almost exclusively remote interpersonal interactions resulted in serious mental health implications. For example, Statistics Canada (2021) reported that one in five Canadians have developed clinically significant symptoms of depression, generalized anxiety, or post-traumatic stress disorder 12 months after the first Canada-wide lockdown. Canadians who reported feelings of loneliness during these 12 months have demonstrated higher prevalence of mental health challenges. Additionally, Nwachukwu and colleagues (2020) found that Canadians under the age of 25 were more susceptible to higher symptomology of perceived stress, anxiety, and depression. The pandemic not only affected individuals on a personal level, but also on a professional level. Generally, research in any field was also not immune to the consequences of the pandemic, as many lab-based methods for in-person research were required to adapt to, or pause indefinitely, in order to accommodate health restrictions.

The adaptation of rigid, lab-based methodology to remote data collection may be considered a limitation to research being conducted during this time, as remote environments cannot be totally controlled. However, these adaptations have allowed for the validation of more accessible methods in naturalistic environments. Specific examples of the benefits of the shift to remote data collection are prevalent within the field of research examining stress reactivity. In their 2021 article, Clemens Kirschbaum applauded the adjustment to online data collection. This adjustment not only circumvents a pause in the progression of research, but lowers the resource barriers in conducting research for both participants and researchers and allows for increased inclusivity in participating in stress reactivity research (Kirschbaum, 2021). There have been recent strides in adapting stress inducing procedures to a remote, naturalistic environment. Gunnar and colleagues (2021) measured acute stress reactivity (measured via hormone concentration) in response to an online version of previously validated stress induction techniques. Eagle and colleagues (2021), as well as Harvie and colleagues (2021) also found a significant acute stress response to this online version of these stress inducing protocols (measured via cardiac activity and self-report). However, there remains a considerable gap in research examining factors that may attenuate reactivity to, and facilitate recovery from such a stressor.

Social buffering, as summarized by Hostinar, Sullivan, and Gunnar (2014), is a phenomenon wherein activation of biological systems implicated in stress neurobiology, such as the hypothalamic-pituitary-adrenocortical (HPA) axis, may be attenuated as a result of social factors, such as the presence of a close social partner. Social buffering is found throughout human and animal species, but usually only considers interactions within a particular species (Hennessy, Kaiser, & Sacher, 2009). However, a potential buffer for humans from acute stressors may be interactions with a household pet. Previous research has displayed that interactions with a pet or service animal can result in positive physiological and self-reported reactions, such as an increase in oxytocin (Nagasowa et al., 2015), improved mental health and wellbeing (McConnel et al., 2019), and buffering from an acute stressor in a laboratory setting (Kertes et al., 2017). However, the influence of interacting with a household pet after experiencing a novel stress manipulation, coupled with these interactions occurring in the home environment, has not been examined to date. The current study examined the influence a pet’s presence has on their owner’s stress reactivity and recovery to an internet-delivered stressor, whether the pet's influence differs depending on the species of the pet (i.e., dog vs cat), and the extent to which specific behavioural interactions between owners and their pets are associated with buffered responses to an acute stressor.

Acute Stress Responses: Physiological and Psychological Responses

An acute stress response can be quantified and defined using several physiological and self-reported markers (Bae et al., 2019). Traditionally, a stress response includes activation of the HPA axis, in which glucocorticoid hormones are secreted in response to an acute stressor, resulting in cortisol levels peaking 20 to 30 minutes after exposure to the stressor. (Allen et al., 2014; Dickerson & Kemeny, 2004; Kirschbaum, Pirke, & Hellhammer, 1993). This glucocorticoid hormone production influences essentially every physiological system in the body, particularly the central nervous system and the cardiovascular system (Spencer & Deak, 2017). The activation of these systems manifests in the sympathetic nervous system through a reaction colloquially referred to as the "fight-or-flight" response, during which an individual's heart rate will elevate, and their vigilance and fear generally increase (Derakhshan et al., 2019; Gershoff, 2016).

When quantifying the experience of stress, many within the field consider the "gold-standard" measure of stress to be the concentration of cortisol in saliva (e.g., Kirschbaum, Pirke, & Hellhammer, 1993) or blood plasma (e.g., Monzer et al., 2021). However, there are several limitations to considering cortisol the premier indicator of HPA axis activation for research conducted remotely. For example, remote data collection adds limitations to the collection of cortisol, as participants must adhere to stringent guidelines for food consumption, handling, and storage when sampling their own cortisol. The logistics concerning the cost of shipping, storing, handling, and processing cortisol samples may create a financial barrier that prevents researchers without the infrastructure or financial support from conducting this type of stress reactivity research. However, cortisol may not be necessary for studying acute stress, as cardiac activity and self-reported responses have been shown to be reliable indicators of acute stress in humans (Allen et al., 2013).

Although cortisol is often measured during stress reactivity research, the use of cardiac activity has been thoroughly established to be reflective of the presence of a stress response (Allen et al., 2014; Kirschbaum, Pirke, & Hellhammer, 1993). Cardiac indicators include measures such as heart rate, heart rate variability, and blood pressure (both systolic and diastolic), which reflect the physiological effects of an acute stressor (Allen et al., 2014). Cardiac activity can also be collected using various types of equipment, ranging from highly-specialized equipment to low-tech and easily accessible technology, such as photoplethysmography (PPG) – the technology utilized in devices such as consumer fitness watches. Electrocardiogram (ECG), involving placement of electrodes on the torso, is considered the "gold standard" of cardiac data collection (Khunti, 2014; Lancia et al., 2018) and is utilized to collect information regarding heart rate and heart rate variability during an acute stress response (e.g., Eagle et al., 2021; Wagner et al., 2015). However, this specific mode of cardiac data collection provides similar pitfalls to that of cortisol collection: ECG equipment and corresponding software can be cost-prohibitive, and the use of this equipment requires expertise in the placement of electrodes and navigating the software.

Technology specializing in providing nuanced cardiac data in a user-friendly format have improved to the point where the use of such technology has become more common in a research environment. For example, commercial heart rate monitors with wireless chest straps have been validated in recording heart rate variability with accuracy comparable to ECG (Cassirame et al., 2017; Gilgen-Ammann, Schweizer, & Wyzz, 2019). Moreover, measures of heart rate via PPG have gained more prevalence in research on cardiac activity. Unlike ECG, which relies on electrodes to detect cardiac activity, PPG devices rely on a light source placed directly on the skin to detect the volume of blood within the capillaries. Heart rate is then quantified based off the variation of capillary blood volume due to individual pluses (Hernando et al. 2018). Research exploring the validity of heart rate monitors utilizing PPG have found these devices to collect comparable heart rate data to ECG (Claes et al., 2017; Goncalves et al. 2016) and electrode-based, commercially available heart rate monitors (Hernando et al., 2018; Muggeridge et al., 2021). The emerging research concerning PPG heart rate collection via smartphone application is of particular interest. In terms of the logistics of collecting cardiac data, collecting PPG via smartphone circumvents the financial burden of purchasing a specialized piece of equipment for data collection. Research validating PPG data collection via smartphone app demonstrates high validity in the heart rate data collected via PPG smartphone app as compared to ECG output (Fan et al., 2019; Yan et al., 2017). As billions of individuals own a smartphone (O'dea, 2020), this allows for a simplified and accessible means for collecting valid cardiac data.

Although the vast majority of the research examining stress reactivity favours physiological responses to an acute stressor, it is important to consider the subjective experience of stress to supplement physiological responses. Self-reports of the psychological experience of an acute stressor can be an important predictor of a number of both negative mental health (Somma et al., 2021) and physical health ailments (Nielsen et al., 2005). Furthermore, self-reported stress responses provide an accessible and immediate validation that indeed a stress response has occurred, and to what extent an individual experienced said stressor (Allen et al., 2013). Of the research that has considered self-reported stress, acute stressors can be reliably documented via self-report by scaling an individual's stress, anxiety, and calmness (Allen et al., 2013; Folstein & Luria, 1973). Thus, combining self-reported insights on a stress response with physiological data that is both accessible and user-friendly should allow for remote assessment of an acute stress response.

Stress Buffering

When researching stress reactivity, oftentimes the goal is not to merely induce an acute stress response, but also to examine how to relieve individuals from stress and the related health detriments that accompany stress (McEwan, 2004). Stress buffering can be defined as either a blunted response to acute stress (e.g. Hennessy, Kaiser, & Sacher, 2009) or an expedited recovery to a baseline state (e.g. Engert et al., 2016, Meuwly et al., 2012). Research considering acute stress responses oftentimes will examine whether environmental influences will assist in stress buffering, such as interacting with peers. Research has examined the relationship between stress and social support (Dean & Lin, 1977; Hostinar, Sullivan, and Gunnar, 2014). Being social animals, humans live, communicate and cooperate with others to protect themselves from physical and psychological threats (Kikusui et al., 2006). Consequently, research has linked social support and social interactions with positive effects on aspects of cardiovascular, endocrine and immune function (Uchino et al., 1996), in particular attenuation of cortisol responses (Ditzen et al., 2008). Psychological effects of social buffering include an individual experiencing a stressor as less severe, seen as reduced self-reported stress and anxiety levels (Kikusui et al., 2006).

Another source of stress buffering, particularly in a remote setting, could include interacting with a household pet. As humans and dogs have co-evolved over 10,000 years, the relationship between these two species are unmatched in emotional reciprocation (Udell et al., 2010). However, research examining how pet ownership influences physical and mental health is largely unexplored, can be inconclusive due to methodological limitations, or even demonstrate negative effects of pet ownership (Saunders et al., 2015). Such negative effects of pet ownership arise from aggression from the pet, allergies, and increased incidence of heart attack. Furthermore, pet owners could fundamentally differ from non-pet owners in terms of sociodemographic variables, which may influence the extent to which one responds to a stressor. Be that as it may, the existing literature provides compelling evidence that pet ownership may also provide physical and mental health benefits in certain situations. For example, Nagasowa and colleagues (2015) found evidence that production of oxytocin, a hormone associated with emotional bonding, in both humans and dogs increase during mutual gaze – to a similar extent found between mother and infant mutual gaze. Research examining the effects of owning a pet have provided evidence that owning a pet could be related to positive health outcomes and physiological reactions (Utz, 2014). Indeed, people generally expect positive physical and mental consequences when they adopt a dog (Powell et al., 2018). As well, ownership and interaction with pet dogs has been related to several physical health benefits such as increased physical activity in both adults and children (Owen et al., 2010). There is also evidence that interacting with an individual's own dog may result in a buffered acute stress response (Barker et al., 2015). This result has been replicated in acute stress research involving children (Kertes et al, 2017). There is also evidence that buffering from a dog is comparable to buffering from a peer (Polherber & Matchock, 2014).

Although research examining the buffering effects of a pet have typically centered around dogs as the vehicle for buffering, other species such as cats may provide similar forms of social support. Martens, Enders-Sleger, and Walker (2016) found that, while dog owners may attribute more complex emotions to dogs than cat owners attribute to their cats, the extent to which an owner bonds to their pet does not differ according to pet species. Furthermore, Allen, Blascovich, and Mendes (2002) found that pet owners had significantly lower baseline heart rate and blood pressure, a blunted response to an acute stressor and a faster recovery from a stressor. However, there was no significant difference between dog and cat owners at any point in the experiment. Thus, these findings suggest that, while the specific behaviours may differ between the two species, cats may provide a comparable buffering effects to their owners as dogs provide.

Remote Stress Induction

When examining stress responses, the Trier Social Stress Test (TSST: Kirschbaum et al., 1993) is considered to be the "gold standard" in eliciting an acute stress response. What is believed to be one of the most potent factors of the TSST methodology in inducing an acute stress response is the exposure of the participant to a socially evaluative threat (Dickerson & Kemeny, 2004). Specifically, the TSST involves the preparation and delivery of a speech, as well as a challenging mental arithmetic task. However, these tasks must be coupled with the presence of the TSST panelists. These panelists are research personnel who are trained to give as little social feedback as possible to participants as they perform these tasks. Thus, regardless of the quality of their performance, participants are still threatened by the nature of this evaluation. This format of socially evaluative threat is so effective in inducing stress that participants will demonstrate a stress response even when implemented via the online game Second Life (Riem et al., 2019) or virtual reality goggles (Felnhofer et al., 2019). However, it is important to be aware that these aforementioned studies involved participants sitting in a laboratory setting. In fact, this type of sterile, unfamiliar environment may play a major role in amplifying the socially evaluative threat of the TSST procedure (Roos et al., 2017).

Before the SARS-CoV-2 pandemic, research on the TSST largely consisted of in-person interactions between researchers and participants. The TSST was occasionally implemented virtually via pre-recorded video clips or interactions with a simulation (Riem et al., 2019; Felnhofer et al., 2019). Recently, there has been new precedent in implementing the TSST in an online format (Eagle et al., 2021; Gunnar et al., 2021). Such research has been recognized by Kirschbaum (2021), in which the potential for easing the resource burdens on both participants and researchers, as well as the potential for heightened inclusivity of historically elusive populations was highlighted. Whereas Gunnar and colleagues (2021) showed significant endocrine reactivity to an online version of the TSST, Eagle and colleagues (2021) were successful in inducing a pronounced cardiac response to an online version of the TSST (iTSST). Pertaining to the current study, Harvie and colleagues (2021) demonstrated that the acute stress response elicited from an online TSST included significant reactivity as measured by photoplethysmography (PPG), relative to a control group performing similar, socially unthreatening tasks.

Current Study

My thesis aims to examine whether interacting with a household pet (i.e. a dog or a cat) will result in an individual experiencing a blunted stress response after being exposed to a remote stressor. Stress responses will be quantified using remote and user-friendly self-reported and heart rate data by interacting with an online questionnaire and a free smartphone heart rate app. Furthermore, this study will examine whether the species of the pet (dog or cat), pre-existing attitudes owners hold regarding their pet, and certain behaviours occurring during owner/pet interactions, are associated with a more pronounced buffering effect. It is hypothesized that participants buffered by their pet will display a blunted PPG response and self-report to the online TSST tasks and an accelerated return to baseline measures, as compared to participants who did not experience a pet interaction. As well, we predict that the extent of stress buffering will be influenced by an owner's pet attitude, and the specific behaviours occurring during the pet interaction, such that more sensitive interactions will be associated with greater buffering.

Methods

Participants

Participants were recruited from the University of Manitoba's *Introduction to Psychology* course through the online SONA recruitment system and volunteered in exchange for course credits. An initial screening process was performed to ensure participants met the following inclusion criteria: currently living with a household pet such as a dog or cat, owning a computer with a webcam, having a friend or acquaintance available for a phone call, no new mental health diagnosis within the last 12 months, and not currently experiencing severe symptoms of anxiety or depression (questionnaires described below in detail). The screening process was completed either on a day before a scheduled time slot or at the beginning of the time slot. A total of 390 participants (284 females, 72.8%) meeting inclusion criteria participated in the online experiment (65.4% aged 18-19; range 17-50+ years old). The use of this participant pool and all experimental procedures described herein were approved by the University of Manitoba's Research Ethics Board.

General Procedure

Participants were randomly assigned to a *Stressor-No-Interaction,* a *Stressor + Peer Interaction,* a *Stressor + Pet Interaction* condition, or a *Non-Stressful Control* condition before the date of their participation. Experiments were scheduled anytime between 09:00 to 17:30, with participants choosing the time they participated in the experiment. Participants were provided with a Zoom link 10 minutes before the scheduled time slot for their experimental session. Upon arriving in the Zoom call, the research assistant leading the session established that the participant was alone and in a private space in their home, and allowed the participant to ready themselves for the experiment (e.g., gathering writing material, using the washroom). The researcher also ensured that the participants were not eating or drinking coffee or caffeinated beverages throughout the experiment, to minimize potential confounds of the cardiac estimates.

Once informed consent was obtained, the participant was instructed to download the Heart Rate Plus smartphone application (PVD Apps, 2015), unless they had already downloaded the app. In order to ensure quality heart rate measurements, the participant was instructed to follow the instructions for recording PPG with their particular model of smartphone, as provided by Health Rate Plus. This usually consisted of making sure that their finger entirely covered both the rear camera and the flashlight and to be still during the measurement. Once a PPG measure was taken, the participant verbally communicated the heart rate estimate to the researcher as well as entered into an online survey sent to the participant. Immediately following each PPG measure of heart rate, participants self-reported their current stress, anxiety, and insecurity using a visual analogue scale (VAS), with possible responses ranging from 0-100: 0 representing "feeling not stressed" and 100 representing "feeling highly stressed". Seven heart rate and VAS measurements were taken throughout the experimental session: 1) initial test measure, 2) first baseline measure, 3) placebo pre-buffering or pre-buffering stage, 4) placebo speech task or iTSST speech task, 5) placebo math task or iTSST math task, 6) placebo post-buffering or post-buffering, and 7) second baseline measure.

All participants, regardless of the assigned condition, started the experimental session with a PPG measure of heart rate, followed by a VAS measurement. Immediately after the initial measurement, they were directed to a video via YouTube link – the purpose of which allowed for the participant to achieve a state of rest and for their baseline state to be measured. This video was five minutes in duration, and contained scenes of underwater wildlife accompanied by tranquil instrumental music. Participants were instructed to sit still and relax their body while watching the baseline video, to turn the audio on to a comfortable volume, and to not touch their computer until the video was complete. Immediately after the video, participants were then instructed to record a second heart rate and VAS measurement. Participants then proceeded to either a pre-stressor reading task or a pre-stressor pet interaction.

Participants assigned to the *Stressor-No-Interaction* and the *Control* conditions experienced a reading control task in place of an interaction with their pet. During this task, participants were sent five magazine/scientific journal articles over the Zoom chat function. These articles were neutral and unlikely to elicit a significant emotional response. Participants were instructed to read for a total of five minutes while sharing their screen, to allow for monitoring the activity of the participant to ensure that they remained on task. The researcher turned off their video and microphone feed during this time, but would engage with participants if they had questions.

During the pre-stressor pet interaction, participants assigned to the *Stress + Pet Buffering* condition were instructed to interact with their pet for a five-minute period. The researcher instructed the participant that their pet was there to provide them with support, and to interact with their pet as they are normally accustomed to within the view of their webcam. The researcher shut off their video and microphone feed when the participant brought their pet within view of their webcam, and did not interact with the participant until the five-minute period was complete. Similar to the *Stressor + Pet Interaction* group, participants in the *Stressor + Peer Interaction* group were instructed to contact a peer of their choice via phone call or Zoom video call for five minutes. These participants received comparable instructions to the *Stressor + Pet Interaction* group, in that the researcher instructed the participant and their peer to interact with one another as they are normally accustomed to for five minutes. As well, the researcher also shut off their video and microphone feed during this interaction period. Upon completing this task, participants were asked to record a third heart rate and VAS measurement.

Participants then proceeded to either the placebo speech task or the iTSST speech task.[1] All participants, regardless of the assigned condition, were initially given the same instructions at the start of the speech task. Participants were told that they were to imagine that they were applying for a job, and that they had five minutes to prepare a five-minute speech. Their speech was to outline their strengths as an employee, how they overcome their weaknesses, and why they are the ideal employee. Participants were encouraged to use the five minutes allocated to preparation to take notes on their speaking points. The researcher shut off their video feed and microphone during this time, and did not interact with the participant until the five-minute preparation period was complete.

Participants assigned to the *Control* condition proceeded to the placebo speech task. Participants were permitted to refer to the notes that they had made during the preceding preparation phase of this task. The researcher outlined to the participant that they would be required to speak for a total of five minutes, and they could discuss their coursework or the events of their day if their speech did not span the full five minutes. The researcher turned their

---

[1] Participants in the *Control* group took part in a placebo iTSST task. For more information about this condition please reference Harvie et al. (*2021*).

video feed and microphone off during the speech, and were instructed to only interject brief suggestions of possible talking points should the participant display distress. These interjections would only involve the researcher's microphone to be utilized, and their video feed remained off during the speech. The researcher turned their video and microphone feed on after the five-minute period was complete.

Participants assigned to the *Stressor-No-Interaction, Stressor + Peer Interaction,* and the *Stressor + Pet Interaction* groups performed the iTSST speech task. Upon the completion of the preparation phase of the task, the researcher informed the participant that colleagues would be joining to watch their speech and lead the next few tasks. The introduction of these novel researchers adheres to the methodological ideals of the original, in-person TSST by suddenly creating a novel and uncontrollable environment for the participants. At this point, two additional researchers joined the Zoom call and acted as the iTSST panelists. These panelists were dressed in business casual attire, and seated in an area that was devoid of distraction. The researcher originally interacting with the participant turned off their video and microphone feed. One member of the iTSST panel then outlined the expectations of the speech to the participant, noting that the participant was to destroy or put away the notes they had prepared for the speech, and to set their Zoom screen to "Gallery" view in order to clearly see each panelist clearly, as the panelists were to leave their video feed on for the duration of the speech. As well, the participant was told they would have five minutes to perform the speech, and they must use all five minutes. The participant then performed the speech to the panelists who were instructed to provide no positive feedback and maintain neutral affect throughout the speech. If the participant paused the panelists interjected with phrases such as, "You still have time remaining," and, "Continue your speech." Upon the completion of the five-minute period for the speech, one of the panelists guided the participant through the fourth heart rate and VAS measurement, and then on to the next phase of the experiment.

Participants proceeded to either the placebo math task or the iTSST math task. Participants assigned to the *Control* condition completed a placebo math task, during which the researcher instructed that the participant was to count up from zero in increments of 15 for a five-minute period. The researcher would then turn off their video feed and microphone during the five-minute period and did not interject until five minutes had expired.

Alternatively, participants in the *Stressor-No-Interaction, Stressor + Peer Interaction,* and the *Stressor + Pet Interaction* groups proceeded to the iTSST Math Task. One of the panelists instructed that the participant was to count down from 2043 in increments of 17 as quickly and accurately as possible. If the participant was to make a mistake during this task, the panelists would intervene and ask the participant to start from the beginning. The panelists also interjected with phrases such as, “You need to go as fast as you can,” or, “Try not to pause between numbers during this task,” if the participant was to pause to calculate the next number. The panelist would inform the participant when the five-minute period was complete, and would perform the heart rate and VAS measurement. Upon completion of these measurements, the original researcher reactivated their video feed and microphone, and instructed the panelists to leave the call. Immediately after the math performance, participants completed a fifth heart rate and VAS measurement.

Participants then proceeded to either read silently for five minutes (*Stressor-No-Interaction* and *Control* groups), to interact with their pet for five minutes (*Stress + Pet Interaction*), or to interact with a peer for five minutes (*Stressor + Peer Interaction*). The instructions for both the post-stressor reading and the post-stressor pet interaction mirrored those provided during the pre-stressor phase. The participants assigned to the *Stressor-No-Interaction* and the *Control* groups were told to read a new article for five minutes while sharing their screen through Zoom. Participants in the *Stress + Pet Interaction* condition were instructed to bring their pet back into the view of the webcam and interact with their pet for five minutes. Participants in the *Stressor + Peer Interaction* group contacted the same peer they initially interacted with via the same medium of communication (phone call or Zoom video call) for five minutes. The researcher shut off their video feed and microphone in all conditions during this time, and did not interact with the participant. Upon completion of this task, participants completed a sixth heart rate and VAS measurement.

All participants then completed a final resting cardiac assessment while watching a 5-minute video of ocean scenes, similar to the previous ocean video and also accessed via YouTube link sent over Zoom chat by the lead assessor. Participants were given the same instructions as the first baseline video. As soon as the final ocean video ended, participants completed a seventh and final heart rate and VAS measurement. Participants were then debriefed on their participation of the study specific to the condition they were assigned to and awarded their course credits at the conclusion of the study. The general procedure of this study is depicted in Figure 1. Descriptive statistics for participant characteristics in the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* groups can be found in Table 1.

Behavioural Coding

After initial data collection, the video recordings of the buffering period for the *Stressor + Pet Interaction* participants were further analyzed, in order to quantify individual differences within the buffering periods. The behavioural coders consisted of one “master” coder and five additional coders. Although some of the members of the coding team were involved during initial data collection, no coder was permitted to analyze the videos of participants they interacted with (as either the lead assessor or a panelist). Members of the coding team only coded one of the two interaction periods per participant (i.e., either the pre- or post- stressor pet interaction).

Consistent with previous research on interactions between humans and pets (Kertes et al., 2017), behaviours of interest are broadly categorized as *Positive Owner Interactions, Neutral Owner Interactions, Negative Owner Interactions*, *Pet-Centric Behaviours, Owner/Pet Contact,* and *Owner/Pet Closeness*. *Positive Owner Interactions* include behaviours such as 1) the amount of times the owner affectionately spoke to the pet (i.e. *Owner Affectionate Speech*); and 2) the amount of times the owner engaged in affectionate behaviours towards the pet (i.e. *Owner Affectionate Behaviours*). *Neutral Owner Interactions* include the number of times the owner generally spoke to the pet (i.e. *Owner Neutral Speech*). *Negative Owner Interactions* include behaviours such as 1) the number of times the owner engaged in frustrated speech towards the pet (i.e. *Owner Frustrated Speech*); and 2) the number of times the owner displayed distracted behaviours (i.e. engaging in tasks unrelated to the buffering period: *Owner Distracted Behaviours*). *Pet-Centric Behaviours* include 1) the number of times the pet approached the owner (i.e. came within arm's reach or ~0.5m of the owner: *Pet Approaches Owner*); 2) the number of times the pet engaged in negative behaviours towards the owner (i.e. running away from the owner, struggling with the owner, biting, scratching, etc.: *Pet Negative Behaviours*); and 3) the amount of times the owner and pet engaged in play (i.e. *Owner-Pet Play*). *Owner/Pet Contact* is defined as the number of seconds within the buffering period the owner and the pet were in physical contact with one another. *Owner/Pet Closeness* is defined as the number of seconds the owner and the pet remained within ~0.5m of one another without making contact with one another.

The beginning of the interaction period is defined as the moment the lead assessor turned their video stream off after delivering the instructions to the participant. The end of the interaction period is defined as the moment the lead assessor turned their video steam back on to instruct the participant to remove their pet from their workspace. Videos were coded using the BORIS video coding software (Friard & Gamba, 2016) via the "Live" coding option. Coders were instructed to open the video of corresponding participant ID they were assigned, and to fast-forward to the specific interaction period via high-speed scrubbing. These videos were muted until the specific timestamp was located in the video, in order to avoid previous events in the run influencing the coder's objectivity during behavioural analysis during the buffering. Coders were also instructed to code videos in shifts lasting no longer than 2 hours, while focusing on a maximum of two behaviours at one time per repetition of the buffering video.

Inter-rater reliability between the master coder and the five additional coders was calculated by double coding 38 of the 5-minute interactions videos (28.8% of the total interactions, n = 132). Interclass correlation coefficient (ICC) was used to calculate the reliability between the double-coded videos. All these double coded videos exceeded the minimum acceptable value of 0.7, ranging within the "excellent" range of 0.825 to 1.00. Once acceptable inter-rater reliability was reached, the five coders then continued to code the remaining videos independently. Descriptive statistics for these video coded behaviours are displayed in Table 2.

Excluded Participants

Participants who experienced significant deviations from our previously described procedures (due to technical difficulties with their laptop or smartphone, interruptions from other household members, or experiences of excessive emotional responses to the iTSST tasks as per the discretion of the lead assessor, etc.) were immediately flagged during data collection, and excluded from further analyses (*n* = 32). Participants who did not provide successful heart rate or VAS values at any of the seven timepoints were excluded from further analyses (*n* = 39). As well, a number of participants during the early stages of data collection were recorded who did not meet our criteria listed previously (*n* = 28). These participants were also excluded from further data analyses. As a result, a final sample size resulted in *N* = 289 (*Control* group, *n* = 50; *Stressor-No-Interaction* group, *n* = 54; *Stressor + Peer Interaction, n* = 98*; Stressor + Pet Interaction* group, *n* = 87). During video coding of pre- and post- stressor owner-pet interactions, participants were excluded on the basis of the participant or the pet being obscured for over half (2.5 minutes) in either one of the 5-minute interaction periods (*n* = 11), errors in recording or downloading the video (*n* = 9), or researcher error in the experimental procedure (*n* = 1) This left a total of 132 pre- and post-stressor interactions (66 participants) to be video coded.

Data Analyses

In order to examine effects of pet buffering at the group level, heart rate and self-reported stress and anxiety was analyzed using a 4 (Group) x 7 (Timepoint) repeated measures ANCOVA between the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* groups. Self-reported stress and anxiety was averaged together at each timepoint to create one “stress and anxiety” score. Any significant Group x Time interactions was proceeded with Bonferroni-corrected pairwise comparisons. Owner gender and pet species was included as covariates in these ANCOVA tests. Furthermore, a second 4 (Group) x 7 (Timepoint) repeated measures ANCOVA was run between the *Control, Stressor-No-Interaction, Stressor + Dog Interaction,* and *Stressor + Cat Interaction* in order identify main effects of pet species at the group level. Gender (male or female) was a covariate for both ANCOVAs. Greenhouse-Geisser adjusted degrees of freedom were used for repeated measures to account for potential violations of sphericity. These ANCOVAs were run using SPSS.

In order to identify basic relationships between variables, a correlation matrix was run between all independent variables and a general *reactivity* and *recovery* score for both heart rate and VAS. *Reactivity* was calculated by subtracting Timepoint 3 from the average of Timepoints 4 and 5 (the peak stress during the experiment). Values closer to zero suggest blunted recovery, while higher positive values suggest greater reactivity to the stressor. *Recovery* was calculated by subtracting the average of Timepoints 4 and 5 from Timepoint 6. Positive values and values closer to zero suggest a lack of recovery, while negative values suggest efficient recovery from the stressor. As well, paired samples correlations and *t*-tests were run between the individual pre- and post-stressor video coding behaviours in order to examine whether a specific video coded behaviour differed between the pre- and post-stressor interactions. These analyses were also run using SPSS.

In order to determine which factors may influence the buffering effect of a pet, additional exploratory analyses will also be run for the *Stressor + Dog Interaction,* and *Stressor + Cat Interaction* conditions. As a generalized linear mixed model (GLMM), a class of linear regression models, has the capacity to consider fixed and random effects, and does not assume normal distribution (Hedeker, 2005), two GLMMs were used to assess which variables account for the most variance within the heart rate and self-reported stress and anxiety data from Timepoint 3 to Timepoint 6 in these separate groups. The dependent variables in these models were a *reactivity* and a *recovery* scores for both heart rate and self-reported stress and anxiety.

Both GLMMs included the following variables as fixed effects for simple models: *gender* (male or female), *Timepoint* (pre- or post- stressor), and *Pet Type* (dog or cat). Once the best simple model was identified, the fixed effects of the sum of *Positive Owner Interactions, Neutral Owner Interactions, Negative Interactions,* as well as *Owner/Pet Contact,* and *Owner/Pet Closeness,* and a *No contact* variable (calculated by subtracting the *Owner/Pet Closeness* variable from the total time of the interaction phase*;* continuous variables) were applied to the best simple model in order to identify if these additional variables account for significantly more variance. As well, mental health symptomatology (average z-score of *BDI* and *GAD-7* scores), *Recent Stressful Events, Pet Attitude Score,* and *Pet-Centric Behaviours* were included as random effects variables. As *Pet-Centric Behaviours* demonstrated a strong floor effect (see Table 2), these behaviours were represented in these GLMMs as binomial representation of occurrences (i.e. ‘0’ representing no occurrences of these behaviours, and ‘1’ representing occurrences of these behaviours). These variables were selected to represent both the specific differences within the pre- and post-interaction periods, as well as external influences which may influence the participant’s responsiveness to the buffering effect of an interaction. To determine the model that best represents the variance in both heart rate and self-reported stress and anxiety scores, Akaike’s Information Criterion weight (AICw) was referenced to determine the best model, in addition to marginal R^2. AICw values closest to 1.0 indicate the model with the most explanatory power (Tredennick et al., 2016). A summary of the R packages used to complete these GLMMs, as well as the list of simple models and complex models are listed in Appendix A. Alpha was set as $p < .05$ for all analyses.

Results

Heart Rate and Self-Report

Descriptive statistics for heart rate and self-report across all timepoints for the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* (including the *Stressor + Dog Interaction* and *Stressor + Cat Interaction*) groups are presented in Table 3. As Mauchly's Test of Sphericity was violated for both the main effects of heart rate ($\chi^2(20) = 161.389$, $p < .001$) and self-report ($\chi^2(20) = 661.970$, $p < .001$), Greenhouse-Geisser estimates of sphericity ($\varepsilon = .528$) were used to correct the degrees of freedom for self-reported responses and heart rate ($\varepsilon = .834$). There were non-significant trends of a between-subjects main effect of Group on heart rate [$F(3, 286) = 2.555$, $p = .056$, $\eta^2_{partial} = .026$] and self-report [$F(3, 286) = 2.245$, $p = .083$, $\eta^2_{partial} = .023$]. There was a significant main effect of Gender on both heart rate [$F(1, 286) = 11.341$, $p < .001$, $\eta^2_{partial} = .038$] and self-report [$F(1, 286) = 23.199$, $p < .001$, $\eta^2_{partial} = .075$]. For self-report, there were significant effects of Timepoint [$F(3.254, 930.542) = 3.237$, $p = .019$, $\eta^2_{partial} = .011$], as well as interactions between Timepoint and Gender [$F(3.254, 930.542) = 5.545$, $p < .001$, $\eta^2_{partial} = .019$], and Timepoints and Group [$F(9.761, 930.542) = 3.869$, $p < .001$, $\eta^2_{partial} = .039$] for self-report. In contrast, effects of Timepoint, Timepoint x Gender, and Timepoint x Group were not significant for heart rate (all *p*s > .117). This indicates that, while the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* groups did not generally differ from one another in heart rate across the experiment, self-report significantly interacted with timepoints, resulting in meaningful differences at key points of the experiment.

Concerning the general efficacy of the stressor, timepoints associated with peak stress during the experiment were significantly higher across groups for both heart rate and self-report. When examining the main effects of timepoint using pairwise comparisons, timepoint 4 was significantly higher in heart rate than timepoint 2 ($M_{Difference} = 4.600$, $p < .001$, 95% C.I. = 1.213, 7.987), timepoint 3 ($M_{Difference}$ = 5.011, p < .001; 95% C.I. = 2.235, 7.788), timepoint 6 ($M_{Difference}$ = 4.731, p < .001;; 95% C.I. = 2.099, 7.364), and timepoint 7 ($M_{Difference}$ = 4.600, p < .001; 95% C.I. = 1.213, 7.987). Similarly, timepoint 5 was significantly higher than timepoint 2 ($M_{Difference}$ = 3.799, p = .016; 95% C.I. = .380, 7.218), timepoint 3 ($M_{Difference}$ = 4.210, p < .001; 95% C.I. = 1.353, 7.069), timepoint 6 ($M_{Difference}$ = 3.931, p < .001; 95% C.I. = 1.008, 6.854), and timepoint 7 ($M_{Difference}$ = 5.140, p < .001; 95% C.I. = 2.013, 8.268). A similar pattern was reflected in self-report scores, with timepoint 4 demonstrating higher self-report responses than timepoint 1 ($M_{Difference}$ = 18.567, p < .001; 95% C.I. = 14.185, 22.949), timepoint 2 ($M_{Difference}$ = 25.687, p < .001; 95% C.I. = 21.032, 30.342), timepoint 3 ($M_{Difference}$ = 28.959, p < .001; 95% C.I. = 24.586, 33.332), timepoint 6 ($M_{Difference}$ = 24.851, p < .001; 95% C.I. = 20.649, 29.052), and timepoint 7 ($M_{Difference}$ = 28.236, p < .001; 95% C.I. = 23.652, 32.819), as well as timepoint 5 demonstrating higher self-report responses than timepoint 1 ($M_{Difference}$ = 15.854, p < .001; 95% C.I. = 10.831, 20.876), timepoint 2 ($M_{Difference}$ = 22.973, p < .001; 95% C.I. = 17.664, 28.283), timepoint 3 ($M_{Difference}$ = 26.245, p < .001; 95% C.I. = 21.185, 31.305), timepoint 6 ($M_{Difference}$ = 22.137, p < .001; 95% C.I. = 17.994, 26.279), and timepoint 7 ($M_{Difference}$ = 4.600, p < .001; 95% C.I. = 1.213, 7.987). Given that measurement timepoints 4 and 5 were collected during and immediately after the acute stress manipulation or control task, this provides evidence that the stressor and placebo procedures were effective at challenging participants across the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* groups.

To follow up on the significant Group by Timepoint interaction, differences between the *Control, Stressor-No-Interaction, Stressor + Peer Interaction* and *Stressor + Pet Interaction* groups at each timepoint were examined using pairwise comparisons. A complete table of these pairwise comparisons can be found in Table 4. There were no significant differences between the heart rate of the separate groups at any of the timepoints (all *p*s > .068). However, during the acute stress manipulation, there were significant differences in self-report between groups. At timepoint 4, the mean self-report responses of the *Control* group were significantly lower than the *Stressor-No-Interaction* ($M_{Difference}$ = -17.960, *p* = .002; 95% C.I. = -31.210, -4.709), the *Stressor + Peer Interaction* ($M_{Difference}$ = -14.061, *p* = .010; 95% C.I. = -25.815, -2.307), and the *Stressor + Pet Interaction* ($M_{Difference}$ = -12.380, *p* = .037; 95% C.I. = -24.309, -.450). Similarly, at timepoint 5 the mean self-report responses of the *Control* group were significantly lower than the *Stressor-No-Interaction* ($M_{Difference}$= -20.216, *p* = .001; 95% C.I. = -34.459, -5.974), the *Stressor + Peer Interaction* ($M_{Differencee}$ = -16.761, *p* = .003; 95% C.I. = -29.396, -4.127), and the *Stressor + Pet Interaction* ($M_{Differencee}$ = -18.554, *p* < .001; 95% C.I. = -31.337, -5.731). However, the *Stressor-No-Interaction, Stressor + Peer Interaction,* and *Stressor + Pet Interaction* groups did not differ significantly from one another at any timepoint. These results are depicted in Figure 2. Concerning how each group separately reacted throughout the experiment, the *Control* group displayed significantly lower heart rates, self-reported stress and anxiety than all other groups.

A second repeated measures ANCOVA was run to consider the pet species (*Stressor + Dog Interaction* and *Stressor + Cat Interaction* groups) separately against the *Control* and *Stressor-No-Interaction* groups, with Gender included as a covariate. As Mauchly's Test of Sphericity was violated for both the main effects of heart rate ($\chi^2(20) = 125.559$, *p* < .001) and self-report responses ($\chi^2(20) = 410.027$, *p* < .001), Greenhouse-Geisser estimates of sphericity (ε = .550) were used to correct the degrees of freedom for self-report responses, and Huynh-Feldt estimates of sphericity (ε = .875) were used to correct the degrees of freedom for heart rate. There was a significant between-subjects main effect of Pet Group on self-report [*F*(3, 188) =

3.797, p = .011, $\eta^2_{partial}$ = .057], such that cat owners reported significantly lower stress and anxiety across the experiment than dog owners. As well, there was a significant effect of Gender on both heart rate [F(1, 188) = 6.112, p = .014, $\eta^2_{partial}$ = .031] and self-report responses [F(1, 188) = 13.976, p < .001, $\eta^2_{partial}$ = .069]. There were also significant interactions between Timepoint and Gender [F(3.299, 620.241) = 4.754, p = .002, $\eta^2_{partial}$ = .025], and Timepoint and Pet Group [F(9.897, 620.241) = 4.291, p < .001, $\eta^2_{partial}$ = .064] for self-report. However, there was no significant main effect of Timepoint on VAS responses [F(3.299, 620.241) = 1.641., p = .174, $\eta^2_{partial}$ = .009]. For heart rate, there were no significant within-subjects main effects of Timepoint [F(5.253, 987.501) = .941, p = .457, $\eta^2_{partial}$ = .005], nor interactions between Timepoint and Gender [F(5.006, 906.385) = 1.766, p = .117, $\eta^2_{partial}$ = .006] or Timepoint and Group [F(15.018, 906.385) = .838, p = .655, $\eta^2_{partial}$ = .009].

Differences between the *Control, Stressor-No-Interaction, Stressor + Dog Interaction* and *Stressor + Cat Interaction* groups across measurement timepoints were examined using pairwise comparisons with Bonferroni corrections. A complete table of these pairwise comparisons can be found in Table 5. At timepoint 4, the mean self-report responses of the *Control* group were significantly lower than the *Stressor-No-Interaction* ($M_{Difference}$ = -17.952, p = .002; 95% C.I. = -31.219, -4.686), and the *Stressor + Dog Interaction* ($M_{Difference}$ = -17.324, p = .004; 95% C.I. = -30.774, -3.875). However, self-report responses of the *Control* group were not significantly different from the *Stressor + Cat Interaction* group at timepoint 4 ($M_{Difference}$ = -5.740, p = 1.00; 95% C.I. = -20.309, 8.803). Similarly, at timepoint 5 the mean self-report responses of the *Control* group were significantly lower than the *Stressor-No-Interaction* ($M_{Difference}$ = -20.220, p < .001; 95% C.I. = -34.127, -6.313), and the *Stressor + Dog Interaction* group ($M_{Difference}$ = -16.761, p = .003; 95% C.I. = -40.508, -12.311). Again, mean self-report responses of the *Control* group did not significantly differ from the *Stressor + Cat Interaction* group at timepoint 5 ($M_{Difference}$ = -8.012, p = .976; 95% C.I. = -23.257, 7.233). As well, the *Stressor + Cat Interaction* group displayed significantly lower self-report responses at timepoint 5 as compared to the *Stressor + Dog Interaction* group ($M_{Difference}$ = -18.398, p = .009; 95% C.I. = -33.579, -3.216). Finally, the *Stressor + Dog Interaction* group displayed significantly higher self-report responses at timepoint 6 as compared to the *Control* group ($M_{Difference}$ = 15.672, p = .006; 95% C.I. = 3.252, 28.091). Concerning group differences when examining dog and cat owners separately, dog owners displayed significantly higher self-reported stress and anxiety during the stressor as compared to cat owners. These results are depicted in Figure 3.

Observations of Pet-Owner Interactions

Descriptive statistics for pet-owner interaction codes are shown in Table 2 for the dog and cat groups. To examine whether pet-owner interactions differed between interaction periods before and after the stressor, paired samples *t*-tests were run separately for the *Stressor + Dog Interaction* and *Stressor + Cat Interaction* groups on the pre- and post-stressor observational codes: *Pet Within Arm's Reach, Owner Contact with Pet, Pet Approaching Owner, Affectionate Speech, Neutral Speech, Frustrated Speech, Owner and Pet Play, Pet Negative Behaviour, Owner Affectionate Behaviours,* and *Owner Distracted Behaviours*. For both the Dog and Cat groups, the occurrences of these behaviours did not significantly differ between the pre- and post-stressor interaction phases (all *p*s > .088, see Table 2). This was followed by an examination of correlations between pre- and post- interaction codes for each group. Within the *Stressor + Dog Interaction* group, all behaviours significantly and positively were correlated with one another except *Pet Approaching Owner* (r = .292, two-sided p = .080) and *Pet Negative Behaviours* (r = .081, two-sided p = .635). Within the *Stressor + Cat Interaction* group, significantly correlated behaviours include *Owner Contact with Pet* (r = .920, two-sided p < .001), *Neutral Speech* (r = .652, two-sided p < .001), *Affectionate Speech* (r = .391, two-sided p = .040), *Owner and Pet Play* (r = .968, two-sided p < .001), and *Owner Affectionate Behaviours* (r = .759, two-sided p < .001).

Select questionnaire data, as well as several behaviours during the pre- and post-stressor interactions were found to be related with general *reactivity,* general *recovery,* and the occurrence of specific interaction behaviours. Pearson correlations were run between the general heart rate and self-reported *reactivity* and *recovery* scores, the individual video coding behaviours, and the questionnaires in order to determine potential multicollinearity in any of the independent variables, as well as identify any general relationships between the independent variables and the heart rate and self-reported *reactivity* and *recovery* scores. Table 6 (containing the pre-stressor behavioural interactions) and Table 7 (containing the post-stressor behavioural interactions) displays the results of these correlations. While some of the behavioural codes correlated with one another, none of these behaviours exceeded r > 0.85, thus suggesting the absence of multicollinearity (Schroeder, Lander, & Levine-Silverman, 1990). None of the video coded behaviours were significantly correlated with the *reactivity* or *recovery* scores. Pet attitude scores were significantly correlated to the higher self-reported *reactivity* scores (r = .364, p < .001). Higher reports of Total Mental Health Diagnoses were significantly correlated with higher trait measures of depression, (r = 262, p = .014), more frequent occurrences of pre-stressor *Affectionate Speech* (r = .503, p < .001) and pre-stressor *Owner Affectionate Behaviours* (r = .295, p = .016). More frequent occurrences of pre-stressor *Frustrated Speech* was significantly correlated with higher trait measures of anxiety (r = .253, p = .041) and depression (r = .361, p =

.003). Finally, more frequent occurrences of post-stressor *Frustrated Speech* was correlated with higher reports of Recent Stressful Events (r = .264, p = .032).

GLMMs were sun separately for heart rate and self-reported stress and anxiety responses, showing that timepoint and gender accounted for the most variance in both heart rate and self-reported stress and anxiety data. When comparing all models, the best model for heart rate was the simple model of Timepoint (Pre and Post-Stressor) and Owner Gender (Male and Female) as fixed-effects, with ID as a random-effects variable (formula: HR ~ TX * Gender + (1|ID); *AICw* = .089, see Table 8). Variables included in the complex models building upon this simple model did not account for further variance in the heart rate data. The model's fixed-effects explanatory power was small (marginal R^2 = 0.116). The model's intercept, which included Timepoint = Pre and Gender = Female, was at 5.66 [$t(178)$ = 3.27, p < 0.01; 95% CI = 2.25, 9.08]. The effect of timepoint was statistically significant (beta = -11.94; 95% CI = -16.77, -7.10, $t(178)$ = -4.88, p < .001; Std. beta = -0.82; 95% CI = -1.15, -0.49). Specifically, heart rate *recovery* scores were demonstrated to be lower than heart rate *reactivity* scores. The effect of Gender was not statistically significant (beta = -4.99; 95% CI = -10.98, 0.99, $t(178)$ = -1.65, p = 0.101; Std. beta = -0.34, 95% CI [-0.76, 0.07]). However, the interaction between Gender and Timepoint was statistically significant (beta = 10.04; 95% CI = 1.57, 18.50, $t(178)$ = 2.34, p = 0.020; Std. beta = 0.69; 95% CI = 0.11, 1.27). Specifically, females demonstrated higher reactivity and more effective recovery than males, who demonstrated a more blunted reactivity to and recovery from the stressor. This model is summarized in Figure 5.

When comparing all models, the best model for self-reported stress and anxiety was the simple model of Timepoint (Pre and Post-Stressor), Owner Gender (Male and Female) with ID as random effect (formula: SR ~ TX * Gender + (1|ID); *AICw* = .107, see Table 9). Variables included in the complex models building upon this simple model did not account for further variance in the self-reported stress and anxiety data. The model's fixed-effects explanatory power was large (marginal $R^2 = 0.589$). The model's intercept, which included Timepoint = Pre, Gender = Female was 35.42 [$t(178) = 11.95$, $p < .001$; 95% CI = 29.57, 41.26]. The effect of Timepoint was statistically significant (beta = -61.22; 95% CI = -69.49, -52.95, $t(178) = -14.61$, $p < .001$; Std. beta = -1.68; 95% CI = -1.91, -1.45). Specifically, self-reported *recovery* scores were lower than the *reactivity* scores. The effect of Gender was not significant (beta = -9.62; 95% CI = -19.87, 0.62, $t(178) = -1.85$, $p = 0.065$; Std. beta = -0.26; 95% CI = -0.54, 0.02). However, the interaction between Gender and Timepoint was statistically significant (beta = 18.78; 95% CI = 4.30, 33.27, $t(178) = 2.56$, $p = 0.011$; Std. beta = 0.52; 95% CI = 0.12, 0.91). Similar to the previously described heart rate model, females demonstrated higher reactivity and more effective recovery than males, who also demonstrated a comparably more blunted reactivity to and recovery from the stressor. This model is summarized in Figure 6.

Discussion

The purpose of this study was to examine if interacting with a household pet – as compared to interacting with a friend, experiencing no interaction, and experiencing no stressor – assisted in attenuating an acute stress response induced by a novel adaptation of the TSST. Additionally, the behaviours demonstrated by both the owner and the pet during these interactions, as well as responses to several questionnaires regarding mental health, pet attitude, and recent stressful events, were examined in order to determine if these variables assisted or hindered stress attenuation. Initially, it was predicted that those who interacted with a pet would demonstrate blunted heart rate activity and decreased self-reported stress and anxiety when experiencing the stressor and immediately after interacting with a pet following the stressor, as compared to those who interacted with a peer or who did not engage in any interactions. While there was little precedent to reference for which specific behavioural and questionnaire variables would influence the efficacy of pet interactions on acute stress responses, positive owner interactions with their pet were predicted to result in attenuated reactivity and improved recovery to the stressor.

When examining both dog and cat owners together, those who interacted with a pet did not differ from those who did not interact with a pet in terms of heart rate activity or self-reported stress and anxiety. However, when considering dog and cat owners separately, individuals who interacted with a pet cat demonstrated blunted self-reported stress and anxiety to the stressor as compared to those who interacted with a pet dog. Many of the behaviours observed during interactions with a cat or dog displayed stability over the experiment. As well, specific behaviours during the pre- and post-stressor interactions for those who generally interacted with a pet were examined to identify basic relationships in general reactivity and recovery. More positive attitudes towards a pet were found to be correlated with less effective self-reported recovery from the stressor, contrary to previous literature examining the interplay of pet attachment and acute stress responses (Barker at al., 2015). Additionally, several of the questionnaires (depression and anxiety symptoms, diagnoses of mental health, and recent stressful experiences) were positively correlated with specific behaviours (affectionate speech, affectionate behaviours, and frustrated speech). Finally, in addition to timepoint for both mixed-effects models, pet type was identified to significantly interact with timepoint to account for variance for heart rate reactivity and recovery, while owner contact significantly accounted for variance for self-reported stress and anxiety reactivity and recovery.

Across the experiment, the heart rate and self-report for those who experienced a stressor and interacted with a pet did not significantly differ from those who did not experience a stressor, those who experienced a stressor without interacting with a pet or peer, and those who experienced a stressor and interacted with a peer. However, when considering those who interacted with a pet dog and those who interacted with a pet cat separately, those who interacted with a pet dog demonstrated significantly higher self-reported stress and anxiety during and immediately after the stressor as compared to those who did not experience a stressor. However, those who interacted with a pet dog did not demonstrate significant differences at these timepoints as compared to those who experienced a stressor without interacting with a pet or peer. This suggests that those who interacted with a pet dog before and after the acute stressor did not demonstrate a blunted response to, or accelerated recovery from, the stressor as compared to those who did not receive any buffering, as measured by self-reported stress and anxiety. Furthermore, this suggests that individuals who interacted with their pet dog and individuals who experienced the stressor without interacting with a pet demonstrated significant stress reactivity as compared to those who did not experience a stressor.

However, those who interacted with their pet cat demonstrated significantly lower self-reported stress and anxiety immediately after the mental math portion of the stressor as compared to those who interacted with their pet dog. As well, it is noteworthy that those who interacted with a pet cat also showed a non-significant trend of lower self-reported stress and anxiety after the post-stressor interaction with their pet as compared to those who interacted with their pet dog. Yet similarly to those who interacted with their pet dog, those who interacted with their pet cat did not significantly differ from those who experienced a stressor without interacting with a pet in terms of self-reported stress and anxiety. This suggests that those who interacted with a pet cat before and after the acute stressor had a significantly blunted reaction to the acute stressor compared to those who interacted with a pet dog. This also suggests that interacting with a pet cat may provide more effective stress buffering than interacting with a pet dog. This finding, while contrary to the original hypothesis, is remarkable because this is contrary to much of the existing literature concerning the efficacy of pet buffering, which to date has prioritized interactions between owners and pet dogs (i.e. Barker et al., 2015; Kertes et al, 2017; Polherber & Matchock, 2014). These results also contradict research considering both cats and dogs, which suggest few differences in the efficacy dogs and cats when buffering acute stress (Allen et al., 2002). As of yet, the literature considering only pet cats, as opposed to only pet dogs, is very limited. Thus, these results highlight a much-needed exploration gap in this literature.

The video coded behaviours during the pre- and post-stressor pet interaction phases were compared against one another for both dog and cat owners. These analyses were conducted in order to identify if correlations between the occurrences of behaviours between the pre- and post-stressor interactions, as well as number of occurrences significantly differed both between interaction periods and pet type. When considering the correlation of occurrence of behaviour for those who interacted with their pet dog, the occurrences of all behaviours were significantly correlated between one another except for the frequency with which a dog approached their owner, and frequency of the dog engaging in negative behaviours. Those who interacted with their pet cat demonstrated slightly more behaviours that did not significantly correlate between the pre- and post-stressor interactions than those who interacted with their pet dog – specifically, the *Pet Within Arm's Reach, Pet Approaches Owner, Frustrated Speech, Pet Negative Behaviour,* and *Owner Distracted Behaviours*. Of note, *Pet Within Arm's Reach, Pet Approaches Owner*, and *Pet Negative Behaviours* were heavily influenced by the behaviours of the cat, suggesting that cats generally may be less predictable in these specific behaviours across time. This leaves *Frustrated Speech* and *Owner Distracted Behaviours* as the only variables that are informative of the owner's autonomous behaviours. Furthermore, the occurrences of any of these video coded behaviours did not significantly differ between the pre- and post-stressor interaction periods for both those who interacted with their pet dog and those who interacted with their pet cat.

These results suggest that the behaviours the participant chose to engage in with their pet may demonstrate trait-like characteristics, and these traits may differ between dog and cat owners. This hypothesis is supported by previous literature. For example, Kidd and Kidds (1980) demonstrated significant differences in an owner's personality characteristics between dog pet owners and cat pet owners, such as autonomy, dominance, aggression, and nurturance as a function of owner gender (male and female). Regarding stress, previous literature has identified a relationship between attachment style, another human trait characteristic, and cortisol responses to acute stress (Kidd, Hamer, & Steptoe, 2011). Thus, these results suggest that pet ownership may be intertwined with human trait characteristics, which then may be predictive of behaviour and physiological responses to acute stress. This may suggest that traits that compel individuals to identify as "dog people" rather than "cat people" could interact with acute stress, thus resulting in more reactivity to and less efficient recovery from acute stress. This explanation may also extend to those who display strong attachments to their pets, as pet attachment was positively correlated with less effective self-reported *recovery* from the stressor. Perhaps traits that compel individuals to bond more with their pet may also present susceptibilities to prolonged experiences of acute stress.

When examining the questionnaires, self-reported attitudes towards one's pet were significantly positively correlated with the *reactivity* score for self-reported stress and anxiety. This indicates that more positive attitudes towards one's pet, were related with a higher *reactivity* score, or less effective pre-emptive stress buffering. This finding is particularly noteworthy, as this is in contrast with previous literature demonstrating that interacting with a loved pet, results in decreased self-reported and physiological (i.e. cardiac and salivary cortisol) responses to a stressor (Barker et al., 2015). The lack of significant correlations in the interaction behaviours demonstrated that no single behavioural variable had a significant relationship with general reactivity and recovery for either dependent variables. Again, this suggests that trait-like attitudes towards one's pet are more relevant to stress reactivity than specific behaviours in the moment. While these analyses were exploratory and there was no definitive prediction for potential correlations, this finding is somewhat contrary to existing literature, where certain variables demonstrated a more straightforward relationship with stress reactivity. For example, Kertes and colleagues (2017) demonstrated that children who initiated petting behaviours with their dog demonstrated a blunted cortisol response after experiencing a modified TSST. Due to in-person research restrictions preventing the collection of saliva during the experiment, the current study is not able to exclude the possibility that these behaviours may have been correlated with cortisol responses.

However, there were unexpected and compelling significant correlations between video coded behaviours and the questionnaire scales. For example, higher instances of mental health diagnoses an individual reported was significantly correlated with increased instances of *Owner Affectionate Speech* and *Owner Affectionate Behaviours* during the pre-stressor interaction phase, but not during the post-stressor interaction phase. As well, more frequent instances of

Frustrated Speech during the pre-stressor interaction phase were correlated with increases in both depression and anxiety symptomatology. Similar to the correlations associated with Total Mental Health Diagnoses, these correlations did not occur during the post-stressor interaction phase. Finally, increased instances of *Frustrated Speech* during the post-stressor interaction phase were correlated with greater reports of Recent Stressful Experiences preceding participating in the experiment. Again, this correlation was not demonstrated in the pre-stressor interaction phase. A possible explanation for these results may be that acute stress could generally moderate the relationship between owner-reported psychological characteristics and owner-pet behaviours. Acute stress may reduce the association between mental health and general affection towards a pet and exaggerate the relationship between recent stressful events and frustration. However, further research examining the interaction between specific mechanisms and acute stress is required to better understand these results.

When examining models of both heart rate and self-reported stress and anxiety across the experiment, Timepoint and Owner Gender emerged as fixed-effects. Specifically, the change in heart rate and self-reported stress and anxiety was demonstrated to significantly decrease between the post-stressor pet interaction and the conclusion of the stressor, as compared to the change between the pre-stressor pet interaction and the stressor. This trend of recovery was expected, as participants were predicted to experience significant recovery from the stressor following the post-stressor pet interaction. While there was no significant main effect of owner gender in either models, both models displayed a significant interaction between Owner Gender and Timepoint. Females displayed higher *reactivity* scores for both heart rate and self-reported stress and anxiety as compared to males, indicating greater physiological and psychological activation in response to the stressor. Furthermore, females displayed lower *recovery* for both heart rate and self-reported stress and anxiety as compared to males, indicating more effective recovery from the stressor. While no specific predictions were made regarding gender differences in acute stress reactions in the current study, previous literature has found significant gender differences in acute stress attenuation. Specifically, females have been documented to demonstrate more self-reported acute stress reactivity following an acute stressor as compared to males (i.e. Kelly et al., 2008). Thus, these results support the existing literature on gender differences in stress reactivity.

Strengths and Limitations

Some strengths of the current study include novelty of the experimental design, allowing participants to interact with their pet in their home environments, and including both the pre- and post-stressor interaction phases. This study was one of the first studies to validate the TSST to be conducted remotely, while also validating psychological and physiological measures that are inexpensive and user-friendly (see Harvie et al., 2021). Validating such methodology allows for similar research to be replicated easily, and to include populations that have oftentimes been excluded from participating in classic lab-based research experiments. As well, these methods allowed for arguably the most naturalistic interactions between an owner and their pet possible for a cross sectional study. This is in contrast to much of the previous lab-based research that may not be accurately documenting relationship between owners and their pets (where pets are brought into a laboratory setting, which might induce stress), because in the present study both the owner and pet remained in their comfortable home environment, which may have lessened the anticipatory anxiety experienced by participants, as well as stress related to transportation for the pet. Finally, this study is the first to examine both pre- and post-stressor pet interactions in tandem. This allowed me to directly compare the efficacy the timing of the interaction in terms of blunting reactivity to the stressor and recovering from the stressor, as well as providing information on potential trait characteristics associated with these naturalistic interactions.

However, this study was not without limitations. Some of these limitations include potential of unnatural interactions between owners and pets throughout the experiment, the influence of movement on heart rate measures, inequality between genders across groups, missing data concerning pet ownership, and potential introduction of socioeconomic confounds between dog and cat owners. As participants were instructed to remain in view of their laptop camera during these interaction phases, compounded with the fact that the participants knew they were being observed by researchers, this could have been an additional stressor for the participants, as well as limiting the possible physical interactions with their pet. When interacting with a pet, physical movement seems to be almost inherent, as compared to sitting still while reading (demonstrated by those who did not experience a stressor and those who those who experienced a stressor without interacting with a pet), or speaking on the phone (demonstrated by those who interacted with a peer). As well, the instructions provided to participants required the participant to physically remove the pet from the room before recording their heart rate and VAS measurements. This was done in order to maintain consistency across conditions, as those who interacted with a peer were instructed to end the call with their peer before recording these measurements. However, the extraneous movement as compared to the other groups may have muddled the heart rate results at these key timepoints. As well, gender was not evenly represented within these groups, with females outnumbering males. Therefore, potentially significant effects of gender may be underpowered in this study. Furthermore, this study did not collect information on when the pet that the owner interacted with was acquired. As this study took place during the COVID-19 pandemic, which generated a surge in pet adoption (Slugoski, 2021), there is a possibility that some owners may have been interacting with pets they had yet to develop a strong relationship/positive attitudes towards them, while others may have been interacting with a long-adored family pet, thus creating a potential confounding variable. Finally, potential confounds associated with socioeconomic differences between dog and cat owners may have an unmeasured influence over the results of this study. Although speculative, dog owners may be more likely to live in an owned house, due to the special demands of dog ownership and limited rental housing options for particularly large-breed dogs. Cat owners, on the other hand, may have an increased likelihood of living in a rented apartment. Therefore, more research is required to definitively reject this potential confound.

Study Implications

There is no shortage of anecdotal experiences of owners reporting that their pet assists in maintaining the quality of their mental health – particularly in the belief that a pet is a calming force in their everyday life (McNicholas et al., 2005). However, the buffering influence of a pet during an acute stress response still requires more research to be fully understood. This study has validated novel methodological designs and has produced results that directly refute much of the existing literature. Therefore, the implications of this study include identifying potential avenues for similar future research, such as validating these methods with previously accepted gold-standard measures of acute stress reactivity (i.e. salivary cortisol, ECG measures of cardiac activity), as well as better contextualizing the potential benefits and risks of relying on a pet for attenuating stress reactivity. While this study has produced results that have not been demonstrated in the literature previously, specifically that interactions with a pet cat resulted in a blunted response to, and accelerated recovery from, an acute stressor, many questions remain ambiguous and available for future research. For example, to what extent are the interactions one chooses to engage in with their pet a manifestation of trait characteristics, and to what extent may these interactions be disrupted by acute stress? It is clear from the results of this study that aspects of pet interactions, such as pet species and physical contact, influenced the extent to which one reacted to an acute stressor. Once the mechanisms of this influence are better understood, this can be applied to individuals susceptible to the noxious physiological and psychological effects of chronic exposure to acute stress, thus resulting in better quality of life.

This research study successfully adapted previously accepted methodology for inducing acute stress responses remotely. However, it is important to once again reference the unprecedented social environment in which this study took place. As previously discussed, the COVID-19 pandemic did not only impact how research has recently been conducted, but countless individual's mental wellbeing. Therefore, the experience of acute stress in general may have been exacerbated due to the social conditions. Furthermore, the necessity for many to remain primarily within their homes may have influenced the manner in which participants interacted with their pet in many unpredictable ways. This study had assisted in setting the precedent in remote data collection for acute stress reactivity, as well as examining the potential buffering effect interacting with a pet may have on acute stress. In order to further substantiate the results of this study, replication of these methods may be required when the world returns to more "normal" conditions.

References

Allen, A. P., Kennedy, P. J., Cryan, J. F., Dinan, T. G., & Clarke, G. (2014). Biological and psychological markers of stress in humans: Focus on the Trier Social Stress Test. *Neuroscience and Biobehavioral Reviews*, *38*, 94–124. https://doi.org/10.1016/j.neubiorev.2013.11.005

Allen, K., Blascovich, J., & Mendes, W. B. (2002). Cardiovascular reactivity and the presence of pets, friends, and spouses: The truth about cats and dogs. *Psychosomatic Medicine*, *64*(5), 727–739. https://doi.org/10.1097/01.PSY.0000024236.11538.41

Bae, Y. J., Reinelt, J., Netto, J., Uhlig, M., Willenberg, A., Ceglarek, U., ... & Kratzsch, J. (2019). Salivary cortisone, as a biomarker for psychosocial stress, is associated with state anxiety and heart rate. *Psychoneuroendocrinology*, *101*, 35-41.

Barker, S. B., Knisely, J. S., McCain, N. L., Schubert, C. M., & Pandurangi, A. K. (2015). Exploratory study of Stress-Buffering response patterns from interaction with a therapy dog. *Anthrozoos*, *23*(1), 79–91. https://doi.org/10.2752/175303710X12627079939341

Cassirame, J., Vanhaesebrouck, R., Chevrolat, S., & Mourot, L. (2017). Accuracy of the Garmin 920 XT HRM to perform HRV analysis. *Australasian Physical and Engineering Sciences in Medicine*, *40*(4), 831–839. https://doi.org/10.1007/s13246-017-0593-8

Claes, J., Buys, R., Avila, A., Finlay, D., Kennedy, A., Guldenring, D., Budts, W., & Cornelissen, V. (2017). Validity of heart rate measurements by the Garmin Forerunner 225 at different walking intensities. *Journal of Medical Engineering and Technology*, *41*(6), 480–485. https://doi.org/10.1080/03091902.2017.1333166

Dean, A., & Lin, N. (1977). The stress-buffering role of social support. *Journal of Nervous and Mental Disease, 165*(6), 403–417. https://doi.org/10.1097/00005053-197712000-00006

Derakhshan, A., Mikaeili, M., Nasrabadi, A. M., & Gedeon, T. (2019). Network physiology of "fight or flight" response in facial superficial blood vessels. *Physiological Measurement*, *40*(1). https://doi.org/10.1088/1361-6579/aaf089

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, *130*(3), 355–391. https://doi.org/10.1037/0033-2909.130.3.355

Ditzen, B., Schmidt, S., Strauss, B., Nater, U. M., Ehlert, U., & Heinrichs, M. (2008). Adult attachment and social support interact to reduce psychological but not cortisol responses to stress. *Journal of Psychosomatic Research*, *64*(5), 479–486. https://doi.org/10.1016/j.jpsychores.2007.11.011

Eagle, D. E., Rash, J. A., Tice, L., & Proeschold-Bell, R. J. (2021). Evaluation of a remote, internet-delivered version of the Trier Social Stress Test. *International Journal of Psychophysiology*, *165*(March), 137–144. https://doi.org/10.1016/j.ijpsycho.2021.03.009

Engert, V., Koester, A. M., Riepenhausen, A., & Singer, T. (2016). Boosting recovery rather than buffering reactivity: Higher stress-induced oxytocin secretion is associated with increased cortisol reactivity and faster vagal recovery after acute psychosocial stress. *Psychoneuroendocrinology*, *74*, 111–120. https://doi.org/10.1016/j.psyneuen.2016.08.029

Fan, Y. Y., Li, Y. G., Li, J., Cheng, W. K., Shan, Z. L., Wang, Y. T., & Guo, Y. T. (2019). Diagnostic performance of a smart device with photoplethysmography technology for atrial fibrillation detection: Pilot study (pre-mafa II registry). *JMIR MHealth and UHealth*, *7*(3), 1–11. https://doi.org/10.2196/11437

Felnhofer, A., Kaufmann, M., Atteneder, K., Kafka, J. X., Hlavacs, H., Beutl, L., Hennig-Fast, K., & Kothgassner, O. D. (2019). The mere presence of an attentive and emotionally responsive virtual character influences focus of attention and perceived stress. *International Journal of Human Computer Studies*, *132*(July 2018), 45–51. https://doi.org/10.1016/j.ijhcs.2019.07.010

Folstein, M. F., & Luria, R. (1973). Reliability, validity, and clinical application of the visual analogue mood scale. *Psychological Medicine*, *3*(4), 479–486. https://doi.org/10.1017/S0033291700054283

Friard, O., & Gamba, M. (2016). BORIS: a free, versatile open-source event-logging software for video/audio coding and live observations. *Methods in Ecology and Evolution*, *7*(11), 1325–1330. https://doi.org/10.1111/2041-210X.12584

Gershoff, E. T. (2016). Should Parents' Physical Punishment of Children Be Considered a Source of Toxic Stress That Affects Brain Development? *Family Relations*, *65*(1), 151–162. https://doi.org/10.1111/fare.12177

Gilgen-Ammann, R., Schweizer, T., & Wyss, T. (2019). RR interval signal quality of a heart rate monitor and an ECG Holter at rest and during exercise. *European Journal of Applied Physiology*, *119*(7), 1525–1532. https://doi.org/10.1007/s00421-019-04142-5

Gonçalves, H., Pinto, P., Silva, M., Ayres-de-Campos, D., & Bernardes, J. (2016). Electrocardiography versus photoplethysmography in assessment of maternal heart rate variability during labor. *SpringerPlus*, *5*(1). https://doi.org/10.1186/s40064-016-2787-z

Gunnar, M. R., Reid, B. M., Donzella, B., Miller, Z. R., Gardow, S., Tsakonas, N. C., ... & Bendezú, J. J. (2021). Validation of an online version of the Trier Social Stress Test in a study of adolescents. *Psychoneuroendocrinology*, *125*, 105111.

Harvie, H. M. K., Jain, B., Nelson, B. W., Knight, E. L., Roos, L. E., & Giuliano, R. J. (2021). Induction of acute stress through an internet-delivered Trier Social Stress Test as assessed by photoplethysmography on a smartphone. *Stress*, *0*(0), 1–10. https://doi.org/10.1080/10253890.2021.1995714

Hedeker, D. (2005). Generalized linear mixed models. *International Encyclopedia of Education*, *2*, 171–177. https://doi.org/10.1016/B978-0-08-044894-7.01332-4

Hennessy, M. B., Kaiser, S., & Sachser, N. (2009). Social buffering of the stress response: Diversity, mechanisms, and functions. *Frontiers in Neuroendocrinology*, *30*(4), 470–482. https://doi.org/10.1016/j.yfrne.2009.06.001

Hernando, D., Roca, S., Sancho, J., Alesanco, Á., & Bailón, R. (2018). Validation of the apple watch for heart rate variability measurements during relax and mental stress in healthy subjects. *Sensors (Switzerland)*, *18*(8). https://doi.org/10.3390/s18082619

Hostinar, C. E., Sullivan, R. M., & Gunnar, M. R. (2014). Psychobiological mechanisms underlying the social buffering of the hypothalamic-pituitary-adrenocortical axis: A review of animal models and human studies across development. *Psychological Bulletin*, *140*(1), 256–282. https://doi.org/10.1037/a0032671

Karmali, S. N., Sciusco, A., May, S. M., & Ackland, G. L. (2017). Heart rate variability in critical care medicine: a systematic review. *Intensive Care Medicine Experimental*, *5*(1), 1–15. https://doi.org/10.1186/s40635-017-0146-1

Kertes, D. A., Liu, J., Hall, N. J., Hadad, N. A., Wynne, C. D. L., & Bhatt, S. S. (2017). Effect of Pet Dogs on Children's Perceived Stress and Cortisol Stress Response. *Social Development*, *26*(2), 382–401. https://doi.org/10.1111/sode.12203

Kelly, M. M., Tyrka, A. R., Anderson, G. M., Price, L. H., & Carpenter, L. L. (2008). Sex differences in emotional and physiological responses to the Trier Social Stress Test. *Journal of Behavior Therapy and Experimental Psychiatry*, *39*(1), 87–98. https://doi.org/10.1016/j.jbtep.2007.02.003

Khunti, K. (2014). Accurate interpretation of the 12-lead ECG electrode placement: A systematic review. *Health Education Journal*, *73*(5), 610–623. https://doi.org/10.1177/0017896912472328

Kidd, T., Hamer, M., & Steptoe, A. (2011). Examining the association between adult attachment style and cortisol responses to acute stress. *Psychoneuroendocrinology*, *36*(6), 771–779. https://doi.org/10.1016/j.psyneuen.2010.10.014

Kidd A.H., Kidds R. M. (1980). Personality Characteristics and Preferences in Pet Ownership. *Psychological Reports*, 46(3):939-949. doi:10.2466/pr0.1980.46.3.939

Kikusui, T., Winslow, J. T., & Mori, Y. (2006). Social buffering: Relief from stress and anxiety. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *361*(1476), 2215–2228. https://doi.org/10.1098/rstb.2006.1941

Kirschbaum, C. (2021). Why we need an online version of the Trier Social Stress Test. *Psychoneuroendocrinology*, 105129.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test'–a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*(1-2), 76-81.

Lancia, L., Toccaceli, A., Petrucci, C., Romano, S., & Penco, M. (2018). Continuous ECG Monitoring in Patients With Acute Coronary Syndrome or Heart Failure: EASI Versus Gold Standard. *Clinical Nursing Research*, *27*(4), 433–449. https://doi.org/10.1177/1054773817704653

Martens, P., Enders-Slegers, M. J., & Walker, J. K. (2016). The emotional lives of companion animals: Attachment and subjective claims by owners of cats and dogs. *Anthrozoos*, *29*(1), 73–88. https://doi.org/10.1080/08927936.2015.1075299

McConnell, A. R., Paige Lloyd, E., & Humphrey, B. T. (2019). We Are Family: Viewing Pets as Family Members Improves Wellbeing. *Anthrozoos*, *32*(4), 459–470. https://doi.org/10.1080/08927936.2019.1621516

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: Allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences*, *1032*, 1–7. https://doi.org/10.1196/annals.1314.001

McNicholas, J., Gilbey, A., Rennie, A., Ahmedzai, S., Dono, J. A., & Ormerod, E. (2005). Pet ownership and human health: A brief review of evidence and issues. *British Medical Journal*, *331*(7527), 1252–1254. https://doi.org/10.1136/bmj.331.7527.1252

Meuwly, N., Bodenmann, G., Germann, J., Bradbury, T. N., Ditzen, B., & Heinrichs, M. (2012). Dyadic coping, insecure attachment, and cortisol stress recovery following experimentally induced stress. *Journal of Family Psychology*, *26*(6), 937–947. https://doi.org/10.1037/a0030356

Monzer, N., Hartmann, M., Buckert, M., Wolff, K., Nawroth, P., Kopf, S., Kender, Z., Friederich, H. C., & Wild, B. (2021). Associations of Childhood Neglect With the ACTH and Plasma Cortisol Stress Response in Patients With Type 2 Diabetes. *Frontiers in Psychiatry*, *12*(June), 1–14. https://doi.org/10.3389/fpsyt.2021.679693

Muggeridge, D. J., Hickson, K., Davies, A. V., Giggins, O. M., Megson, I. L., Gorely, T., & Crabtree, D. R. (2021). Measurement of heart rate using the polar OH1 and fitbit charge 3 wearable devices in healthy adults during light, moderate, vigorous, and sprint-based exercise: Validation study. *JMIR MHealth and UHealth*, *9*(3). https://doi.org/10.2196/25313

Nagasawa, M., Mitsui, S., En, S., Ohtani, N., Ohta, M., Sakuma, Y., Onaka, T., Mogi, K., Kikusui, T., Mccoy, R. C., Demko, Z., Ryan, A., Banjevic, M., Hill, M., Sigurjonsson, S., Rabinowitz, M., Fraser, H. B., & Petrov, D. A. (2015). Oxytocin-Gaze Positive Loop and the Coevolution of Human-Dog Bonds Common Variants Spanning PLK4 Are Associated With Mitotic-Origin Aneuploidy in Human Embryos. *Science*, *348*(6232), 450–451.

Nielsen, N. R., Zhang, Z. F., Kristensen, T. S., Netterstrøm, B., Schnohr, P., & Grønbæk, M. (2005). Self reported stress and risk of breast cancer: Prospective cohort study. *British Medical Journal*, *331*(7516), 548–550. https://doi.org/10.1136/bmj.38547.638183.06

Nwachukwu I, Nkire N, Shalaby R, Hrabok M, Vuong W, Gusnowski A, & Surood S. (2020). Covid-19 pandemic: Age-related differences in measures of stress, anxiety and depression in Canada. International Journal of Environmental Research and Public*; 17(17): 1-10.* 1–10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7503671/pdf/ijerph-17-06366.pdf

Oddone, C. G., Hybels, C. F., McQuoid, D. R., & Steffens, D. C. (2011). Social support modifies the relationship between personality and depressive symptoms in older adults. *American Journal of Geriatric Psychiatry*, *19*(2), 123–131. https://doi.org/10.1097/JGP.0b013e3181f7d89a

O'dea, S. (2020). Number of smartphone users worldwide from 2016 to 2021. Statista Research Department. https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Owen, C. G., Nightingale, C. M., Rudnicka, A. R., Ekelund, U., McMlnn, A. M., Van Sluijs, E. M. F., Griffin, S. J., Cook, D. G., & Whincup, P. H. (2010). Family dog ownership and levels of physical activity in childhood: Findings from the child heart and health study in England. *American Journal of Public Health*, *100*(9), 1669–1671. https://doi.org/10.2105/AJPH.2009.188193

Polheber, J. P., & Matchock, R. L. (2014). The presence of a dog attenuates cortisol and heart rate in the Trier Social Stress Test compared to human friends. *Journal of Behavioral Medicine*, *37*(5), http://dx.doi.org.uml.idm.oclc.org/10.1007/s10865-013-9546-1

Powell, L., Chia, D., McGreevy, P., Podberscek, A. L., Edwards, K. M., Neilly, B., Guastella, A. J., Lee, V., & Stamatakis, E. (2018). Expectations for dog ownership: Perceived physical, mental and psychosocial health consequences among prospective adopters. *PLoS ONE*, *13*(7), 1–13. https://doi.org/10.1371/journal.pone.0200276

PVD Apps (2015). *Heart Rate Plus* (Version 2.0.2). [Mobile App]. App Store. http://heartrateplus.pvdapps.com/#:~:text=Trusted%20by%20more%20than%205,your%20pulse%20on%20your%20finger!

Rabe-Hesketh, S., & Skrondal, A. (2010). Generalized linear mixed models. *International Encyclopedia of Education*, *2*, 171–177. https://doi.org/10.1016/B978-0-08-044894-7.01332-4

Riem, M. M. E., Kunst, L. E., Bekker, M. H. J., Fallon, M., & Kupper, N. (2020). Intranasal oxytocin enhances stress-protective effects of social support in women with negative childhood experiences during a virtual Trier Social Stress Test. *Psychoneuroendocrinology*, *111*(September 2019), 104482. https://doi.org/10.1016/j.psyneuen.2019.104482

Roos, L. E., Knight, E. L., Beauchamp, K. G., Giuliano, R. J., Fisher, P. A., & Berkman, E. T. (2017). Conceptual precision is key in acute stress research: A commentary on Shields, Sazma, & Yonelinas, 2016. *Neuroscience & Biobehavioral Reviews*, *83*, 140-144.

Saunders, J., Parast, L., Babey, S. H., & Miles, J. V. (2017). Exploring the differences between pet and non-pet owners: Implications for human-animal interaction research and policy. *PLoS ONE*, *12*(6), 1–15. https://doi.org/10.1371/journal.pone.0179494

Shantanam, S. (2018). Effect of Pet Dogs on Children's Perceived Stress and Cortisol Stress Response. *Physiology & Behavior*, *176*(1), 139–148. https://doi.org/10.1016/j.physbeh.2016.11.014.A

Slugoski, K. (2021, September 26). *Pandemic pets a lifesaver to many Canadians during COVID-19 isolation*. Global News. Retrieved June 15, 2022, from https://globalnews.ca/news/8187460/covid-19-pandemic-pets-family-matters/

Somma, A., Krueger, R. F., Markon, K. E., Gialdi, G., Colanino, M., Ferlito, D., Liotta, C., Frau, C., & Fossati, A. (2021). A longitudinal study on clinically relevant self-reported depression, anxiety and acute stress features among Italian community-dwelling adults during the COVID-19 related lockdown: Evidence of a predictive role for baseline dysfunctional personality dimensions. *Journal of Affective Disorders*, *282*(November 2020), 364–371. https://doi.org/10.1016/j.jad.2020.12.165

Spencer, R. L., & Deak, T. (2017). A users guide to HPA axis research. *Physiology and Behavior*, *178*, 43–65. https://doi.org/10.1016/j.physbeh.2016.11.014

Statistics Canada. (2021). *Survey on COVID-19 and mental health, September to December 2020*. *December 2020*, 2020–2022. https://www150.statcan.gc.ca/n1/daily-quotidien/210318/dq210318a-eng.htm

Strahler, J., Skoluda, N., Kappert, M. B., & Nater, U. M. (2017). Simultaneous measurement of salivary cortisol and alpha-amylase: Application and recommendations. *Neuroscience and Biobehavioral Reviews*, *83*(July), 657–677. https://doi.org/10.1016/j.neubiorev.2017.08.015

Tredennick, A. T., Hooker, G., Ellner, S. P., & Adler, P. B. (2021). A practical guide to selecting models for exploration, inference, and prediction in ecology. *Ecology*, *102*(6). https://doi.org/10.1002/ecy.3336

Uchino, B., Cacioppo, J., Kiecolt-Glaser, J. & (1996). The Relationship Between Social Support and Physiological Processes. *Psychological Bulletin, 119* (3), 488-531. doi: 10.1037/0033-2909.119.3.488.

Udell, M. A. R., Dorey, N. R., & Wynne, C. D. L. (2010). What did domestication do to dogs? A new account of dogs' sensitivity to human actions. *Biological Reviews*, *85*(2), 327–345. https://doi.org/10.1111/j.1469-185X.2009.00104.x

Utz, R. L. (2014). Walking the Dog: The Effect of Pet Ownership on Human Health and Health Behaviors. *Social Indicators Research*, *116*(2), 327–339. https://doi.org/10.1007/s11205-013-0299-6

Wagner, J., Lampert, R., Tennen, H., & Feinn, R. (2015). Exposure to discrimination and heart rate variability reactivity to acute stress among women with diabetes. *Stress and Health*, *31*(3), 255–262. https://doi.org/10.1002/smi.2542

Yan, B. P., Chan, C. K. Y., Li, C. K. H., To, O. T. L., Lai, W. H. S., Tse, G., Poh, Y. C., & Poh, M. Z. (2017). Resting and postexercise heart rate detection from fingertip and facial photoplethysmography using a smartphone camera: A validation study. *JMIR MHealth and UHealth*, *5*(3), 1–11. https://doi.org/10.2196/mhealth.7275

Tables

Table 1.

Sample Characteristics

		Control (*n* = 50)	Stressor-No-Interaction (*n* = 54)	Stressor + Peer Interaction (*n* = 98)	Stressor + Pet Interaction (*n* = 87)		
						Stressor + Pet Dog (*n* = 50)	Stressor + Pet Cat (*n* = 37)
Age							
	17 and younger	5 (10.0%)	5 (9.3%)	15 (15.3%)	10 (11.5%)	6 (12.0%)	4 (10.8%)
	18-19	30 (60.0%)	37 (68.5%)	72 (73.5%)	53 (66.7%)	33 (66.0%)	20 (54.1%)
	20-21	7 (14.0%)	4 (7.4%)	4 (4.1%)	12 (13.8%)	6 (12.0%)	6 (16.2%)
	22-23	2 (4.0%)	4 (7.4%)	3 (3.1%)	4 (4.6%)	2 (4.0%)	2 (5.4%)
	24-25	2 (4.0%)	1 (1.9%)	1 (1.0%)	11 (1.1%)	1 (2.0%)	0 (0%)
	26-27	1 (2.0%)	3 (5.6%)	0 (0%)	1 (1.1%)	1 (2.0%)	0 (0%)
	28-29	1 (2.0%)	0 (0%)	1 (1.0%)	2 (2.3%)	1 (2.0%)	1 (2.7%)
	30-40	0 (0%)	0 (0%)	2 (2.0%)	2 (2.3%)	0 (0%)	2 (5.4%)
	40-50	0 (0%)	0 (0%)	0 (0%)	1 (1.1%)	0 (0%)	1 (2.7%)
	50+	2 (4.0%)	0 (0%)	0 (0%)	1 (1.1%)	0 (0%)	1 (2.7%)
Gender							
	Male	16 (32.0%)	19 (35.2%)	23 (23.5%)	29 (33.3%)	17 (34.0%)	12 (32.4%)
	Female	34 (68.0%)	35 (64.8%)	75 (76.5%)	58 (66.7%)	33 (66.0%)	25 (67.6%)
Race or Ethnicity							
	Black	1 (2.0%)	0 (0%)	1 (1.0%)	1 (1.1%)	1 (2.0%)	
	Chinese	3 (6.0%)	2 (3.7%)	1 (1.0%)	2 (2.3%)	1 (2.0%)	1 (2.7%)
	Filipino	3 (6.0%)	10 (18.5%)	7 (7.1%)	2 (2.3%)	2 (4.0%)	1 (2.7%)

Indigenous	2 (4.0%)	1 (1.8%)	5 (5.1%)	3 (3.4%)	1 (2.0%)	1 (2.7%)
Japanese	1 (2.0%)	0 (0%)	0 (0%)	2 (2.3%)	0 (0%)	0 (0%)
Korean	0 (0%)	1 (1.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Metis	3 (6.0%)	3 (5.6%)	4 (4.1%)	3 (3.4%)	2 (4.0%)	1 (2.7%)
Other	2 (4.0%)	3 (5.6%)	4 (4.1%)	4 (4.6%)	0 (0%)	2 (5.4%)
South Asian	0 (0%)	1 (1.9%)	5 (5.1%)	4 (4.6%)	3 (6.0%)	1 (2.7%)
Southeast Asian	4 (8.0%)	0 (0%)	2 (2.0%)	1 (1.1%)	1 (2.0%)	0 (0%)
White/European	30 (60.0%)	33 (61.1%)	67 (68.4%)	66 (75.9%)	37 (74.0%)	29 (78.4%)
Decline to Answer	1 (2.0%)	0 (0%)	1 (1.0%)	1 (1.1%)	0 (0%)	1 (2.7%)

Note. N = 289

Table 2.

Descriptive Statistics and Pairwise Comparisons for Behaviours During Pre- and Post-Stressor Interactions

		Pre-Stressor Interaction *M (SD)*	Post Stressor Interaction *M (SD)*	Paired Samples Test	Paired Samples Correlations
Stressor + Pet Dog (*n* = 37)					
	Pet Within Arm's Reach (seconds)	270.77 (77.23)	274.78 (62.38)	$t(1, 36) = -.389, p = .700$	$r = .614, p < .001$
	Owner Contact with Pet (seconds)	222.72 (111.38)	207.74 (108.52)	$t(1, 36) = 1.209, p = .235$	$r = .765, p < .001$
	Pet Approaching Owner	0.5 (1.28)	0.41 (1.40)	$t(1, 36) = .513, p = .611$	$r = .292, p = .080$
	Neutral Speech	16.67 (17.22)	14.95 (12.80)	$t(1, 36) = .822, p = .416$	$r = .673, p < .001$
	Affectionate Speech	3 (6.11)	2.19 (3.66)	$t(1, 36) = .963, p = .342$	$r = .547, p < .001$
	Frustrated Speech	0.9 (2.71)	1.97 (4.79)	$t(1, 36) = -1.372, p = .178$	$r = .327, p = .048$
	Owner-Pet Play	5.37 (12.42)	5.19 (11.08)	$t(1, 36) = .134, p = .894$	$r = .739, p < .001$
	Pet Negative Behaviours	0.65 (1.32)	0.76 (1.79)	$t(1, 36) = -.309, p = .759$	$r = .081, p = .635$
	Owner Affectionate Behaviours	1.54 (2.98)	1.97 (4.32)	$t(1, 36) = -.833, p = .410$	$r = .682, p < .001$
	Owner Distracted Behaviours	0.35 (1.27)	0.30 (0.85)	$t(1, 36) = .279, p = .782$	$r = .442, p = .006$
Stressor + Pet Cat (*n* = 28)					
	Pet Within Arm's Reach (seconds)	298.28 (24.18)	289.97 (44.29)	$t(1, 27) = .938, p = .357$	$r = .163, p = .406$

	Owner Contact with Pet (seconds)	270.21 (74.08)	267.86 (70.73)	$t(1, 27) = .427$, $p = .673$	$r = .920$, $p < .001$
	Pet Approaching Owner	0.14 (.49)	0.25 (0.80)	$t(1, 27) = -.593$, $p = .558$	$r = -.103$, $p = .601$
	Neutral Speech	9.79 (8.65)	10.32 (11.93)	$t(1, 27) = -.312$, $p = .758$	$r = .652$, $p < .001$
	Affectionate Speech	1.89 (4.87)	0.93 (1.96)	$t(1, 27) = 1.138$, $p = .265$	$r = .391$, $p = .040$
	Frustrated Speech	1.04 (2.69)	0.54 (1.29)	$t(1, 27) = .841$, $p = .408$	$r = -.145$, $p = .463$
	Owner-Pet Play	2.82 (11.08)	3.86 (12.04)	$t(1, 27) = -1.770$, $p = .088$	$r = .968$, $p < .001$
	Pet Negative Behaviours	1.54 (3.65)	0.68 (1.44)	$t(1, 27) = 1.279$, $p = .212$	$r = .267$, $p = .170$
	Owner Affectionate Behaviours	2.14 (4.50)	3.29 (8.05)	$t(1, 27) = -1.104$, $p = .279$	$r = .759$, $p < .001$
	Owner Distracted Behaviours	0.43 (2.08)	0.57 (2.50)	$t(1, 27) = -.238$, $p = .814$	$r = .044$, $p = .825$
Males (n = 23)					
	Pet Within Arm's Reach (seconds)	267.58 (86.69)	267.15 (66.18)		
	Owner Contact with Pet (seconds)	232.77 (102.50)	222.44 (90.70)		
	Pet Approaching Owner	0.57 (1.34)	0.30 (0.88)		
	Neutral Speech	11.61 (10.68)	11.70 (12.35)		
	Affectionate Speech	0.43 (1.12)	1.17 (3.17)		
	Frustrated Speech	1.13 (2.72)	2.91 (2.13)		
	Owner-Pet Play	3.78 (12.52)	5.22 (13.22)		
	Pet Negative Behaviours	0.70 (1.72)	0.91 (2.13)		
	Owner Affectionate Behaviours	0.52 (1.34)	0.17 (0.83)		
	Owner Distracted Behaviours	0.17 (0.65)	0.70 (2.75)		

Females (*n* = 43)			
	Pet Within Arm's Reach (seconds)	290.69 (40.59)	289.53 (47.14)
	Owner Contact with Pet (seconds)	247.21 (97.68)	240.03 (101.24)
	Pet Approaching Owner	0.30 (0.83)	0.35 (1.31)
	Neutral Speech	14.88 (16.03)	13.93 (12.74)
	Affectionate Speech	3.58 (6.61)	1.86 (3.03)
	Frustrated Speech	0.86 (2.66)	0.49 (1.50)
	Owner-Pet Play	4.60 (11.46)	4.19 (10.38)
	Pet Negative Behaviours	1.19 (2.95)	0.60 (1.29)
	Owner Affectionate Behaviours	2.44 (4.31)	3.77 (7.30)
	Owner Distracted Behaviours	0.49 (1.98)	0.26 (0.77)

Table 3.

Descriptive Statistics for Heart Rate and Self-Reported Stress and Anxiety for Control, Stressor-No-Interaction, Stressor + Peer Interaction, and Stressor + Pet Interaction Groups

		Control *M (SD)*	Stressor-No-Interaction *M (SD)*	Stressor + Peer Interaction *M (SD)*	Stressor + Pet Interaction *M (SD)*		
						Stressor + Pet Dog *M (SD)*	Stressor + Pet Cat *M (SD)*
Heart Rate	Timepoint						
	1	74.9 (14.34)	79.02 (19.56)	79.32 (14.83)	78.36 (16.50)	78.30 (18.03)	78.43 (14.41)
	2	74.74 (15.33)	76.19 (16.42)	77.02 (15.55)	77.87 (14.51)	78.00 (15.12)	77.70 (13.84)
	3	72.80 (11.92)	77.81 (11.42)	75.42 (13.56)	78.00 (14.55)	78.12 (16.14)	77.84 (12.30)
	4	74.98 (18.76)	82.56 (16.66)	82.82 (19.59)	83.46 (20.84)	81.90 (20.70)	85.57 (21.13)
	5	74.14 (13.02)	82.98 (21.81)	82.11 (18.55)	81.63 (20.69)	81.94 (22.08)	81.22 (18.95)
	6	72.60 (11.25)	76.35 (13.33)	78.33 (16.11)	78.11 (19.30)	80.14 (22.76)	75.38 (13.08)
	7	70.40 (11.25)	77.09 (12.82)	76.69 (14.42)	76.01 (16.83)	75.72 (18.18)	76.43 (15.04)
Self-Report							
	1	33.59 (23.89)	34.72 (25.35)	36.51 (23.12)	35.44 (23.74)	39.33 (23.42)	30.19 (22.45)
	2	26.72 (23.95)	28.61 (24.00)	27.83 (21.11)	27.56 (22.09)	29.30 (22.40)	25.20 (21.75)
	3	24.81 (21.74)	27.01 (22.77)	24.56 (20.57)	21.11 (19.60)	22.55 (20.44)	19.16 (18.49)
	4	42.20 (26.52)	59.28 (26.66)	57.76 (26.25)	54.03 (27.01)	59.53 (25.07)	46.61 (28.08)
	5	36.76 (28.54)	57.51 (27.70)	55.06 (28.67)	54.30 (28.52)	62.47 (27.19)	43.27 (26.81)
	6	21.77 (20.28)	34.04 (26.65)	28.35 (22.22)	31.33 (24.15)	37.20 (25.99)	23.41 (19.03)
	7	20.20 (20.74)	28.69 (23.24)	24.78 (22.01)	26.11 (24.26)	29.76 (27.62)	21.18 (17.99)

Table 4.

Pairwise Comparisons of Heart Rate and Self-report between for Control, Stressor-No-Interaction, Stressor + Peer Interaction, and Stressor + Pet Interaction Groups

							95% Confidence Interval for Difference[b]	
	Timepoint	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
Heart Rate	1	Control	Stress	-4.438	3.166	.972	-12.850	3.973
			Peer	-4.056	2.809	.899	-11.518	3.407
			Pet	-3.563	2.851	1.000	-11.136	4.011
		Stress	Control	4.438	3.166	.972	-3.973	12.850
			Peer	.383	2.744	1.000	-6.908	7.674
			Pet	.876	2.783	1.000	-6.518	8.269
		Peer	Control	4.056	2.809	.899	-3.407	11.518
			Stress	-.383	2.744	1.000	-7.674	6.908
			Pet	.493	2.369	1.000	-5.802	6.787
		Pet	Control	3.563	2.851	1.000	-4.011	11.136
			Stress	-.876	2.783	1.000	-8.269	6.518
			Peer	-.493	2.369	1.000	-6.787	5.802
	2	Control	Stress	-1.863	3.002	1.000	-9.838	6.113
			Peer	-1.907	2.663	1.000	-8.981	5.168
			Pet	-3.229	2.703	1.000	-10.410	3.951
		Stress	Control	1.863	3.002	1.000	-6.113	9.838
			Peer	-.044	2.602	1.000	-6.957	6.869
			Pet	-1.367	2.638	1.000	-8.376	5.642
		Peer	Control	1.907	2.663	1.000	-5.168	8.981

		Stress	.044	2.602	1.000	-6.869	6.957
		Pet	-1.323	2.246	1.000	-7.291	4.645
	Pet	Control	3.229	2.703	1.000	-3.951	10.410
		Stress	1.367	2.638	1.000	-5.642	8.376
		Peer	1.323	2.246	1.000	-4.645	7.291
3	Control	Stress	-5.400	2.597	.231	-12.299	1.500
		Peer	-2.331	2.304	1.000	-8.451	3.790
		Pet	-5.467	2.338	.120	-11.679	.745
	Stress	Control	5.400	2.597	.231	-1.500	12.299
		Peer	3.069	2.251	1.000	-2.911	9.049
		Pet	-.067	2.282	1.000	-6.131	5.997
	Peer	Control	2.331	2.304	1.000	-3.790	8.451
		Stress	-3.069	2.251	1.000	-9.049	2.911
		Pet	-3.136	1.943	.646	-8.299	2.027
	Pet	Control	5.467	2.338	.120	-.745	11.679
		Stress	.067	2.282	1.000	-5.997	6.131
		Peer	3.136	1.943	.646	-2.027	8.299
4	Control	Stress	-8.545	3.731	.136	-18.457	1.367
		Peer	-7.223	3.310	.179	-16.016	1.570
		Pet	-8.433	3.359	.076	-17.357	.491
	Stress	Control	8.545	3.731	.136	-1.367	18.457
		Peer	1.322	3.234	1.000	-7.269	9.913
		Pet	.112	3.279	1.000	-8.599	8.824
	Peer	Control	7.223	3.310	.179	-1.570	16.016
		Stress	-1.322	3.234	1.000	-9.913	7.269
		Pet	-1.210	2.792	1.000	-8.627	6.207
	Pet	Control	8.433	3.359	.076	-.491	17.357

		Stress	-.112	3.279	1.000	-8.824	8.599
		Peer	1.210	2.792	1.000	-6.207	8.627
5	Control	Stress	-9.362	3.675	.068	-19.126	.401
		Peer	-7.272	3.260	.159	-15.933	1.389
		Pet	-7.638	3.309	.130	-16.429	1.152
	Stress	Control	9.362	3.675	.068	-.401	19.126
		Peer	2.091	3.185	1.000	-6.372	10.553
		Pet	1.724	3.230	1.000	-6.857	10.305
	Peer	Control	7.272	3.260	.159	-1.389	15.933
		Stress	-2.091	3.185	1.000	-10.553	6.372
		Pet	-.367	2.750	1.000	-7.673	6.939
	Pet	Control	7.638	3.309	.130	-1.152	16.429
		Stress	-1.724	3.230	1.000	-10.305	6.857
		Peer	.367	2.750	1.000	-6.939	7.673
6	Control	Stress	-4.186	3.119	1.000	-12.473	4.101
		Peer	-5.357	2.767	.323	-12.708	1.994
		Pet	-5.493	2.808	.309	-12.953	1.968
	Stress	Control	4.186	3.119	1.000	-4.101	12.473
		Peer	-1.171	2.703	1.000	-8.353	6.012
		Pet	-1.307	2.741	1.000	-8.590	5.976
	Peer	Control	5.357	2.767	.323	-1.994	12.708
		Stress	1.171	2.703	1.000	-6.012	8.353
		Pet	-.136	2.334	1.000	-6.337	6.065
	Pet	Control	5.493	2.808	.309	-1.968	12.953
		Stress	1.307	2.741	1.000	-5.976	8.590
		Peer	.136	2.334	1.000	-6.065	6.337
7	Control	Stress	-7.155	2.940	.093	-14.965	.655

			Peer	-5.700	2.608	.178	-12.629	1.228
			Pet	-5.922	2.647	.156	-12.953	1.110
		Stress	Control	7.155	2.940	.093	-.655	14.965
			Peer	1.455	2.548	1.000	-5.315	8.224
			Pet	1.233	2.584	1.000	-5.631	8.098
		Peer	Control	5.700	2.608	.178	-1.228	12.629
			Stress	-1.455	2.548	1.000	-8.224	5.315
			Pet	-.221	2.200	1.000	-6.066	5.623
		Pet	Control	5.922	2.647	.156	-1.110	12.953
			Stress	-1.233	2.584	1.000	-8.098	5.631
			Peer	.221	2.200	1.000	-5.623	6.066
Self-Report	1	Control	Stress	-1.009	4.598	1.000	-13.225	11.207
			Peer	-2.135	4.079	1.000	-12.971	8.702
			Pet	-2.127	4.140	1.000	-13.125	8.871
		Stress	Control	1.009	4.598	1.000	-11.207	13.225
			Peer	-1.126	3.985	1.000	-11.714	9.462
			Pet	-1.118	4.041	1.000	-11.854	9.618
		Peer	Control	2.135	4.079	1.000	-8.702	12.971
			Stress	1.126	3.985	1.000	-9.462	11.714
			Pet	.008	3.441	1.000	-9.133	9.149
		Pet	Control	2.127	4.140	1.000	-8.871	13.125
			Stress	1.118	4.041	1.000	-9.618	11.854
			Peer	-.008	3.441	1.000	-9.149	9.133
	2	Control	Stress	-2.785	4.422	1.000	-14.533	8.962
			Peer	-.442	3.923	1.000	-10.864	9.979
			Pet	-1.168	3.981	1.000	-11.745	9.409
		Stress	Control	2.785	4.422	1.000	-8.962	14.533

		Peer	2.343	3.833	1.000	-7.839	12.526
		Pet	1.618	3.886	1.000	-8.707	11.942
	Peer	Control	.442	3.923	1.000	-9.979	10.864
		Stress	-2.343	3.833	1.000	-12.526	7.839
		Pet	-.726	3.309	1.000	-9.516	8.065
	Pet	Control	1.168	3.981	1.000	-9.409	11.745
		Stress	-1.618	3.886	1.000	-11.942	8.707
		Peer	.726	3.309	1.000	-8.065	9.516
3	Control	Stress	-3.101	4.107	1.000	-14.013	7.811
		Peer	.978	3.644	1.000	-8.702	10.658
		Pet	3.243	3.698	1.000	-6.581	13.068
	Stress	Control	3.101	4.107	1.000	-7.811	14.013
		Peer	4.079	3.560	1.000	-5.379	13.537
		Pet	6.344	3.610	.479	-3.246	15.935
	Peer	Control	-.978	3.644	1.000	-10.658	8.702
		Stress	-4.079	3.560	1.000	-13.537	5.379
		Pet	2.265	3.073	1.000	-5.900	10.430
	Pet	Control	-3.243	3.698	1.000	-13.068	6.581
		Stress	-6.344	3.610	.479	-15.935	3.246
		Peer	-2.265	3.073	1.000	-10.430	5.900
4	Control	Stress	-17.960*	4.987	.002	-31.210	-4.709
		Peer	-14.061*	4.424	.010	-25.815	-2.307
		Pet	-12.380*	4.490	.037	-24.309	-.450
	Stress	Control	17.960*	4.987	.002	4.709	31.210
		Peer	3.899	4.323	1.000	-7.586	15.383
		Pet	5.580	4.383	1.000	-6.066	17.225
	Peer	Control	14.061*	4.424	.010	2.307	25.815

		Stress	-3.899	4.323	1.000	-15.383	7.586
		Pet	1.681	3.732	1.000	-8.234	11.596
	Pet	Control	12.380*	4.490	.037	.450	24.309
		Stress	-5.580	4.383	1.000	-17.225	6.066
		Peer	-1.681	3.732	1.000	-11.596	8.234
5	Control	Stress	-20.216*	5.361	.001	-34.459	-5.974
		Peer	-16.761*	4.756	.003	-29.395	-4.127
		Pet	-18.554*	4.827	<.001	-31.377	-5.731
	Stress	Control	20.216*	5.361	.001	5.974	34.459
		Peer	3.455	4.647	1.000	-8.889	15.800
		Pet	1.662	4.712	1.000	-10.855	14.180
	Peer	Control	16.761*	4.756	.003	4.127	29.395
		Stress	-3.455	4.647	1.000	-15.800	8.889
		Pet	-1.793	4.011	1.000	-12.450	8.865
	Pet	Control	18.554*	4.827	<.001	5.731	31.377
		Stress	-1.662	4.712	1.000	-14.180	10.855
		Peer	1.793	4.011	1.000	-8.865	12.450
6	Control	Stress	-11.315	4.523	.078	-23.331	.701
		Peer	-5.705	4.012	.937	-16.364	4.954
		Pet	-10.312	4.072	.071	-21.131	.506
	Stress	Control	11.315	4.523	.078	-.701	23.331
		Peer	5.610	3.920	.921	-4.805	16.025
		Pet	1.003	3.975	1.000	-9.558	11.563
	Peer	Control	5.705	4.012	.937	-4.954	16.364
		Stress	-5.610	3.920	.921	-16.025	4.805
		Pet	-4.607	3.384	1.000	-13.599	4.384
	Pet	Control	10.312	4.072	.071	-.506	21.131

		Stress	-1.003	3.975	1.000	-11.563	9.558
		Peer	4.607	3.384	1.000	-4.384	13.599
7	Control	Stress	-9.611	4.443	.188	-21.415	2.194
		Peer	-3.619	3.942	1.000	-14.091	6.852
		Pet	-6.759	4.000	.553	-17.387	3.869
	Stress	Control	9.611	4.443	.188	-2.194	21.415
		Peer	5.992	3.851	.725	-4.240	16.223
		Pet	2.852	3.905	1.000	-7.523	13.227
	Peer	Control	3.619	3.942	1.000	-6.852	14.091
		Stress	-5.992	3.851	.725	-16.223	4.240
		Pet	-3.140	3.325	1.000	-11.973	5.694
	Pet	Control	6.759	4.000	.553	-3.869	17.387
		Stress	-2.852	3.905	1.000	-13.227	7.523
		Peer	3.140	3.325	1.000	-5.694	11.973

Table 5.

Pairwise Comparisons of Heart Rate and Self-report between for Control, Stressor-No-Interaction, Stressor + Dog Interaction, and Stressor + Cat Interaction Groups

Measure	Timepoint	(I) PetGroups	(J) PetGroups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Heart Rate	1	Control	Stress	-4.412	3.317	1.000	-13.256	4.432
			Dog Interaction	-3.577	3.363	1.000	-12.543	5.389
			Cat Interaction	-3.533	3.636	1.000	-13.228	6.162
		Stress	Control	4.412	3.317	1.000	-4.432	13.256
			Dog Interaction	.835	3.299	1.000	-7.962	9.632
			Cat Interaction	.879	3.579	1.000	-8.663	10.421
		Dog Interaction	Control	3.577	3.363	1.000	-5.389	12.543
			Stress	-.835	3.299	1.000	-9.632	7.962
			Cat Interaction	.044	3.621	1.000	-9.611	9.698
		Cat Interaction	Control	3.533	3.636	1.000	-6.162	13.228
			Stress	-.879	3.579	1.000	-10.421	8.663
			Dog Interaction	-.044	3.621	1.000	-9.698	9.611
	2	Control	Stress	-1.862	2.996	1.000	-9.849	6.126
			Dog Interaction	-3.357	3.037	1.000	-11.455	4.740
			Cat Interaction	-3.057	3.284	1.000	-11.814	5.699
		Stress	Control	1.862	2.996	1.000	-6.126	9.849
			Dog Interaction	-1.496	2.980	1.000	-9.441	6.450
			Cat Interaction	-1.196	3.232	1.000	-9.814	7.422

	Dog Interaction	Control	3.357	3.037	1.000	-4.740	11.455
		Stress	1.496	2.980	1.000	-6.450	9.441
		Cat Interaction	.300	3.270	1.000	-8.420	9.019
	Cat Interaction	Control	3.057	3.284	1.000	-5.699	11.814
		Stress	1.196	3.232	1.000	-7.422	9.814
		Dog Interaction	-.300	3.270	1.000	-9.019	8.420
3	Control	Stress	-5.388	2.583	.230	-12.274	1.498
		Dog Interaction	-5.612	2.618	.200	-12.594	1.369
		Cat Interaction	-5.266	2.831	.387	-12.815	2.283
	Stress	Control	5.388	2.583	.230	-1.498	12.274
		Dog Interaction	-.225	2.569	1.000	-7.074	6.625
		Cat Interaction	.122	2.786	1.000	-7.308	7.551
	Dog Interaction	Control	5.612	2.618	.200	-1.369	12.594
		Stress	.225	2.569	1.000	-6.625	7.074
		Cat Interaction	.346	2.819	1.000	-7.171	7.864
	Cat Interaction	Control	5.266	2.831	.387	-2.283	12.815
		Stress	-.122	2.786	1.000	-7.551	7.308
		Dog Interaction	-.346	2.819	1.000	-7.864	7.171
4	Control	Stress	-8.511	3.717	.139	-18.422	1.399
		Dog Interaction	-7.102	3.768	.366	-17.149	2.945
		Cat Interaction	-10.205	4.074	.079	-21.069	.659
	Stress	Control	8.511	3.717	.139	-1.399	18.422
		Dog Interaction	1.410	3.697	1.000	-8.448	11.267
		Cat Interaction	-1.693	4.010	1.000	-12.386	8.999
	Dog Interaction	Control	7.102	3.768	.366	-2.945	17.149
		Stress	-1.410	3.697	1.000	-11.267	8.448
		Cat Interaction	-3.103	4.057	1.000	-13.922	7.716

	Cat Interaction	Control	10.205	4.074	.079	-.659	21.069
		Stress	1.693	4.010	1.000	-8.999	12.386
		Dog Interaction	3.103	4.057	1.000	-7.716	13.922
5	Control	Stress	-9.375	3.726	.076	-19.310	.560
		Dog Interaction	-8.210	3.777	.186	-18.282	1.862
		Cat Interaction	-6.876	4.084	.564	-17.767	4.015
	Stress	Control	9.375	3.726	.076	-.560	19.310
		Dog Interaction	1.165	3.706	1.000	-8.717	11.047
		Cat Interaction	2.499	4.020	1.000	-8.220	13.218
	Dog Interaction	Control	8.210	3.777	.186	-1.862	18.282
		Stress	-1.165	3.706	1.000	-11.047	8.717
		Cat Interaction	1.334	4.067	1.000	-9.512	12.179
	Cat Interaction	Control	6.876	4.084	.564	-4.015	17.767
		Stress	-2.499	4.020	1.000	-13.218	8.220
		Dog Interaction	-1.334	4.067	1.000	-12.179	9.512
6	Control	Stress	-4.145	3.115	1.000	-12.451	4.161
		Dog Interaction	-7.440	3.158	.117	-15.861	.980
		Cat Interaction	-2.861	3.415	1.000	-11.966	6.244
	Stress	Control	4.145	3.115	1.000	-4.161	12.451
		Dog Interaction	-3.296	3.098	1.000	-11.558	4.966
		Cat Interaction	1.284	3.361	1.000	-7.678	10.245
	Dog Interaction	Control	7.440	3.158	.117	-.980	15.861
		Stress	3.296	3.098	1.000	-4.966	11.558
		Cat Interaction	4.580	3.401	1.000	-4.488	13.647
	Cat Interaction	Control	2.861	3.415	1.000	-6.244	11.966
		Stress	-1.284	3.361	1.000	-10.245	7.678
		Dog Interaction	-4.580	3.401	1.000	-13.647	4.488

	7	Control	Stress	-7.119	3.052	.124	-15.256	1.019
			Dog Interaction	-5.560	3.094	.444	-13.810	2.690
			Cat Interaction	-6.391	3.346	.346	-15.312	2.529
		Stress	Control	7.119	3.052	.124	-1.019	15.256
			Dog Interaction	1.559	3.036	1.000	-6.536	9.653
			Cat Interaction	.727	3.293	1.000	-8.053	9.507
		Dog Interaction	Control	5.560	3.094	.444	-2.690	13.810
			Stress	-1.559	3.036	1.000	-9.653	6.536
			Cat Interaction	-.831	3.332	1.000	-9.715	8.052
		Cat Interaction	Control	6.391	3.346	.346	-2.529	15.312
			Stress	-.727	3.293	1.000	-9.507	8.053
			Dog Interaction	.831	3.332	1.000	-8.052	9.715
Self-Report	1	Control	Stress	-.968	4.663	1.000	-13.402	11.467
			Dog Interaction	-5.653	4.728	1.000	-18.259	6.953
			Cat Interaction	2.623	5.112	1.000	-11.008	16.254
		Stress	Control	.968	4.663	1.000	-11.467	13.402
			Dog Interaction	-4.685	4.639	1.000	-17.054	7.683
			Cat Interaction	3.591	5.031	1.000	-9.825	17.006
		Dog Interaction	Control	5.653	4.728	1.000	-6.953	18.259
			Stress	4.685	4.639	1.000	-7.683	17.054
			Cat Interaction	8.276	5.091	.634	-5.298	21.850
		Cat Interaction	Control	-2.623	5.112	1.000	-16.254	11.008
			Stress	-3.591	5.031	1.000	-17.006	9.825
			Dog Interaction	-8.276	5.091	.634	-21.850	5.298
	2	Control	Stress	-2.746	4.606	1.000	-15.029	9.537
			Dog Interaction	-2.484	4.670	1.000	-14.937	9.968
			Cat Interaction	.616	5.050	1.000	-12.849	14.081

	Stress	Control	2.746	4.606	1.000	-9.537	15.029
		Dog Interaction	.262	4.582	1.000	-11.956	12.480
		Cat Interaction	3.362	4.970	1.000	-9.890	16.614
	Dog Interaction	Control	2.484	4.670	1.000	-9.968	14.937
		Stress	-.262	4.582	1.000	-12.480	11.956
		Cat Interaction	3.100	5.029	1.000	-10.309	16.509
	Cat Interaction	Control	-.616	5.050	1.000	-14.081	12.849
		Stress	-3.362	4.970	1.000	-16.614	9.890
		Dog Interaction	-3.100	5.029	1.000	-16.509	10.309
3	Control	Stress	-3.063	4.203	1.000	-14.269	8.143
		Dog Interaction	2.241	4.261	1.000	-9.119	13.602
		Cat Interaction	4.604	4.607	1.000	-7.680	16.889
	Stress	Control	3.063	4.203	1.000	-8.143	14.269
		Dog Interaction	5.304	4.180	1.000	-5.842	16.451
		Cat Interaction	7.667	4.534	.555	-4.423	19.757
	Dog Interaction	Control	-2.241	4.261	1.000	-13.602	9.119
		Stress	-5.304	4.180	1.000	-16.451	5.842
		Cat Interaction	2.363	4.588	1.000	-9.871	14.596
	Cat Interaction	Control	-4.604	4.607	1.000	-16.889	7.680
		Stress	-7.667	4.534	.555	-19.757	4.423
		Dog Interaction	-2.363	4.588	1.000	-14.596	9.871
4	Control	Stress	-17.952*	4.975	.002	-31.219	-4.686
		Dog Interaction	-17.324*	5.044	.004	-30.774	-3.875
		Cat Interaction	-5.740	5.454	1.000	-20.283	8.803
	Stress	Control	17.952*	4.975	.002	4.686	31.219
		Dog Interaction	.628	4.949	1.000	-12.568	13.824
		Cat Interaction	12.212	5.368	.144	-2.102	26.525

	Dog Interaction	Control	17.324*	5.044	.004	3.875	30.774
		Stress	-.628	4.949	1.000	-13.824	12.568
		Cat Interaction	11.584	5.431	.205	-2.898	26.066
	Cat Interaction	Control	5.740	5.454	1.000	-8.803	20.283
		Stress	-12.212	5.368	.144	-26.525	2.102
		Dog Interaction	-11.584	5.431	.205	-26.066	2.898
5	Control	Stress	-20.220*	5.215	<.001	-34.127	-6.313
		Dog Interaction	-26.410*	5.287	<.001	-40.508	-12.311
		Cat Interaction	-8.012	5.717	.976	-23.257	7.233
	Stress	Control	20.220*	5.215	<.001	6.313	34.127
		Dog Interaction	-6.190	5.188	1.000	-20.023	7.643
		Cat Interaction	12.208	5.627	.188	-2.796	27.212
	Dog Interaction	Control	26.410*	5.287	<.001	12.311	40.508
		Stress	6.190	5.188	1.000	-7.643	20.023
		Cat Interaction	18.398*	5.693	.009	3.216	33.579
	Cat Interaction	Control	8.012	5.717	.976	-7.233	23.257
		Stress	-12.208	5.627	.188	-27.212	2.796
		Dog Interaction	-18.398*	5.693	.009	-33.579	-3.216
6	Control	Stress	-11.295	4.594	.089	-23.545	.956
		Dog Interaction	-15.672*	4.658	.006	-28.091	-3.252
		Cat Interaction	-3.111	5.036	1.000	-16.540	10.319
	Stress	Control	11.295	4.594	.089	-.956	23.545
		Dog Interaction	-4.377	4.570	1.000	-16.562	7.809
		Cat Interaction	8.184	4.957	.602	-5.033	21.401
	Dog Interaction	Control	15.672*	4.658	.006	3.252	28.091
		Stress	4.377	4.570	1.000	-7.809	16.562
		Cat Interaction	12.561	5.015	.079	-.812	25.934

	Cat Interaction	Control	3.111	5.036	1.000	-10.319	16.540
		Stress	-8.184	4.957	.602	-21.401	5.033
		Dog Interaction	-12.561	5.015	.079	-25.934	.812
7	Control	Stress	-9.563	4.572	.227	-21.754	2.627
		Dog Interaction	-9.871	4.635	.207	-22.230	2.488
		Cat Interaction	-2.562	5.012	1.000	-15.926	10.802
	Stress	Control	9.563	4.572	.227	-2.627	21.754
		Dog Interaction	-.307	4.548	1.000	-12.434	11.819
		Cat Interaction	7.002	4.933	.945	-6.151	20.154
	Dog Interaction	Control	9.871	4.635	.207	-2.488	22.230
		Stress	.307	4.548	1.000	-11.819	12.434
		Cat Interaction	7.309	4.991	.868	-5.999	20.617
	Cat Interaction	Control	2.562	5.012	1.000	-10.802	15.926
		Stress	-7.002	4.933	.945	-20.154	6.151
		Dog Interaction	-7.309	4.991	.868	-20.617	5.999

Table 6.

Correlations Between Pre-Stressor Pet Interactions, Questionnaires, Heart Rate Reactivity, and Self-Reported Reactivity

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*	*14.*	*15.*	*16.*	*17.*
1. Pet Within Arm's Reach	--																
2. Owner Contact	.701**	--															
3. Pet Approaches Owner	-.285*	-.377**	--														
4. Neutral Speech	.012	-.236	.140	--													
5. Affectionate Speech	-.040	-.209	.196	.711**	--												
6. Frustrated Speech	-.249*	-.161	.330**	.221	.386**	--											
7. Owner-Pet Play	-.238	-.706**	.204	.232	.169	.153	--										
8. Pet Negative Behaviours	-.010	.053	-.031	.058	.069	.362**	-.057	--									
9. Affectionate Behaviours	.160	.221	-.166	.036	.079	-.077	-.140	-.094	--								
10. Distracted Behaviours	.088	.142	-.089	-.041	.108	-.070	-.084	-.052	-.003	--							
11. Anxiety Symptoms	-.096	.054	.158	-.060	.100	.253*	-.113	.196	-.158	-.131	--						
12. Depression Symptoms	.024	.156	.049	.127	.159	.361**	-.157	.046	-.198	-.030	.570**	--					
13. Pet Attitude	-.082	-.062	.109	.138	.105	.094	.081	.111	.106	.020	-.032	.007	--				
14. Stressful Expereinces	-.235	-.063	-.019	.149	.010	-.117	-.088	-.191	-.001	-.021	-.137	.136	-.045	--			
15. Mental Health Diagnoses	.036	.088	.078	.214	.503**	.236	-.038	.167	.295*	-.071	.262*	.123	.087	-.134	--		
16. HR Reactivity Score	.056	.092	-.019	-.079	-.034	.023	-.093	-.067	.018	.003	-.180	-.034	.023	-.073	-.007	--	
17. SR Reactivity Score	-.017	.081	-.035	-.006	.022	.163	.043	-.034	.058	-.031	-.010	.198	.364**	.134	.061	.093	--

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Note. HR = Heart Rate, SR = Self-Report

Table 7.

Correlations Between Post-Stressor Pet Interactions, Questionnaires, Heart Rate Recovery, and Self-Reported Recovery

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*	*14.*	*15.*	*16.*	*17.*
1. Pet Within Arm's Reach	--																
2. Owner Contact	.632**	--															
3. Pet Approaches Owner	-.125	-.244*	--														
4. Neutral Speech	.082	-.201	-.094	--													
5. Affectionate Speech	-.094	-.270*	-.059	.575**	--												
6. Frustrated Speech	-.134	-.105	.069	.350**	.467**	--											
7. Owner-Pet Play	-.260*	-.594**	.416**	.187	.186	.015	--										
8. Pet Negative Behaviours	-.110	-.062	.197	.315**	.295*	.434**	.072	--									
9. Affectionate Behaviours	.103	.200	-.099	.038	.099	-.145	-.160	.012	--								
10. Distracted Behaviours	.065	.125	-.068	-.124	-.115	-.050	-.093	-.089	-.072	--							
11. Anxiety Symptoms	-.153	.004	-.073	-.119	.038	-.098	-.147	.057	-.126	.218	--						
12. Despression Symptoms	-.090	.019	-.184	.132	.197	.099	-.175	-.021	-.157	.065	.570**	--					
13. Pet Attitude	-.085	-.113	.061	.104	.025	.060	.023	-.138	.077	.005	-.032	.007	--				
14. Stressful Expereinces	-.077	-.103	-.014	.192	.151	.264*	-.088	.161	-.055	-.106	-.137	.136	-.045	--			
15. Mental Health Diagnoses	-.016	.145	-.097	.014	.175	-.012	-.134	-.172	.095	.111	.262*	.123	.087	-.134	--		
16. HR Recovery Score	-.040	-.044	.039	.104	.199	.116	.039	.128	-.108	.097	.198	.078	-.095	-.019	.092	--	
17. SR Recovery Score	-.173	-.212	-.091	-.090	-.055	.071	.048	.097	-.090	.145	.103	-.080	-.113	.078	-.008	.209*	--

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Note. HR = Heart Rate, SR = Self-Report

Table 8.

Comparison of Mixed-Effects Models for Heart Rate Reactivity and Recovery

GLMM_performance

Name	Model	R2_marginal	RMSE	Sigma	ICC	AIC_wt	AICc_wt	BIC_wt	Performance_Score
HR_M5	lmerMod	0.1161909	13.63126	13.63126	NA	0.0895135	0.0967821	0.0647728	0.7822970
HR_M1	lmerMod	0.0897422	13.83272	13.83272	NA	0.0444710	0.0545145	0.8013265	0.6780788
HR_M8.5	lmerMod	0.1214484	13.59085	13.59085	NA	0.0568642	0.0567040	0.0082457	0.6608794
HR_M25	lmerMod	0.1214484	13.59085	13.59085	NA	0.0568642	0.0567040	0.0082457	0.6608794
HR_M26	lmerMod	0.1214484	13.59085	13.59085	NA	0.0568642	0.0567040	0.0082457	0.6608794
HR_M27	lmerMod	0.1214484	13.59085	13.59085	NA	0.0568642	0.0567040	0.0082457	0.6608794
HR_M14.5	lmerMod	0.1202536	13.60004	13.60004	NA	0.0502110	0.0500695	0.0072809	0.6322826
HR_M9.5	lmerMod	0.1194624	13.60613	13.60613	NA	0.0462436	0.0461134	0.0067057	0.6149294
HR_M15.5	lmerMod	0.1180822	13.61674	13.61674	NA	0.0400658	0.0399529	0.0058098	0.5873415
HR_M16.5	lmerMod	0.1177308	13.61943	13.61943	NA	0.0386308	0.0385220	0.0056017	0.5808159
HR_M10.5	lmerMod	0.1169204	13.62566	13.62566	NA	0.0355164	0.0354163	0.0051501	0.5664706
HR_M22.5	lmerMod	0.1163968	13.62968	13.62968	NA	0.0336401	0.0335453	0.0048780	0.5576930
HR_M17.5	lmerMod	0.1163928	13.62971	13.62971	NA	0.0336261	0.0335314	0.0048760	0.5576273
HR_M21.5	lmerMod	0.1162454	13.63084	13.63084	NA	0.0331166	0.0330233	0.0048021	0.5552239
HR_M23.5	lmerMod	0.1161911	13.63126	13.63126	NA	0.0329306	0.0328379	0.0047752	0.5543447
HR_M4	lmerMod	0.1075305	13.69756	13.69756	NA	0.0366571	0.0396337	0.0265254	0.5444061
HR_M7	lmerMod	0.1329843	13.50175	13.50175	NA	0.0094963	0.0068925	0.0000111	0.5295469
HR_M8.4	lmerMod	0.1126649	13.65829	13.65829	NA	0.0228705	0.0228061	0.0033164	0.5045424
HR_M18.5	lmerMod	0.1222939	13.58434	13.58434	NA	0.0084050	0.0068685	0.0000489	0.4863681
HR_M14.4	lmerMod	0.1110532	13.67063	13.67063	NA	0.0193695	0.0193149	0.0028087	0.4857452
HR_M11.5	lmerMod	0.1217202	13.58876	13.58876	NA	0.0079169	0.0064696	0.0000461	0.4825700
HR_M12.5	lmerMod	0.1216035	13.58965	13.58965	NA	0.0078211	0.0063914	0.0000455	0.4818090
HR_M30	lmerMod	0.1214484	13.59085	13.59085	0	0.0076957	0.0062889	0.0000448	0.4808038
HR_M28	lmerMod	0.1214484	13.59085	13.59085	NA	0.0076957	0.0062889	0.0000448	0.4808038
HR_M29	lmerMod	0.1214484	13.59085	13.59085	NA	0.0076957	0.0062889	0.0000448	0.4808038
HR_M13.5	lmerMod	0.1210579	13.59385	13.59385	NA	0.0073889	0.0060382	0.0000430	0.4783026
HR_M16.4	lmerMod	0.1101539	13.67751	13.67751	NA	0.0176569	0.0176072	0.0025604	0.4761282
HR_M9.4	lmerMod	0.1098675	13.67970	13.67970	NA	0.0171442	0.0170959	0.0024860	0.4731838
HR_M19.5	lmerMod	0.1189711	13.60990	13.60990	NA	0.0059468	0.0048597	0.0000346	0.4655844
HR_M20.5	lmerMod	0.1189232	13.61027	13.61027	NA	0.0059173	0.0048356	0.0000345	0.4653043
HR_M15.4	lmerMod	0.1089638	13.68661	13.68661	NA	0.0156232	0.0155791	0.0022655	0.4642424
HR_M10.4	lmerMod	0.1088614	13.68739	13.68739	NA	0.0154597	0.0154161	0.0022418	0.4632613
HR_M17.4	lmerMod	0.1079247	13.69455	13.69455	NA	0.0140420	0.0140025	0.0020362	0.4545690
HR_M22.4	lmerMod	0.1077243	13.69608	13.69608	NA	0.0137561	0.0137174	0.0019947	0.4527721
HR_M21.4	lmerMod	0.1075709	13.69725	13.69725	NA	0.0135414	0.0135033	0.0019636	0.4514120
HR_M23.4	lmerMod	0.1075326	13.69754	13.69754	NA	0.0134883	0.0134503	0.0019559	0.4510742
HR_M18.4	lmerMod	0.1142441	13.64619	13.64619	NA	0.0036435	0.0029774	0.0000212	0.4399501
HR_M11.4	lmerMod	0.1137868	13.64970	13.64970	NA	0.0034753	0.0028400	0.0000202	0.4376506
HR_M12.4	lmerMod	0.1136682	13.65061	13.65061	NA	0.0034329	0.0028054	0.0000200	0.4370582
HR_M20.4	lmerMod	0.1120157	13.66326	13.66326	NA	0.0028947	0.0023655	0.0000169	0.4289790
HR_M13.4	lmerMod	0.1119812	13.66353	13.66353	NA	0.0028844	0.0023571	0.0000168	0.4288136
HR_M19.4	lmerMod	0.1111076	13.67021	13.67021	NA	0.0026361	0.0021542	0.0000154	0.4246627
HR_M6	lmerMod	0.0049721	14.45916	14.45916	NA	0.0000017	0.0000019	0.0000013	0.0182718
HR_M2	lmerMod	0.0047598	14.46069	14.46069	NA	0.0000126	0.0000154	0.0002270	0.0175813
HR_M3	lmerMod	0.0000006	14.49504	14.49504	NA	0.0000081	0.0000100	0.0001467	0.0000561

Table 9.

Comparison of Mixed-Effects Models for Self-Reported Stress and Anxiety Reactivity and Recovery

GLMM_performance

Name	Model	R2_conditional	R2_marginal	ICC	RMSE	Sigma	AIC_wt	AICc_wt	BIC_wt	Performance_Score
SR_M9	lmerMod	0.3603363	0.2511961	0.1457527	15.20237	16.27259	0.2671196	0.2856017	0.0582080	0.6929475
SR_M1	lmerMod	0.3559162	0.2007421	0.1941477	14.94464	16.33102	0.0282852	0.0371770	0.7659115	0.5850091
SR_M36	lmerMod	0.4050080	0.2527533	0.2037542	14.33581	15.72864	0.0005155	0.0002187	0.0000000	0.5609994
SR_M8	lmerMod	0.3570724	0.2428389	0.1508709	15.20445	16.31113	0.1067954	0.1141846	0.0232718	0.5299495
SR_M34	lmerMod	0.3926826	0.2493338	0.1909620	14.54387	15.87190	0.0008992	0.0004530	0.0000000	0.5276213
SR_M5	lmerMod	0.3605045	0.2298759	0.1696202	15.04777	16.27401	0.0751649	0.0871369	0.0817347	0.5250188
SR_M24	lmerMod	0.3883380	0.2445112	0.1903758	14.60308	15.93260	0.0034812	0.0023750	0.0000012	0.5174512
SR_M25	lmerMod	0.3872304	0.2706269	0.1598681	14.79316	15.93182	0.0086031	0.0043346	0.0000001	0.5133555
SR_M23	lmerMod	0.3800465	0.2647775	0.1567811	14.89767	16.02300	0.0297664	0.0203081	0.0000105	0.5106028
SR_M10	lmerMod	0.3715223	0.2331238	0.1804705	14.86364	16.14927	0.0406795	0.0434941	0.0088645	0.5075531
SR_M11	lmerMod	0.3656886	0.2559628	0.1474735	15.12828	16.20544	0.0658080	0.0576611	0.0005759	0.5039557
SR_M30	lmerMod	0.3828347	0.2442529	0.1833706	14.70180	15.99304	0.0033821	0.0023074	0.0000012	0.5024636
SR_M32	lmerMod	0.3817409	0.2463643	0.1796313	14.73486	16.00365	0.0005782	0.0002913	0.0000000	0.4970122
SR_M13	lmerMod	0.3569950	0.2586461	0.1326612	15.32339	16.30816	0.0826114	0.0723843	0.0007229	0.4927931
SR_M7	lmerMod	0.3778780	0.2422081	0.1790333	14.78309	16.05197	0.0070594	0.0054937	0.0000124	0.4920374
SR_M31	lmerMod	0.3782406	0.2428391	0.1788279	14.78035	16.04759	0.0027844	0.0018997	0.0000010	0.4893622
SR_M28	lmerMod	0.3776217	0.2428479	0.1780009	14.79204	16.05466	0.0027777	0.0018951	0.0000010	0.4876422
SR_M26	lmerMod	0.3786103	0.2697325	0.1490931	14.96054	16.03706	0.0070724	0.0035633	0.0000001	0.4876015
SR_M35	lmerMod	0.3775614	0.2426291	0.1781589	14.79143	16.05507	0.0027233	0.0018580	0.0000010	0.4875058
SR_M29	lmerMod	0.3772952	0.2428037	0.1776178	14.79770	16.05818	0.0027667	0.0018876	0.0000010	0.4867600
SR_M33	lmerMod	0.3778915	0.2431659	0.1780121	14.78858	16.05098	0.0003917	0.0001973	0.0000000	0.4865260
SR_M4	lmerMod	0.3701395	0.2099908	0.2027175	14.72627	16.15008	0.0130880	0.0151726	0.0142319	0.4847981
SR_M22	lmerMod	0.3743429	0.2566402	0.1583388	14.95017	16.09030	0.0118846	0.0081082	0.0000042	0.4826648
SR_M20	lmerMod	0.3729333	0.2356409	0.1796178	14.84659	16.12491	0.0078815	0.0069058	0.0000690	0.4789974
SR_M12	lmerMod	0.3597789	0.2549862	0.1406588	15.24052	16.27712	0.0554191	0.0485584	0.0004850	0.4783297
SR_M27	lmerMod	0.3746261	0.2736631	0.1390030	15.06888	16.08212	0.0108907	0.0054871	0.0000002	0.4779834
SR_M16	lmerMod	0.3632998	0.2311333	0.1718977	15.00268	16.24103	0.0323662	0.0346056	0.0070529	0.4773814
SR_M17	lmerMod	0.3606530	0.2301958	0.1694680	15.04710	16.27222	0.0286271	0.0306078	0.0062381	0.4665244
SR_M21	lmerMod	0.3600553	0.2304462	0.1684211	15.05958	16.27843	0.0294670	0.0315058	0.0064211	0.4656992
SR_M14	lmerMod	0.3601621	0.2303228	0.1686932	15.05717	16.27772	0.0289494	0.0309525	0.0063084	0.4654652
SR_M15	lmerMod	0.3598858	0.2304218	0.1682272	15.06285	16.28062	0.0292803	0.0313062	0.0063805	0.4650284
SR_M18	lmerMod	0.3618063	0.2332787	0.1676328	15.04403	16.25613	0.0055296	0.0048451	0.0000484	0.4462781
SR_M19	lmerMod	0.3601220	0.2305211	0.1684268	15.05896	16.27780	0.0040142	0.0035172	0.0000351	0.4406470
SR_M3	lmerMod	0.3496950	0.0268589	0.3317465	15.13187	16.42383	0.0022538	0.0027987	0.0122299	0.3875487
SR_M2	lmerMod	0.3499414	0.0021109	0.3485663	14.96735	16.42382	0.0001992	0.0002474	0.0010810	0.3850788
SR_M6	lmerMod	0.3496636	0.0304898	0.3292114	15.15738	16.42383	0.0004402	0.0004707	0.0000959	0.3834171
SR_M39	lmerMod	0.2802451	0.2802451	0.0000000	15.80682	16.53454	0.0002791	0.0001184	0.0000000	0.2886993
SR_M38	lmerMod	0.2607361	0.2607361	0.0000000	16.97806	17.28240	0.0000871	0.0000370	0.0000000	0.1691819
SR_M40	lmerMod	0.2510022	0.2510022	0.0000000	17.59052	17.60555	0.0000778	0.0000330	0.0000000	0.1118576

Figures

Figure 1.

Graphic of experimental procedure for all groups

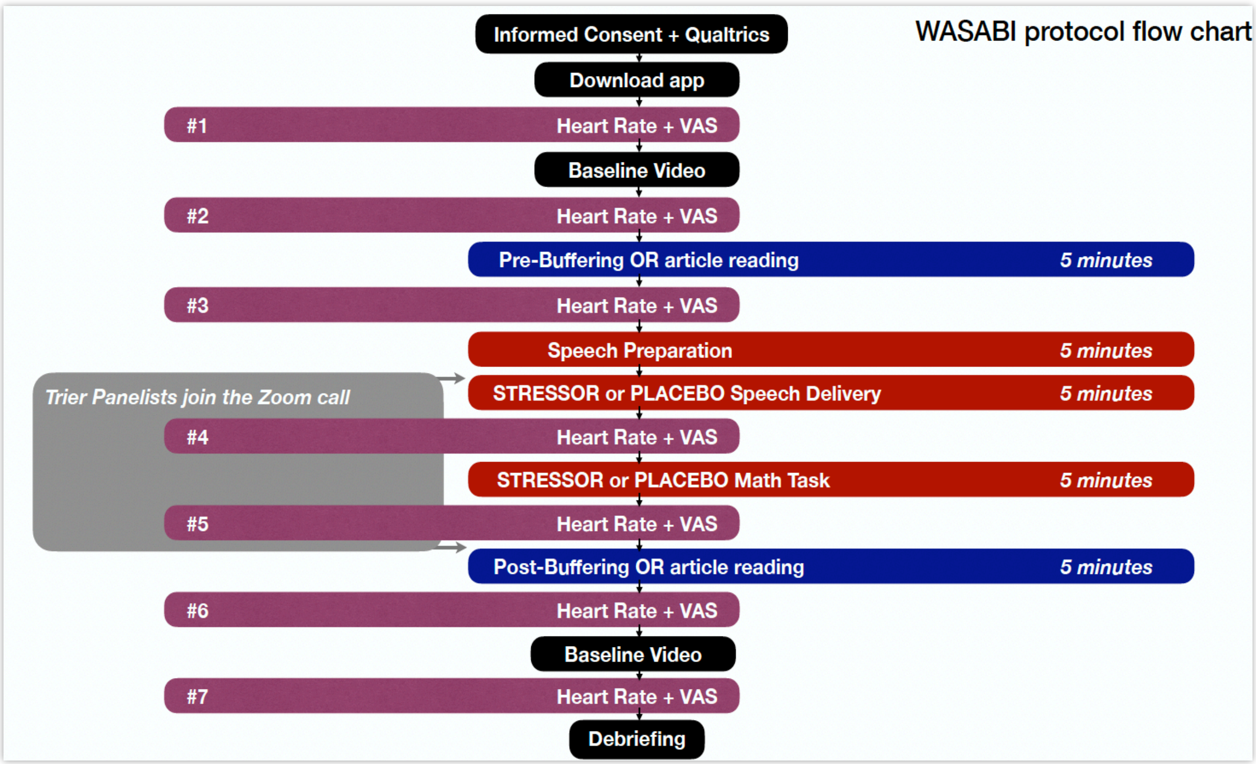
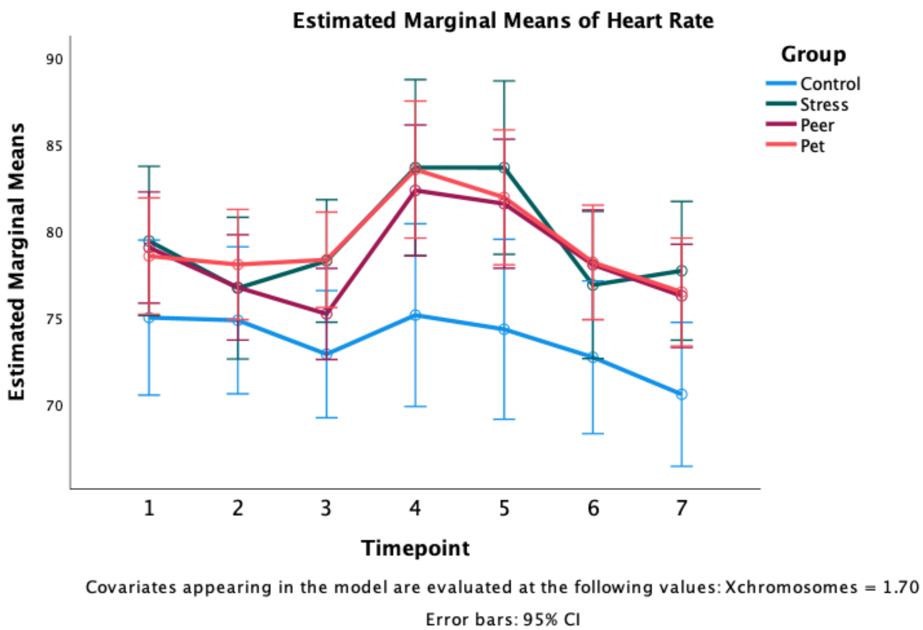


Figure 2.

Line Graphs Depicting Heart Rate (A) and Self-Reported Stress and Anxiety (B) Throughout the Experiment for Control, Stressor-No-Interaction, Stressor + Peer Interaction, and Stressor + Pet Interaction

A.



B.

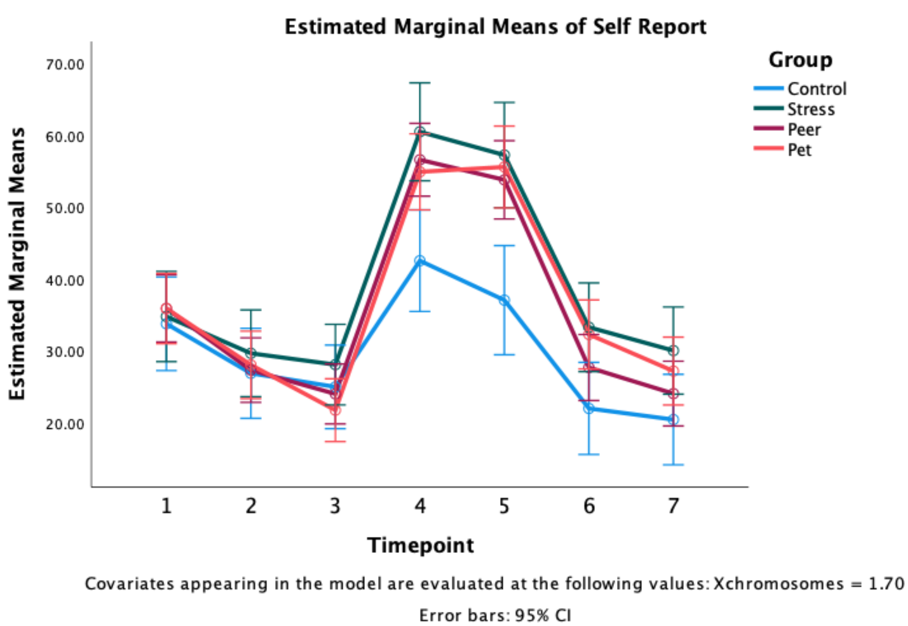
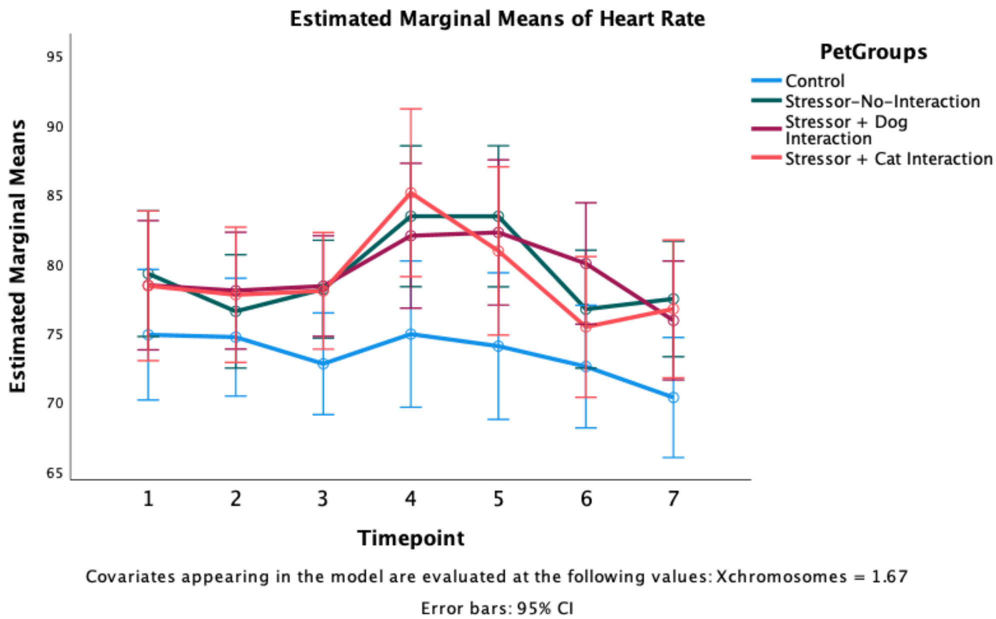


Figure 3.

Line Graphs Depicting Heart Rate (A) and Self-Reported Stress and Anxiety (B) Throughout the Experiment for Control, Stressor-No-Interaction, Stressor + Dog Interaction, and Stressor + Cat Interaction

A.



B.

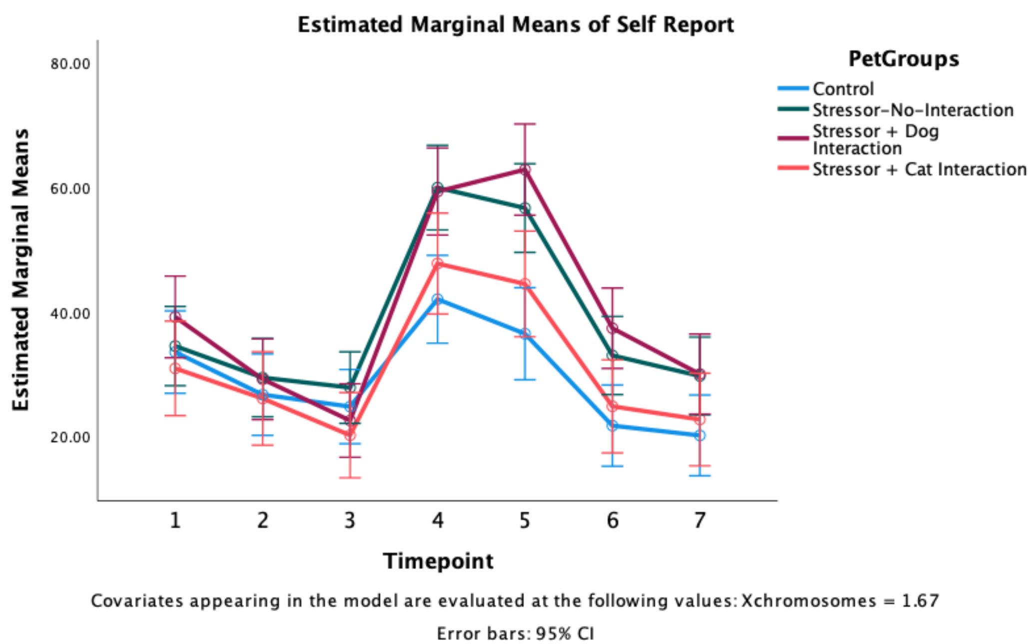


Figure 4.

Figure Depicting Best Mixed-Effects Model for Accounting Variance in Heart Rate Reactivity and Recovery from the Stressor

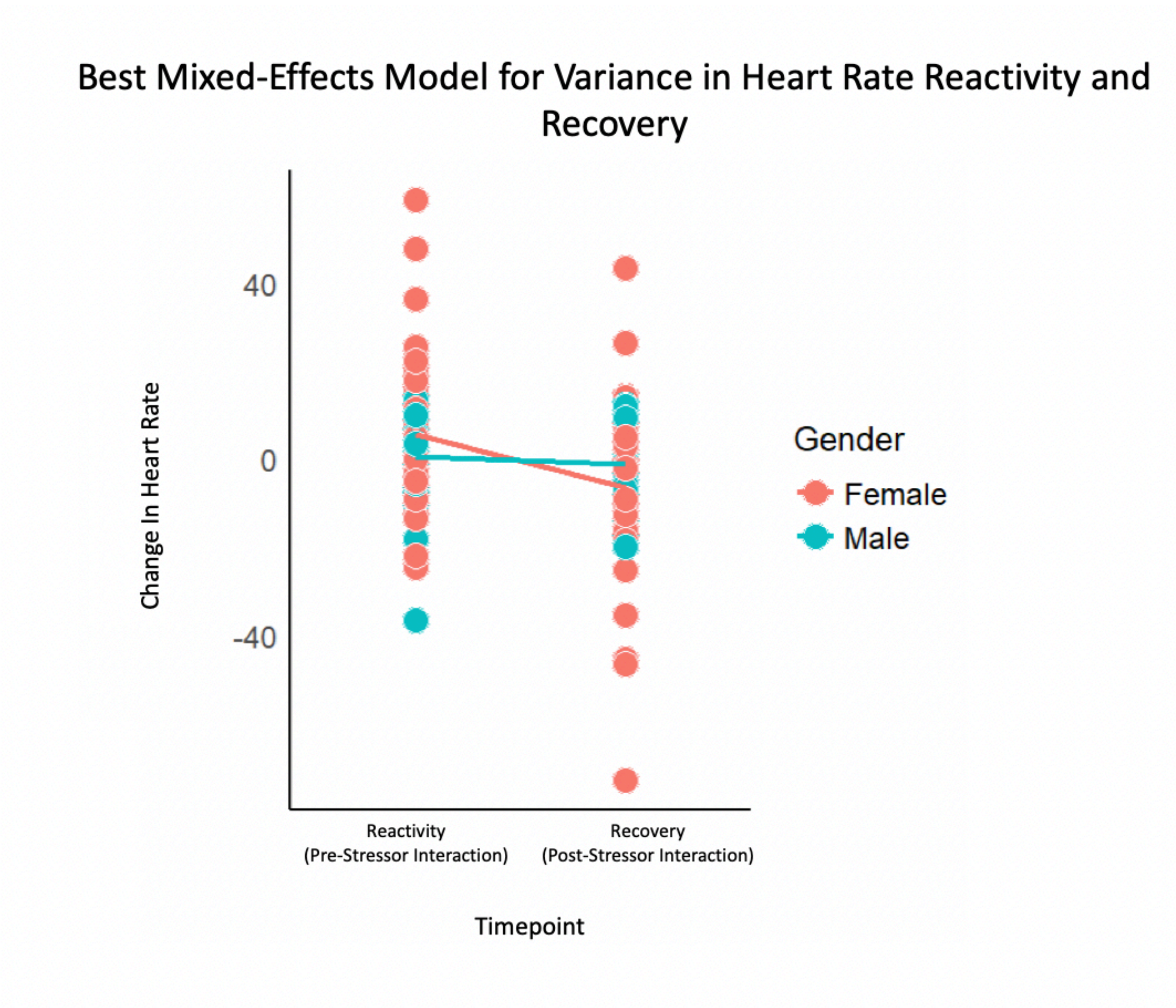
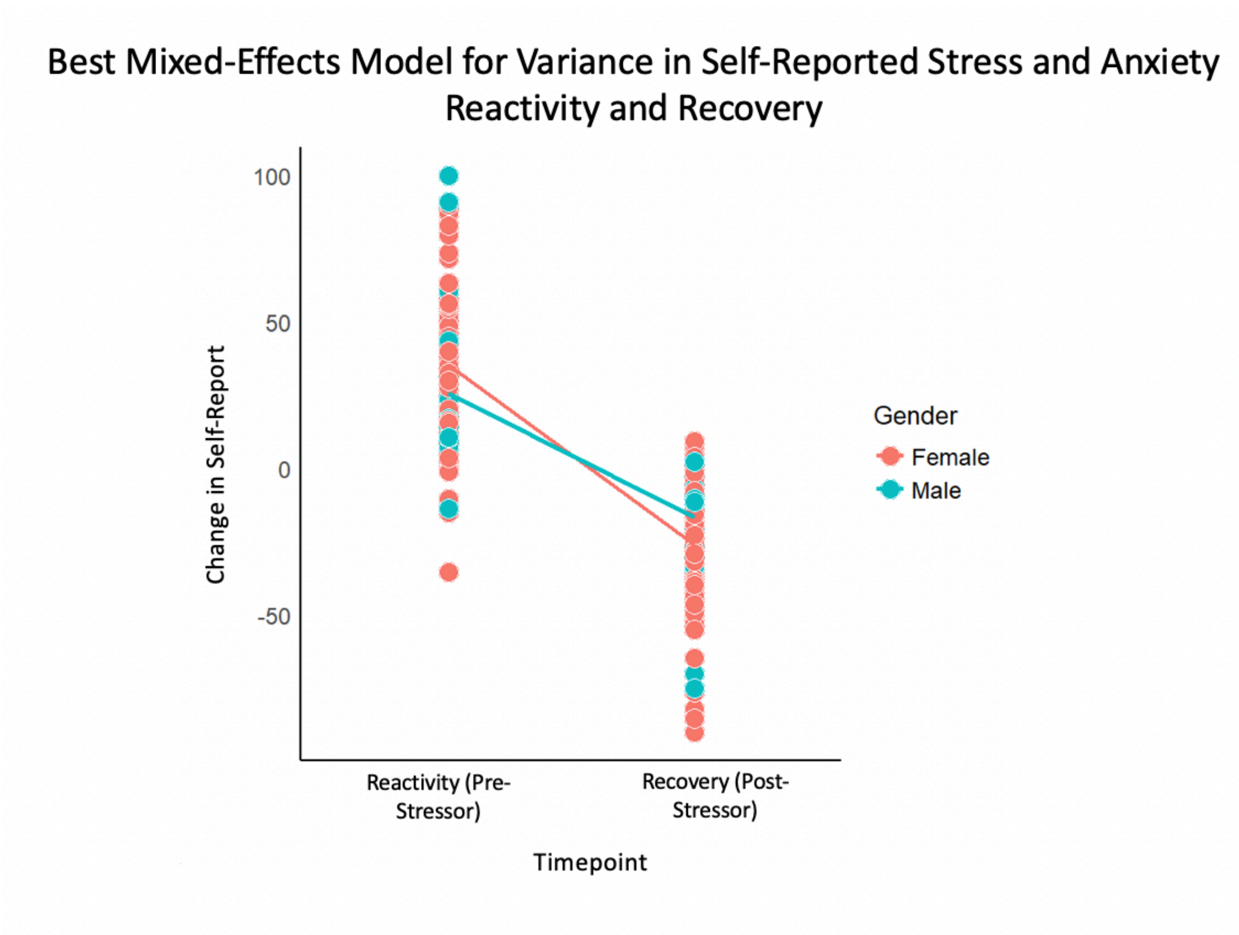


Figure 5.

Figure Depicting Best Mixed-Effects Model for Accounting Variance in Self-Reported Reactivity and Recovery from the Stressor



Appendix A

Heart Rate Mixed-Effects Models	**Self-Report Mixed-Effects Models**
HR_M1: HR ~ TX + (1|ID)	**SR_M1**: SR ~ TX + (1|ID)
HR_M2: HR ~ Pet_Type + (1|ID)	**SR_M2**: SR ~ Pet_Type + (1|ID)
HR_M3: HR ~ Gender + (1|ID)	**SR_M3**: SR ~ Gender + (1|ID)
HR_M4: HR ~ TX * Pet_Type + (1|ID)	**SR_M4**: SR ~ TX * Pet_Type + (1|ID)
HR_M5: HR ~ TX * Gender + (1|ID)	**SR_M5**: SR ~ TX * Gender + (1|ID)
HR_M6: HR ~ Pet_Type * Gender + (1|ID)	**SR_M6**: SR ~ Pet_Type * Gender + (1|ID)
HR_M7: HR ~ TX * Pet_Type * Gender + (1|ID)	**SR_M7**: SR ~ TX * Pet_Type * Gender + (1|ID)
HR_M8: HR ~ TX * Pet_Type + PWAR + (1|ID)	**SR_M8**: SR ~ TX * Gender + PWAR + (1|ID) (from SR_M5 Structure)
HR_M9: HR ~ TX * Pet_Type + OC + (1|ID)	**SR_M9**: SR ~ TX * Gender + OC + (1|ID) (from SR_M5 Structure)
HR_M10: HR ~ TX * Pet_Type + No_Contact + (1|ID)	**SR_M10**: SR ~ TX * Gender + No_contact + (1|ID) (from SR_M5 Structure)
HR_M11: HR ~ TX * Pet_Type + PWAR * OC + (1|ID)	**SR_M11**: SR ~ TX * Gender + PWAR * OC + (1|ID) (from SR_M5 Structure)
HR_M12: HR ~ TX * Pet_Type + PWAR * No_Contact + (1|ID)	**SR_M12**: SR ~ TX * Gender + PWAR * No_contact + (1|ID) (from SR_M5 Structure)
HR_M13: HR ~ TX * Pet_Type + OC * No_Contact + (1|ID)	**SR_M13**: SR ~ TX * Gender + OC * No_contact + (1|ID) (from SR_M5 Structure)
HR_M14: HR ~ TX * Pet_Type + PWAR:OC:No_Contact + (1|ID)	**SR_M14**: SR ~ TX * Gender + PWAR:OC:No_contact + (1|ID) (from SR_M5 Structure)
HR_M15: HR ~ TX * Pet_Type + Positive + (1|ID)	**SR_M15**: SR ~ TX * Gender + Positive + (1|ID) (from SR_M5 Structure)
HR_M16: HR ~ TX * Pet_Type + Negative + (1|ID)	**SR_M16**: SR ~ TX * Gender + Negative + (1|ID) (from SR_M5 Structure)
HR_M17: HR ~ TX * Pet_Type + NS + (1|ID)	**SR_M17**: SR ~ TX * Gender + NS + (1|ID) (from SR_M5 Structure)
HR_M18: HR ~ TX * Pet_Type + Positive * Negative + (1|ID)	**SR_M18**: SR ~ TX * Gender + Positive * Negative + (1|ID) (from SR_M5 Structure)

HR_M19: HR ~ TX * Pet_Type + Positive * NS + (1|ID)	**SR_M19**: SR ~ TX * Gender + Positive * NS + (1|ID) (from SR_M5 Structure)
HR_M20: HR ~ TX * Pet_Type + Negative * NS + (1|ID)	**SR_M20**: SR ~ TX * Gender + Negative * NS + (1|ID) (from SR_M5 Structure)
HR_M21: HR ~ TX * Pet_Type + PAO + (1|ID)	**SR_M21**: SR ~ TX * Gender + Positive:Negative:NS + (1|ID) (from SR_M5 Structure)
HR_M22: HR ~ TX * Pet_Type + PNB + (1|ID)	**SR_M22**: SR ~ TX * Pet_Type * Gender + PWAR + (1|ID) (from SR_M7 Structure)
HR_M23: HR ~ TX * Pet_Type + OandP + (1|ID)	**SR_M23**: SR ~ TX * Pet_Type * Gender + OC + (1|ID) (from SR_M7 Structure)
HR_M24: HR ~ TX * Pet_Type + Positive:Negative:NS + (1|ID)	**SR_M24**: SR ~ TX * Pet_Type * Gender + No_contact + (1|ID) (from SR_M7 Structure)
HR_M25: HR ~ TX * Pet_Type + Negative + (MHS_zlog|ID)	**SR_M25**: SR ~ TX * Pet_Type * Gender + PWAR * OC + (1|ID) (from SR_M7 Structure)
HR_M26: HR ~ TX * Pet_Type + Negative + (RSE_PM|ID)	**SR_M26**: SR ~ TX * Pet_Type * Gender + PWAR * No_contact + (1|ID) (from SR_M7 Structure)
HR_M27: HR ~ TX * Pet_Type + Negative + (TMHD|ID)	**SR_M27**: SR ~ TX * Pet_Type * Gender + OC * No_contact + (1|ID) (from SR_M7 Structure)
HR_M28: HR ~ TX * Pet_Type + Negative + (PAS|Pet_Type)	**SR_M28**: SR ~ TX * Pet_Type * Gender + PWAR:OC:No_contact + (1|ID) (from SR_M7 Structure)
HR_M29: HR ~ TX * Pet_Type + Negative + (PAO|Pet_Type)	**SR_M29**: SR ~ TX * Pet_Type * Gender + Positive + (1|ID) (from SR_M7 Structure)
HR_M30: HR ~ TX * Pet_Type + Negative + (PNB|Pet_Type)	**SR_M30**: SR ~ TX * Pet_Type * Gender + Negative + (1|ID) (from SR_M7 Structure)
HR_M31: HR ~ TX * Pet_Type + Negative + (OandP|ID:Pet_Type)	**SR_M31**: SR ~ TX * Pet_Type * Gender + NS + (1|ID) (from SR_M7 Structure)
	SR_M32: SR ~ TX * Pet_Type * Gender + Positive * Negative + (1|ID) (from SR_M7 Structure)
	SR_M33: SR ~ TX * Pet_Type * Gender + Positive * NS + (1|ID) (from SR_M7 Structure)

	SR_M34: SR ~ TX * Pet_Type * Gender + Negative * NS + (1|ID) (from SR_M7 Structure) **SR_M35**: SR ~ TX * Pet_Type * Gender + Positive:Negative:NS + (1|ID) (from SR_M7 Structure) **SR_M46**: SR ~ TX * Gender + PAO + (1|ID) (from SR_M5 Structure) PNB OandP **SR_M47**: SR ~ TX * Gender + PNB + (1|ID) (from SR_M5 Structure) **SR_M48**: SR ~ TX * Gender + OandP + (1|ID) (from SR_M5 Structure) **SR_M49**: SR ~ TX * Pet_Type * Gender + PAO + (1|ID) **SR_M50**: SR ~ TX * Pet_Type * Gender + PNB + (1|ID) **SR_M51**: SR ~ TX * Pet_Type * Gender + OandP + (1|ID)

R Packages:

Rstatix, effectsize, Matrix, lme4, ggplot2, stringr, forcats, tidyr, readxl, readr, dplyr, kableExtra, tibble, purrr, parameters, insight, performance, see, easystats, correlation, modelbased, bayestestR, report, datawizard, ggraph, and tidyverse.