The Impacts of Social Buffering on Parents' Self-Reported and Cardiac Responsivity to a Remote Stress Induction

by

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Abstract

Elevated and chronic levels of parenting stress in the early years of a child's life can have detrimental effects on social, cognitive, and emotional developmental outcomes. Canadian parents of young children reported significant elevations in stress levels during the COVID-19 pandemic, which highlighted a need to identify reliable methods of inducing and buffering stress remotely in this population. The primary objectives of the present study were (1) to assess whether a novel, internet-delivered version of the TSST (iTSST) could induce acute psychosocial stress in a sample of parents, and (2) to examine the impact of social buffering on parents' perceived and biological reactivity following exposure to the iTSST. Self-identified parents (*N* = 60; *n* = 16, control; *n* = 24, stressor only; *n* = 20, stressor plus social buffering; 60.0% non-White) of children under 48 months old completed a 1 hr Zoom assessment during which the iTSST/placebo protocol was administered. Self-reports of stress and anxiety, along with smartphone measures of photoplethysmography, were collected throughout the assessment to assess reactivity to, and recovery from, the iTSST. Findings revealed that parents who completed the iTSST exhibited significant elevations in stress and anxiety as compared to pre-iTSST levels and parents who completed the placebo procedures. No evidence of reactivity effects on heart rate were observed. Additionally, no evidence of a significant buffering effect emerged; however, it was notable that parents who interacted with a friend, romantic partner, or family member post-iTSST showed a non-significant trend of lower self-reported stress and anxiety relative to parents who engaged in an article reading period post-iTSST. Results of the present study further validate the efficacy of the iTSST in eliciting significant self-reported reactivity in a sample of exclusively parents. Implications and considerations for future studies involving remote stress induction and buffering in parents and racially diverse samples are discussed.

Keywords: parents, acute stress, Trier Social Stress Test, self-reported stress, photoplethysmography, social buffering

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The Impacts of Social Buffering on Parents' Self-Reported and Cardiac Responsivity to a Remote Stress Induction

Elevated and chronic levels of parenting stress, particularly in the early years of a child's life, can have detrimental effects on their social, cognitive, and emotional development (Deater-Deckard, 2005; Fisher et al., 2016; Flouri et al., 2015; Guajardo et al., 2009). Parents of young children reported experiencing severe strains on their mental health early in the COVID-19 pandemic (Cameron et al., 2020a, 2020b; Roos et al., 2021). Specifically, parental depression and stress were considerably elevated from pre-pandemic levels (Cameron et al., 2020a, 2020b). These observations are not surprising considering the pandemic created numerous unprecedented challenges across nearly all aspects of daily living. The rapid implementation of stringent public health orders and restrictions to help curb the spread of COVID-19 resulted in most individuals being limited, almost exclusively, to their respective residences for several days or weeks at a time. This drastic shift to remote work, learning, and interactions had significant impacts on mental health among Canadians, with self-reported mental health deteriorating markedly among those aged 12 and older during the pandemic (Capaldi et al., 2021; Jenkins et al., 2021; Statistics Canada, 2022a). Statistics Canada (2022b) recently reported that Canadians' self-reported mental health has yet to return to pre-pandemic levels.

Pandemic-related elevations in parental stress levels highlight a need to identify reliable methods of inducing and buffering stress remotely in this population. Social buffering is one mechanism through which neurobiological responsivity to stress is attenuated (Hostinar et al., 2014). This phenomenon generally refers to the ability of a social partner to attenuate the stress response and facilitate recovery from stress. Whereas substantial evidence exists to support the potency of parental buffering on children's stress-response system activation (Gunnar 2017;

Gunnar & Hostinar, 2015), less is known about the buffering effects of social support on caregivers’ stress reactivity. Considering the strong associations between heightened parental stress levels and disruptions in parental well-being and parent-child bonding (de Cock et al., 2017; Skreden et al., 2012), it is crucial that this gap in the literature is swiftly acknowledged.

Physiological and Subjective Measures of Acute Stress Reactivity

In order to study the effects of social buffering on caregivers’ physiological and self-reported acute stress reactivity, a stress induction paradigm needs to be employed and subsequent measures of acute stress reactivity examined to validate whether a stress response is initiated. The physiological markers of acute stress are well-documented as involving activation of the sympathetic-adrenomedullary (SAM) axis and the hypothalamic-pituitary-adrenocortical (HPA) axis (Gunnar & Quevedo, 2007). To briefly describe each of their roles in the stress-response, the SAM axis is a part of the sympathetic branch of the autonomic nervous system (ANS) and is responsible for epinephrine (i.e., adrenaline) release, which in increased amounts contributes to the generation of the fight-or-flight response (Gunnar & Quevedo, 2007). The HPA axis is responsible for the initiation of a glucocorticoid cascade in humans, which ends in the production and release of cortisol that then travels to the brain as one of its primary targets. Although these two systems are distinct, their functioning is interrelated as both systems are regulated by the region of the brain known as the hypothalamus (Gunnar & Quevedo, 2007).

Studies utilizing acute stress induction paradigms often validate whether a stress response has been initiated through measures of cortisol concentration collected through saliva or blood samples (Allen et al., 2014, 2017; Kirschbaum, 1993). Cortisol concentration levels thus serve as an important biological marker of HPA axis activation (Allen et al., 2014, 2017; Kirschbaum, 1993). However, obtaining measures of cortisol requires researchers to have the resources to acquire sampling kits, ensure proper storage of samples, and ship the samples off for processing. The COVID-19 pandemic and subsequent transition to online studies added an additional layer of complexity to collecting cortisol samples, as materials needed to be delivered to participants’ homes and then returned to the research facility. As a result, it is important to consider alternative measures of acute stress reactivity that are both cost-effective and able to be collected entirely remotely (i.e., without the need to deliver and return materials).

Smartphone-delivered measures of photoplethysmography (PPG) have recently emerged as a reliable and accessible measure of acute stress reactivity (Cheatham et al., 2015; De Ridder et al., 2018; Harvie et al., 2021; Mitchell et al., 2016; Pipitprapat et al., 2018). Photoplethysmography technology in smartphones utilize the phone’s flash as a light source to illuminate the subcutaneous tissue in the fingertip and the phone’s camera to measure small changes in light intensity associated with fluctuations in blood volume that occur with each heart beat (Allen, 2007; Harvie et al., 2021). Research comparing smartphone measures of PPG to other measures of cardiac reactivity (e.g., electrocardiogram and pulse oximetry) has demonstrated high reliability and validity between methods (Cheatham et al., 2015; De Ridder et al., 2018; Mitchell et al., 2016; Pipitprapat et al., 2018).

To fully capture an individual’s stress reactivity, subjective measures of acute stress should also be collected and analyzed in conjunction with physiological markers (Allen et al., 2014). Subjective effects of acute stress are relatively simple to measure and typically involve individuals self-reporting their anxiety, stress, and mood on a sliding scale at several points during a study (Allen et al., 2014). Given that subjective measures of acute stress are easily administered online and provide immediate information about an individual’s stress reactivity

(Nelson et al., 2023), they are an important tool to use when validating whether an acute stress response has been induced.

Feasibility of Remote Methods of Stress Induction

The Trier Social Stress Test (TSST; Kirschbaum, 1993), which was originally developed nearly three decades ago, has now become the most widely used stress induction task across age groups (Goodman et al., 2017; Seddon et al., 2020). The basis of its frequent use stems from its ecological validity and ability to produce robust physiological and psychological stress responses (Kirschbaum, 1993). Traditionally, the TSST is delivered in a highly controlled, laboratory setting (Helminen et al., 2021) and involves two components: (1) preparation and delivery of a speech and (2) performing a difficult mental arithmetic task, which are both completed in front of a panel of unfamiliar experimenters who are trained to maintain neutral affect and avoid providing positive social feedback for the duration of these tasks (Kirschbaum, 1993). This element of social evaluative threat, combined with the unpredictable nature of the task, is what contributes to effectiveness of the TSST in evoking a reliable acute psychosocial stress response (Dickerson & Kemeny, 2004).

Although the traditional laboratory-delivered version of the TSST is highly effective in inducing a strong stress response, it is not without its limitations. Perhaps the most glaring disadvantage of the traditional TSST protocol is that it requires research personnel and participants to be physically present in the same space, which severely restricts participation to individuals who live near the testing facility and who are able to make the commute (Eagle et al., 2021). This limitation becomes particularly relevant in the context of the COVID-19 pandemic, which brought about stringent regulations to prevent social gatherings in order to contain the spread of the virus. Additionally, caregivers of young children may face specific barriers to engagement in laboratory-based research studies that are linked to unmet childcare or transportation needs. Securing the resources needed to conduct laboratory-delivered versions of the TSST can also be quite costly (Eagle et al., 2021).

Recently, prominent researchers in the field have acknowledged the limitations that the traditional TSST protocol presents and have called for a need to adapt the TSST to remote, online delivery via video chat (Gunnar et al., 2021; Kirschbaum, 2021). Internet-delivered versions of the TSST (iTSST; Eagle et al., 2021; Gunnar et al., 2021; Harvie et al., 2021) are cost-effective, allow for flexible scheduling, and enable individuals from all over the world to participate in this research (given they have stable internet connectivity), thus mitigating the aforementioned limitations (Eagle et al., 2021; Gunnar et al., 2021; Harvie et al., 2021; Kirschbaum, 2021; Pfeifer et al., 2021). Over the past two years, a number of studies have examined the validity of online variants of the TSST in use with adolescents (Gunnar et al., 2021) and adults (Eagle et al., 2021; Harvie et al., 2021; Meier et al., 2022). Gunnar and colleagues (2021) found that an online variant of the TSST produced heightened levels of cortisol, salivary α-amylase, and self-reported stress in adolescents. Similar findings have emerged in studies of adults, with Meier and colleagues (2022) reporting significant increases in cortisol, salivary α-amylase, and arousal levels in response to an online version of the TSST. Stress reactivity to the iTSST, as marked by increases in heart rate and self-reported stress and anxiety, has also been supported (Eagle et al., 2021; Harvie et al., 2021). Taken together, these findings demonstrate the feasibility of capturing stress reactivity to an online variant of the TSST using various measures of psychological and physiological stress.

Social Buffering

While short-term activation of the HPA axis has been found to be adaptive in navigating daily life, its prolonged activation as a result of exposure to chronic stressors (e.g., COVID-19), has been associated with dysregulation of the stress-response system and adverse impacts on psychological and physical well-being (Elder et al., 2023; Gunnar & Quevedo, 2007; Shonkoff et al., 2012). One mechanism through which HPA axis responsivity to stress can be attenuated is known as social buffering. The phenomenon of social buffering has been explored in both animal models and human studies and occurs when the presence of a social partner (e.g., close friend or family member) diminishes HPA axis activation and facilitates recovery to baseline levels of stress following exposure to a perceived threat or challenge (Gunnar, 2017; Hostinar et al., 2014). Furthermore, research has demonstrated the significant effect of positive social support on cardiac responsivity to stress in laboratory settings (Uchino et al., 1996). The positive influences of social buffering are not limited to reducing the physiological effects of stress. Being in the presence of a social companion has also been shown to diminish self-reported stress and anxiety levels (Kikusui, 2006).

In the context of the present study, it is important to consider how research studies conducted entirely online might impact the effectiveness of social buffering. Since this will be the first study, to my knowledge, to examine the impacts of social buffering on caregivers' cardiac responsivity to an online variant of the TSST, it is difficult to predict if and how the potency of the social buffering effect will be altered. However, in a study investigating the effects of parental stress buffering on children's stress reactivity following exposure to a laboratory-delivered version of the TSST for children, it was found that parents' presence during the recovery period facilitated the fastest return to baseline levels of stress (Seltzer et al., 2010). Interestingly, a stress buffering effect was also observed when children called their parents during the recovery period, however, this effect was less pronounced than when parents were physically present (Seltzer et al., 2010). These findings might suggest that, although a stress buffering effect can occur when interactions are remote, the effect will be less robust than seen following a period of in-person social buffering.

Depression and Cardiac Reactivity to Acute Stress

Research examining the relationship between depression and cardiovascular reactivity to stress has produced mixed results (Brindle et al., 2013). Older studies investigating this association revealed that depression was related to heightened cardiac reactivity to stress (Kibler & Ma, 2004). Conversely, more recent studies have observed that depression is linked to blunted cardiac reactivity to stress in non-clinical, adult samples (Brindle et al., 2013; de Rooij et al., 2010). Brindle and colleagues (2013) used the Beck Depression Inventory to assess depression severity and deemed those who scored 10 or above the 'depressed group' and those who scored below 10 the 'non-depressed group.' Their study revealed that the 'depressed group' showed blunted heart rate and systolic blood pressure in response to a mental arithmetic task. These findings could have implications for the present study, but it is difficult to draw any definitive conclusions due to the variability in outcomes.

Present Study

The primary objectives of the study were (1) to assess whether a novel, internet-delivered version of the TSST could induce acute psychosocial stress in a sample of parents, and (2) to examine the impact of social buffering on cardiac and self-reported stress reactivity following exposure to a remote stress induction. Harvie et al. (2021)'s findings provide support for the efficacy of an internet-delivered variant of the TSST to induce significant elevations in heart rate and self-reported stress and anxiety relative to a *control* group (who completed a placebo version of the iTSST) in a sample of undergraduate university students. Thus, this study aimed to replicate and extend these findings to a sample of parents. Additionally, it was hypothesized that caregivers who interacted with a close friend or family member following completion of the iTSST would experience a more rapid return to pre-iTSST levels of perceived and biological stress, as compared to caregivers who did not engage in a buffering period. As a secondary research question of interest, I examined whether caregivers' physiological responsivity to acute stress differed as a function of self-reported depression severity scores. Although research on the directionality of the relationship between these variables remains mixed (Brindle et al., 2013), it was still hypothesized that heart rate reactivity to the stressor (as indexed by raw heart rate values between timepoints 3 to 6 and *reactivity* scores for heart rate) would be related to depression severity scores.

Method

Participants

Primary caregivers of children under 48 months old who reside in Canada were recruited to participate in this study. A power analysis determined that the minimum sample size required to observe the expected effect size of .90 with a significance criterion of $\alpha = .05$ and power = .80 was $N = 90$ ($n = 30$ across the three groups) for the repeated measures General Linear Model (GLM) analyses described in the Analytic Plan section below. Parents were eligible to participate in an online assessment if they were at least 18 years of age, had full or partial custody of at least one child under 48 months old, spoke fluent English, self-reported under severe clinical cut-offs for anxiety and depression (as reported in the Measures section below), indicated not having received a diagnosis or treatment for a psychological disorder within the last 12 months, reported not taking any pharmaceutical medication, and had access to a functioning smartphone and computer/tablet/mobile phone with a webcam or camera. Parents who did not meet any of the above inclusion criteria were excluded from the study.

Sample Characteristics

Sixty-one participants who met the inclusion criteria outlined above participated in an online assessment. One (1.6%) of these participants was unable to complete their assessment due to having to care for their child who awoke from a nap during the iTSST, and thus was excluded from all analyses. The final sample of 60 participants (n = 16, *placebo control*; n = 24, *stressor only*; n = 20, *stressor plus social buffering*) consisted mostly of (73.3%) self-identified mothers who were approximately 32 years of age on average (M = 32.14, SD = 5.53; range, 21-44 years) and had two or more children (53.3%), with their youngest child being 16.76 months old on average (SD = 12.06; range, .16-45.80 months). The majority of participants reported residing in Canada (80.0%), having completed some form of post-secondary education (91.6%), being married or in a common-law relationship (93.3%), working on a full- or part-time basis (68.3%), and having an annual household income over $60,000 (76.5%). Notably, the majority of participants self-identified as non-White Canadian/American/European (60.0%), with the most frequently represented racial minorities being Black (31.7%) and Asian (30%), followed by Indigenous (3.3%), Other (3.3%), and Latin American (1.7%) (see Table 1 for a full breakdown of racial backgrounds). In terms of outcomes on the mental health measures included in this study, mean levels of depression and anxiety fell into the 'none to minimal severity' range (Beck et al., 1996; Spitzer et al., 2006). Similarly, mean levels of parenting stress across the sample were below clinical significance (i.e., $\leq$ 90; Abidin, 1995), however, average parenting stress levels in the *Control* group narrowly met clinical significance (M = 90.44, SD = 30.97). An overview of sample characteristics for the full sample and each group are presented in Table 1.

Non-Parent Suspicions

Initially, participation in the study was open to parents residing both in Canada and abroad with the aim of expanding beyond the traditionally Western, educated, industrialized, rich, and democratic (WEIRD) samples that are recruited in many published research studies in this area, including those in Eagle et al. (2021), Gunnar et al. (2021), and Harvie et al.'s (2021) studies. However, soon after recruitment commenced, we encountered a highly sophisticated group of click farmers who were responding to items on our eligibility screener in a way that made them indistinguishable from our target sample of parents. When members of these click farms joined the Zoom call for their virtual assessments (see Procedure section below), a pattern of suspicious behaviours started to emerge that led us to suspect that they may not be aligned with our target demographic. These individuals often experienced persistent technical issues (e.g., poor internet connectivity, inability to turn on video and/or audio), which caused them to drop out of the call several times over the course of the 1 hr assessment and left the research assistant leading the session unable to complete all the assessment tasks in a timely manner. Some of these individuals even appeared to be joined by another person in the room (who remained off camera) that coached them through verbal responses delivered on camera. Additionally, it was observed that many of these individuals were joining their assessments from a similar environment (e.g., same purple wall colour in the background and similar lighting), which led us to suspect that they may be members of the same group. To prevent members of this group from signing up for future assessments, IP addresses were collected and only participants with IP addresses within Canada were invited to participate in assessments. This additional verification step largely mitigated the problem; however, it did mean that participation was limited to residents of Canada. Given that Canada's population is diverse in terms of race, ethnicity, culture, and religion (Statistics Canada, 2022c) it was expected that limiting recruitment to within Canada would still provide us with a sufficiently representative sample.

Procedure

Recruitment Approach

All study procedures were approved by the University of Manitoba's Psychology/Sociology Research Ethics Board. Participants were recruited using four methods: (1) online advertisements posted on various social media platforms and marketplaces (i.e., Instagram, Facebook, Twitter), (2) contacting Canadian organizations that have a far reach to many parents (e.g., community agencies, daycares, medical centres, etc.) to ask if they were willing to share our recruitment poster with their community of caregivers, (3) providing information about our study to parents who visited recruitment events held by our research team and/or collaborating research teams in Winnipeg, Manitoba (e.g., Kidsfest, Winnipeg Family Fun Fair, etc.), and (4) in-person distribution of posters around Manitoba. Participants reported hearing about the study through several sources, which included social media postings (41.7%), or information shared by a friend/family member (28.3%), a local parent group (11.7%), their child's daycare/preschool (5.1%), or our research team at an in-person recruitment event (1.7%). One other participant (1.7%) reported receiving an email about our study without specifying the source, and six others (10%) did not respond to this question.

Interested participants were directed to complete an eligibility screener through the REDCap electronic data capture tool hosted at the University of Manitoba via a QR code or link available on the poster. Following completion of the eligibility screener, a study coordinator reviewed the responses and only contacted participants who were eligible to participate in a 1 hr Zoom assessment. Eligible participants were subsequently emailed a link to a REDCap survey that contained a consent form and booking instrument for the Zoom assessment. One hour Zoom assessment timeslots were offered from 9:00 a.m. to 4:30 p.m., Monday through Sunday. Once participants selected an assessment timeslot on REDCap, a study coordinator/trained research assistant sent them an email containing a link to their private Zoom session and instructions to help prepare them for their assessments. These instructions included reminders to have a functioning smartphone and computer/tablet/second phone with videocall capacities available, to try to be in a private space during the assessment, and to have writing materials and a wearable device that measures heart rate nearby. One day prior to their scheduled Zoom assessment, participants were randomly assigned to one of three experimental conditions: (1) *stressor only*, (2) *stressor plus social buffering*, or (3) *placebo control*.

Online Assessment

A general overview of the online assessment protocol is shown in Figure 1. On the day of their assessment, participants received a reminder email with the link to their Zoom session and preparation instructions 15 min before the session start time. Simultaneously, a trained lead assessor called the participant to ensure they had read and understood the information in the consent form and review some important points regarding their voluntary participation, as well as the various tasks and data acquisition and storage procedures involved in the study. If the participant could not be reached via telephone, lead assessors reviewed the consent form at the beginning of the assessment. Lead assessors subsequently started the Zoom session and waited for the participant to join. Upon arrival in the Zoom session, participants were verbally and visually guided through downloading a smartphone app (Heart Rate Plus; PVDApps, 2015) for photoplethysmography measurements of heart rate. Once the participant had downloaded the app, an initial heart rate and Visual Analogue Scale (VAS) measurement of perceived stress and anxiety were collected. Immediately afterwards, the participant watched a 5 min neutral video of underwater ocean scenes and marine life for acquisition of baseline measures of cardiac and perceived stress activity. Participants were reminded to relax, watch the video with audio, and refrain from touching their computer while the video was playing. The use of such videos to achieve baseline and recovery measurements of cardiac activity has been validated by several studies (Giuliano et al., 2018; Piferi et al., 2000; Roos et al., 2017). Immediately following the cessation of the video, the participant provided a second heart rate and VAS measurement. Then, all participants completed a 5 min reading activity for which the lead assessor sent six scientific journal/magazine articles – selected for their interesting, but neutral and nonaffective subject matter – over the Zoom chat function, and participants could read as many articles as they wished. During the reading period, participants were asked to share their screen so lead assessors could ensure that they stayed on task and lead assessors turned off their own camera and microphone to avoid distracting the participant. At the end of the reading period, a third heart rate and VAS measurement were collected.

The next task was contingent on which experimental condition the participant had been assigned to. Participants assigned to the *stressor only* (see Stressor Only Condition section below) or *stressor plus social buffering* (see Stressor Plus Social Buffering condition section below) conditions completed an internet-delivered version of the Trier Social Stress Test, while participants assigned to the *placebo* (see Placebo Condition section below) condition completed a placebo version of the iTSST. Participants provided a fourth and fifth heart rate and VAS measurement during, and immediately following, the iTSST/placebo version, respectively. After the iTSST or placebo version of the iTSST, participants completed either a 5 min social buffering period (see Stressor Plus Social Buffering Condition section below) or another 5 min reading period. At the end of the social buffering/reading period, a sixth heart rate and VAS measurement were recorded. Lastly, the participant watched a final 5 min neutral video of underwater ocean scenes and marine life. Once the video ended, participants completed a seventh and final heart rate and VAS measurement. Assessments concluded with participants being debriefed on their participation in the study and receiving a condition-specific debriefing form that included evidence-based tips for recovering from stressful experiences, such as the potential benefits of focused breathing exercises, information about the positive effects of social interactions, and links to resources for mental health and well-being including a popular YouTube meditation channel.

Immediately after the Zoom assessment, participants were sent a link to complete six questionnaires on REDCap assessing sociodemographic information, recent life stressors, perceived social support, parenting stress, workplace flexibility and care arrangement, and resilience. Relevant questionnaires are described in detail in the Measures section below. Participants were reimbursed for their time and participation in the study via a $30/CAD e-gift card sent to their email after they submitted the post-assessment questionnaires on REDCap.

Stressor Only Condition

Figure 2 provides an overview of the iTSST procedures for the two stressor groups. Procedures described in this section are identical to those reported in Harvie et al. (2021). In the *stressor only* condition, participants were instructed to imagine that they were applying for a job and needed to prepare a 5 min speech that would convince their potential employer that they were the ideal candidate for the job. Lead assessors informed participants that their speech should include their strengths, why they would be the ideal employee, and how they would work to overcome their weaknesses. Participants then had 5 min to prepare their speech, during which they were allowed to take notes on a piece of paper. While participants were preparing their speech, lead assessors turned off their own camera and microphone. Once the preparation period had elapsed, lead assessors informed participants that some of their colleagues would be joining the Zoom session to administer the next two assessment tasks. Lead assessors then admitted two panelists (i.e., trained research assistants) into the session and subsequently turned off their own camera and microphone. Panelists were dressed in business casual attire (e.g., collared shirt or blouse) and had plain backgrounds (e.g., white wall) behind them in order to exude an impression of professionalism and authority. Panelist 1 guided participants through setting their Zoom screen to “Gallery” view, such that each panelist was clearly visible throughout the speech. Then participants were instructed to crumple up or destroy any notes they may have made to prepare for this speech, and once that was done were given the cue to begin their speech. For the duration of the speech, panelists maintained flat affect, refrained from providing positive feedback, and provided input (e.g., “Continue your speech” and “There is still time remaining”) when the participant had been silent for at least 3 seconds.

Following completion of the 5 min speech, Panelist 1 informed participants that the next task would involve performing serial subtraction out loud for 5 min. Participants were instructed to count down from 2043 in increments of 17 as quickly and accurately as possible. If a mistake was made, they were told to start over from 2043. For the duration of the math task, panelists again maintained neutral affect, refrained from providing positive feedback, and provided input (e.g., “You need to go as fast as you can” and “You need to continue without pausing”) when the participant had been silent for any length of time. Upon completion of the fifth heart rate and VAS measurement, panelists exited the Zoom session and lead assessors turned their camera and microphone back on and continued to administer the remaining assessment tasks.

Stressor Plus Social Buffering Condition

In the *stressor plus social buffering* condition, procedures were identical to the *stressor only* condition, with the addition of a 5 min interaction with a friend, sibling, parent, or romantic partner immediately following completion of the mental math task. Participants were allowed to interact with their acquaintance remotely (via a phone call or their acquaintance joining the Zoom session) or in-person. Once contact was established, the lead assessor informed the acquaintance of the study and asked for their verbal assent to participate. Once verbal assent was provided by the acquaintance, the lead assessor then instructed the participant-acquaintance dyad to converse as they normally would for the next 5 min and subsequently turned off their own camera and microphone. At the end of the 5 min social buffering period, the acquaintance was thanked for their time and asked to leave the call, so the assessment could be completed.

On the last page of their REDCap data entry form, participants were asked to indicate whether they had called someone during the assessment, and if yes, who they called. Most participants in the *stressor plus social buffering* group reported interacting with a friend (42.1%) or romantic partner/significant other (21.1%) during the buffering period. Others reported interacting with a parent (15.8%), sibling (15.8%), or grandparent (5.3%). Additionally, the majority of participants in this group interacted with their friend or family member via regular phone call (with the speaker turned on), however, a few (n = 3) participants were able to have their friend or family member join the Zoom call or join them in-person.

Placebo Condition

Figure 3 provides an overview of the placebo version of the iTSST for the *Control* group. Procedures described in this section are identical to those reported in Harvie et al. (2021). In the *placebo* condition, participants received the same instructions as those assigned to the *stressor* *only* condition, however, for the speech and math tasks no panelists joined the Zoom session, and the lead assessor had their camera and microphone off for the duration of the two tasks. Additionally, participants were permitted to use any notes they may have made to prepare for their speech. Participants then performed a simplified version of the math task, during which they counted upward from zero in increments of 15 for 5 min.

Measures

Anxiety

Anxiety was measured with the Generalized Anxiety Disorder 7-Item Scale (GAD-7; Spitzer et al., 2006). For the first seven items, respondents were asked to select one statement that best described the prevalence of each anxiety-related symptom (e.g., feeling nervous, anxious, or on edge) in the two weeks prior to completion. These items were rated on a 4-point scale, ranging from 0 (*not at all sure*) to 3 (*nearly every day*). For the eighth item, respondents were asked to rate the extent to which these anxiety-related symptoms had impaired their ability to carry out daily activities (e.g., working) on a 4-point scale, ranging from 0 (*not difficult at all*) to 3 (*extremely difficult*). Total GAD-7 scores were computed for each parent by summing their scores on the first seven items. Parents who scored a total of 15 or higher on the measure were not eligible to participate in an assessment as their score exceeded the clinical cut-off for severe anxiety (Spitzer et al., 2006).

Assessment of the psychometric properties of the GAD-7 has demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of .92, and good test-retest reliability, with an intraclass correlation coefficient of .83 (Spitzer et al., 2006). The scale has also been found to have good procedural validity, with an intraclass correlation coefficient of .83, and good convergent validity, with Pearson's product-moment correlations between the GAD-7 and other widely used measures of anxiety (i.e., Beck Anxiety Inventory and Symptom Checklist-90) of .72 to .74, respectively (Spitzer et al., 2006).

Depression

Depression severity in the two weeks prior to completion was measured with the Beck Depression Inventory II (BDI-II; Beck et al., 1996). The BDI-II is composed of 21 items, each corresponding to a different depression-related symptom (e.g., sadness). Respondents were asked to select one statement that best described the extent to which they had experienced each symptom in the past two weeks. In the present study, one item relating to suicide ideation was excluded due to concerns about adequate clinical training of the assessment team in managing potential mental health crises. All 20 items were rated on a 4-point scale, with 0 indicating the lowest severity of a particular symptom and 3 indicating the highest severity of a particular symptom. Total BDI-II scores were computed for each parent by summing their scores on all 20 items. Parents who received a total score of 30 or higher on the measure were not eligible to participate in an assessment as their score exceeded the clinical cut-off for severe depression in clinical populations (Beck et al., 1996).

Wang & Gorenstein (2013) conducted a review of 188 studies published between the years 1996 and 2012 that reported using the BDI-II in order to assess its psychometric properties in use with diverse populations. They found that the measure had high internal consistency, with Cronbach's alpha coefficients ranging from .83 to .96. The measure has also been shown to have sufficient content validity (Jackson-Koku, 2016; Wang & Gorenstein, 2013) and sufficient to high convergent validity, with Pearson's product-moment correlations between the BDI-II and other widely used scales that measure depression (e.g., BDI-I, Center for Epidemiologic Studies of Depression, Hamilton Depression Rating Scale, etc.) ranging from .66 to .94 (Wang &

Gorenstein, 2013). In use with non-clinical adult samples, the BDI-II has demonstrated excellent test-retest reliability with an alpha coefficient of .93 for an average interval of seven days between administrations of the measure (Wang & Gorenstein, 2013).

History of Mental Health Diagnoses

Self-report data on participants' history of mental health diagnoses was collected via a Mental Health Questionnaire created and implemented in Harvie et al.'s (2021) study. Respondents were asked to indicate which of the following DSM-V psychological disorders they had received a diagnosis or treatment for: (1) major depressive disorder, (2) bipolar disorder, (3) panic disorder, (4) social anxiety disorder, (5) generalized anxiety disorder, (6) post-traumatic stress disorder, (7) anorexia nervosa, (8) bulimia nervosa, (9) binge eating disorder, (10) schizophrenia, (11) attention deficit hyperactivity disorder, (12) substance use disorder, and (13) other (open-ended). For each disorder, respondents reported whether they received a diagnosis or treatment in the past month, 2 to 12 months ago, 1+ years ago, or never. Parents who reported having received a diagnosis or treatment for a psychological disorder within one year of completing the eligibility screener were deemed ineligible to participate in an assessment.

Parenting Stress

Parenting stress at the time of completion was assessed with the 36-item short form of the Parenting Stress Index (PSI-SF), which is comprised of the Parental Distress (PD), Parent-Child Dysfunctional Interactions (PCDI), and Difficult Child (DC) subscales (Abidin, 1995, 2012). Items 1 to 12 constitute the PD subscale, which measures levels of distress related to parental responsibilities, personal sacrifices, and relationship conflicts (e.g., "I often have the feeling that I cannot handle things very well"; Haskett et al., 2010). Items 13 to 24 constitute the PCDI subscale, which reflects levels of dysfunctional interaction in parent-child relationships and parental dissatisfaction toward their children's behaviour (e.g., "This child rarely does things for me that make me feel good"; Haskett et al., 2010). Finally, items 25 to 36 constitute the DC subscale, which measures the degree to which parents are concerned with their children's self-regulatory abilities in typically arising stressful situations (e.g., "This child seems to cry or fuss more often than most children"; Haskett et al., 2010). Total Stress scale scores were computed for each parent by summing their scores on all three subscales.

For 33 of the 36 items, respondents indicated the degree to which they agreed with each item on a 5-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The three remaining items, although also rated on 5-point scales, each had distinct response options: options for item 22 ranged from 1 (*a very good parent*) to 5 (*not very good at being a parent*), options for item 32 ranged from 1 (*much easier than I expected*) to 5 (*much harder than I expected*), and options for item 33 range from 1 (*1–3*) to 5 (*10+*). Higher scores on the three subscales and the Total Stress scale indicated greater levels of parenting stress, with Total Stress scores at or beyond the 85th percentile representing clinical significance (Abidin, 2012). Psychometric properties of the PSI-SF have been investigated in use with non-clinical and diverse samples, and the measure has been found to have good validity, test-retest reliability, and a high degree of internal consistency (Abidin, 2012). The Total Stress scale has demonstrated good test-retest reliability and a high degree of internal consistency in use with non-clinical samples, with alpha coefficients of .84 and .91, respectively (Abidin, 1995).

Photoplethysmography Index of Heart Rate

As in Harvie and colleagues (2021) study, heart rate was collected via smartphone measures of PPG. The present study used the Heart Rate Plus: Pulse Monitor application (PVDApps, 2015), which could be downloaded free of charge for iOS and Android smartphone and tablet users from their respective app stores (i.e., App Store or Google Play Store). At the beginning of each online assessment, participants were verbally and visually instructed on how to download the application and obtain a heart rate reading according to the specific make and model of their smartphone. Heart Rate Plus allows users to remotely measure their heart rate by placing the tip of their index finger over the appropriate area of the back camera lens(es) of their smartphone while sitting as still as possible and refraining from speaking. Through the implementation of PPG technology, the smartphone's flash serves as a light source to illuminate the subcutaneous tissue in the fingertip and the smartphone's camera measures small changes in light intensity associated with fluctuations in blood volume that occur with each heart beat (Allen, 2007; Harvie et al., 2021). This application takes roughly 10 to 20 s to apply an advanced algorithm that generates a single estimate of average heart rate for that measurement timepoint (Harvie et al., 2021). If participants were unable to obtain a successful measure of heart rate within 2 min, they were guided through installing a second application called Withings Health Mate (Withings, 2020), which is also available to download free of charge for iOS and Android smartphone and tablet users and employs similar PPG technology to produce measures of heart rate. If after approximately 1 min the participant still could not obtain a successful heart rate reading, it was deemed unsuccessful, and the assessment proceeded as planned without a PPG measurement for that timepoint.

At the start of the online assessment, participants were asked if they owned and had access to a wearable device that continuously monitors their heart rate (e.g., Fitbit or Apple Watch) that could be worn for the duration of the assessment. If yes, they were asked to provide a heart rate reading from their wearable device immediately after each smartphone measure of PPG. Wrist-worn devices, such as Fitbits and Apple Watches, also utilize PPG technology to continuously track heart rate (Natarajan et al., 2020). Future research will use heart rate measurements from participant's wearable devices to validate smartphone measures of heart rate.

Consistent with the measures outlined in Harvie et al. (2021), heart rate measurements were collected at seven timepoints during the online assessment: (1) before a 5 min resting baseline phase at the beginning of the assessment, (2) after the 5 min resting baseline phase, (3) after a 5 min period of reading, (4) immediately after the speech task, (5) immediately after the math task, (6) after a subsequent 5 min period of reading or social buffering, and (7) after a second 5 min resting baseline phase. For each heart rate measurement, participants were asked to read the number out loud to the lead assessor, show the reading on their phone to the camera (for smartphone measures of PPG), and enter the number into a REDCap form sent to the participant at the start of the assessment. Lead assessors also entered participants' heart rate readings, along with start and end times, into a separate assessment data entry REDCap form to crosscheck accuracy of heart rate data.

Subjective Stress and Anxiety

Immediately following each heart rate measurement, participants completed a set of two Visual Analogue Scales (VAS) to indicate their subjective levels of stress and anxiety at that timepoint (Harvie et al., 2021; Lesage et al., 2012). For each VAS, participants reported how stressed and anxious they were currently feeling on a 101-point sliding scale, ranging from 0 (*feeling not stressed or anxious*) to 100 (*feeling highly stressed or anxious*). Assessment of the psychometric properties of the VAS for measuring subjective stress has demonstrated high inter-rater reliability (Lesage et al., 2011) and construct validity (Lesage et al., 2012), as well as significant correlations with cardiovascular markers of stress such as heart rate and blood pressure (Hulsman et al., 2010), as well as pulse rate (Nelson et al., 2023).

Analytic Plan

The analyses in the present study were performed using the IBM SPSS Statistics (Version 28) statistical program and are comparable to those described in Harvie et al. (2021) and Harvie (2022), with some important distinctions. It is important to note that an alpha level of .05 was used for all analyses described in this section. First, outliers in heart rate data were identified using simple scatterplots. Only one participant was found to have heart rate values that were a distinct outlier and fell outside of the range of plausibility. The variability between heart rate values for this participant was 133 beats per minute (BPM) and two values were in the range associated with intense cardiovascular exercise (i.e., > 140 BPM). Thus, this participant was flagged and excluded from all analyses that involved heart rate data.

Next, zero-order correlations (i.e., Pearson bivariate correlations) were examined to gain a better understanding of the relationships between the physiological, self-report, and mental health variables of interest. Visual Analogue Scale scores of stress and anxiety were averaged at each of the seven measurement timepoints to create a single self-reported stress and anxiety score. In addition to the raw values for heart rate and self-report across the seven measurement timepoints, *reactivity* and *recovery* scores for both measures of stress reactivity were computed (following procedures outlined in Harvie, 2022) and entered in the correlation matrix. *Reactivity* scores were intended to capture participant responding to the iTSST or placebo procedures and were computed by subtracting the pre-task (i.e., timepoint 3) heart rate/VAS value from the average of heart rate/VAS values during (i.e., timepoint 4) and post-task (i.e., timepoint 5). Higher *reactivity* scores are indicative of greater responding to the stressor or placebo procedures, whereas negative, or near zero, scores are indicative of blunted responding to the stressor or placebo procedures. Similarly, *recovery* scores were intended to quantify participants' recovery following exposure to the iTSST or placebo procedures and were computed by subtracting the average of heart rate/VAS values during (i.e., timepoint 4) and post-task (i.e., timepoint 5) from the heart rate/VAS value immediately following the article reading or social buffering period (i.e., timepoint 6). *Recovery* scores below zero represent greater recovery from the stressor or placebo procedures, whereas positive, or near zero, scores represent diminished recovery from the stressor or placebo procedures.

The study's primary hypotheses were then examined using general linear model (GLM) repeated measures procedures. To determine the effects of the iTSST or placebo procedures at the group level, participants were first divided into a *stressor* or *control* group. The *stressor* group consisted of (n = 44) participants assigned to the *stressor only* and *stressor plus social buffering* conditions, while the *control* group consisted of (n =16) participants assigned to the *placebo control* condition. Heart rate and self-reported stress and anxiety averages were then analyzed at each of the seven measurement timepoints using two separate 2 (Group) x 7 (Time) repeated measures ANOVA models. It should be noted that participants who were missing a heart rate (n = 12, *stressor*; n = 5, *control*) or self-reported stress and anxiety (n = 13, *stressor*; n = 5, *control*) value at any of the seven timepoints were excluded from these analyses. Significant Group x Time interactions were then followed-up with Bonferroni-corrected pairwise comparisons. A considerable number of participants were missing heart rate (n = 11, *stressor*; n = 4, *control*) and self-reported stress and anxiety (n = 11, *stressor*; n = 4, *control*) values at the final measurement timepoint (i.e., timepoint 7) due to online assessments frequently exceeding the 1 hr mark and data at this timepoint being deemed nonessential for the purposes of this study. As a result, it was determined that analyzing heart rate and self-reported stress and anxiety averages at timepoints 3 (i.e., pre-stressor or placebo procedure), 4 (i.e., during stressor or placebo procedure), 5 (i.e., immediately after stressor or placebo procedure), and 6 (i.e., immediately after article reading or social buffering period) would sufficiently address the research questions of interest while still retaining as many participants as possible. Thus, heart rate and self-reported stress and anxiety averages were analyzed at each of these four measurement timepoints using two separate 2 (Group) x 4 (Time) repeated measures ANOVA models, and significant Group x Time interactions were once again followed-up with Bonferroni-corrected pairwise comparisons.

Effects of social buffering at the group level were examined by analyzing heart rate and self-reported stress and anxiety averages using two separate 2 (Group) x 4 (Time) repeated measures ANOVA models between the stressor only (n = 24) and stressor plus social buffering (n = 20) groups. Participant age and relationship to child (i.e., self-identification as a mother or father) were included as covariates in separate, post hoc, repeated measures ANCOVA models as there is empirical evidence to support age and gender differences in cardiac reactivity and perceived stress and anxiety to the TSST (Hamidovic et al., 2020; Kudielka et al., 2004). Relationship to child was used as an approximator of gender given that gender identity data was only available for 36.7% (n = 22) of participants as it was added into the REDCap sociodemographic survey late. All repeated measures models utilized Greenhouse-Geisser adjusted degrees of freedom to correct for violations of sphericity.

Due to suspicions surrounding (n = 16) participants’ status as parents, the above 2 (Group) x 4 (Time) repeated measures ANOVA analyses were re-run with these participants omitted to determine if effects of social buffering at the group level significantly differed from previous results. Similarly, participants who experienced interruptions from other individuals or pets during the iTSST or article reading/social buffering periods (n = 15) were flagged during data collection and omitted from post hoc 2 (Group) x 4 (Time) repeated measures ANOVA analyses to determine whether effects of social buffering at the group level were altered.

Results

Bivariate Correlations

Pearson bivariate correlations were examined to elucidate associations between the heart rate, self-report, and mental health variables of interest across groups. Several significant correlations were found between measures of stress reactivity. In general, self-report averages of stress and anxiety throughout the experiment were positively correlated with each other (all r's > .30, p's ≤ .020), with the exception of self-report ratings after the first baseline video (i.e., timepoint 2) and after the math task (i.e., timepoint 5) (r = .20, p = .135) and before speech preparation (i.e., timepoint 3) and after the math task (i.e., timepoint 5) (r = .26, p = .053). Similarly, heart rate values across all seven measurement timepoints were positively correlated with one another (all r's > .40, p's ≤ .002). In terms of associations between self-reported stress and anxiety and heart rate across the experiment, self-report ratings after speech delivery (i.e., at timepoint 4) were positively correlated with heart rate before speech preparation (i.e., timepoint 3) (r = .27, p = .039) and after the post-stressor task (i.e., timepoint 6) (r = .29, p = .030). No other significant associations emerged between the two measures of stress reactivity.

Reactivity and *recovery* scores were negatively correlated for both self-reports of stress and anxiety (r = -.80, p < .001) and heart rate (r = -.45, p < .001), suggesting that greater reactivity to the stressor or placebo procedures (as indicated by higher *reactivity* scores) was related to greater recovery following exposure to the iTSST or placebo procedures (as indicated by lower *recovery* scores). *Recovery* scores for heart rate were also negatively associated with anxiety scores on the GAD-7 (r = -.29, p = .031), which suggests that diminished cardiac recovery following exposure to the iTSST or placebo procedures (as indicated by higher *recovery* scores) was related to lower generalized anxiety; however, the association was weak. Additionally, anxiety (r = .27, p = .037) and depression severity (r = .30, p = .019) scores were both positively, but weakly, correlated with heart rate after the math task (i.e., timepoint 5). Anxiety and depression severity scores were not significantly correlated with any of the other raw self-report or heart rate values, *reactivity* scores, or *recovery* scores. Conversely, scores on the Parenting Stress Index and its subscales were significantly correlated with a number of self-report measures across the experiment. Total parenting stress scores were positively associated with self-report scores after the post-stressor task (i.e., timepoint 6) (r = .35, p = .009). Parental Distress subscale scores were positively associated with self-report scores just prior to the first baseline video (i.e., timepoint 1), and from completion of speech delivery (i.e., timepoint 4) until after the post-stressor task (i.e., timepoint 6) (all r's > .27, p's ≤ .042). Parent-Child Dysfunctional Interactions subscale scores were positively associated with self-report scores after the post-stressor task (i.e., timepoint 6) (r = .29, p = .033), and Difficult Child subscale scores were positively, but weakly, associated with self-report scores after the first baseline video (i.e., timepoint 2) (r = .27, p = .040) and after the post-stressor task (i.e., timepoint 6) (r = .30, p = .024). Finally, several significant correlations emerged between anxiety, depression severity, and parenting stress scores. Higher generalized anxiety scores were strongly associated with higher depression severity scores (r = .85, p < .001). While total parenting stress scores were not significantly correlated with anxiety and depression severity scores, scores on the Parental Distress subscale were found to be positively associated with both anxiety (r = .31, p = .016) and depression severity scores (r = .36, p = .005). Also, Parenting Stress Index total and subscale scores were all positively and strongly correlated with one another (all *r*'s > .52, *p*'s < .001).

General Linear Model Repeated Measures Analyses

Effects of the iTSST or Placebo Procedures at the Group Level

Table 2 presents the results of a 2 (Group) x 7 (Time) repeated measures ANOVA performed on self-reported stress and anxiety and Table 3 presents the results of a 2 (Group) x 7 (Time) repeated measures ANOVA performed on heart rate for the *control* and *stressor* groups. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(20) = 96.671$, $p < .001$)] and heart rate [$\chi^2(20) = 43.612$, $p = .002$)]. As a result, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .528$) and heart rate ($\varepsilon = .744$) were used to correct the degrees of freedom for each of the ANOVA models. There was a significant within-subjects main effect of Time [$F(3.169, 126.773) = 10.240$, $p < .001$, $\eta^2_{partial} = .204$] and a Group x Time interaction [$F(3.169, 126.773) = 3.632$, $p = .013$, $\eta^2_{partial} = .083$] on self-reported stress and anxiety. There was not a significant between-subjects main effect of Group on self-reported stress and anxiety [$F(1, 40) = .001$, $p = .973$, $\eta^2_{partial} < .001$]. Figure 4a displays the estimated marginal means of self-reported stress and anxiety across all seven measurement timepoints during the experiment. Elevations in stress and anxiety scores were observed in the *stressor* group relative to the *control* group starting just after speech delivery (i.e., timepoint 4) and peaking immediately following the math task (i.e., timepoint 5). Stress and anxiety scores in the *stressor* group were also observed to return to baseline ratings, which were comparable to those reported in the *control* group, immediately after the article reading/social buffering period (i.e., timepoint 6) and final baseline video (i.e., timepoint 7). The significant Group x Time interaction for self-reported stress and anxiety throughout the experiment was followed up with Bonferroni-corrected pairwise comparisons (see Table 4 for a full summary of results). The *stressor* group showed significant decreases in self-reported stress and anxiety after the first baseline video (i.e., timepoint 2) relative to before the first baseline video (i.e., timepoint 1) ($M_{\text{timepoint 2 – timepoint 1}}$ = -8.790, SE = 2.651, p = .041) and significant increases after speech delivery (i.e., timepoint 4) relative to before the first baseline video (i.e., timepoint 1) ($M_{\text{timepoint 4 – timepoint 1}}$ = 15.935, SE = 4.462, p = .020), as well as after the math task (i.e., timepoint 5) relative to before the first baseline video (i.e., timepoint 1) ($M_{\text{timepoint 5 – timepoint 1}}$ = 19.339, SE = 5.080, p = .010). Significant increases in self-reports were also observed after speech delivery (i.e., timepoint 4) relative to after the first baseline video (i.e., timepoint 2) ($M_{\text{timepoint 4 – timepoint 2}}$ = 24.726, SE = 5.108, $p < .001$), and after the math task (i.e., timepoint 5) relative to after the first baseline video (i.e., timepoint 2) ($M_{\text{timepoint 5 – timepoint 2}}$ = 28.129, SE = 5.609, $p < .001$). Similarly, self-reports significantly elevated post speech delivery (i.e., timepoint 4) ($M_{\text{timepoint 4 – timepoint 3}}$ = 26.226, SE = 4.661, $p < .001$) and math task completion (i.e., timepoint 5) ($M_{\text{timepoint 5 – timepoint 3}}$ = 29.629, SE = 5.326, $p < .001$) relative to before speech preparation (i.e., timepoint 3). Following the article reading/social buffering phase at timepoint 6 ($M_{\text{timepoint 6 – timepoint 4}}$ = -25.903, SE = 3.979, $p < .001$) and final baseline video at timepoint 7 ($M_{\text{timepoint 7 – timepoint 4}}$ = -28.113, SE = 3.778, $p < .001$), self-reports significantly declined relative to after speech delivery (i.e., timepoint 4). Further reductions in self-reports were observed after the post-stressor task (i.e., timepoint 6) ($M_{\text{timepoint 6 – timepoint 5}}$ = -29.306, SE = 4.661, $p < .001$) and final baseline video (i.e., timepoint 7) ($M_{\text{timepoint 7 – timepoint 5}}$ = -31.516, SE = 4.524, $p < .001$) relative to after the math task (i.e., timepoint 5). In contrast, the *control* group showed no significant differences in self-reported stress and anxiety across any of the seven measurement timepoints (all p's > .05). Taken together, these findings demonstrate significant perceptual reactivity to the iTSST manipulation in the *stressor* group and a lack of perceptual reactivity to the placebo procedures in the *control* group. Additionally, pairwise comparisons confirmed that self-reported stress and anxiety peaked immediately after the iTSST had concluded in the *stressor* group but returned to baseline levels at the last two measurement timepoints in the experiment.

There was a within-subjects main effect of Time on heart rate [$F(4.466, 178.629) = 3.335$, $p = .009$, $\eta^2_{partial} = .077$], however, the Group x Time interaction for heart rate was not significant [$F(4.466, 178.629) = .885$, $p = .483$, $\eta^2_{partial} = .022$]. Additionally, a significant between-subjects main effect of Group on heart rate did not emerge [$F(1, 40) = .162$, $p = .689$, $\eta^2_{partial} = .004$]. Figure 4b displays the estimated marginal means of heart rate across all seven measurement timepoints during the experiment. Although the line graph depicts a nominal increase and peak in heart rate for the *stressor* group relative to the *control* group immediately following the iTSST (i.e., timepoint 5), this difference between groups was not statistically significant, as indicated by the above results.

Next, in order to retain as many participants as possible in these models, separate 2 (Group) x 4 (Time) repeated measures ANOVA analyses were performed on self-reported stress and anxiety averages and heart rate from timepoints 3 (i.e., before speech preparation) to 6 (i.e., after the post-stressor task) for the *control* and *stressor* groups. Descriptive statistics for self-report ratings and heart rate across the four timepoints of interest are displayed in Table 5 and Table 6, respectively. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [($\chi^2(5) = 32.783$, $p < .001$)] and heart rate [$\chi^2(5) = 15.218$, $p = .009$)]. As a result, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .677$) and heart rate ($\varepsilon = .836$) were used to correct the degrees of freedom for each of the ANOVA models. With respect to self-reported stress and anxiety scores, a significant within-subjects main effect of Time [$F(2.031, 103.572) = 13.407$, $p < .001$, $\eta^2_{\text{partial}} = .208$] and Group x Time interaction [$F(2.031, 103.572) = 6.826$, $p = .002$, $\eta^2_{\text{partial}} = .118$] emerged, as seen in Table 7. There was not a significant between-subjects main effect of Group on self-reported stress and anxiety [$F(1, 51) < .001$, $p = .983$, $\eta^2_{\text{partial}} < .001$]. Figure 5a depicts the estimated marginal means of self-reported stress and anxiety across the four measurement timepoints of interest. Similar to what was illustrated in Figure 4a, the *stressor* group displayed elevations in stress and anxiety scores beginning just after speech delivery (i.e., timepoint 4) and self-reports peaked immediately after cessation of the iTSST (i.e., timepoint 5). Following the article reading/social buffering phase (i.e., timepoint 6), stress and anxiety scores were back to pre-iTSST levels in the *stressor* group. The significant Group x Time interaction for self-reported stress and anxiety across timepoint 3 to 6 was once again followed up with Bonferroni-corrected pairwise comparisons (see Table 8 for a full summary of results). As expected, the *stressor* group showed significant elevations in stress and anxiety after speech delivery (i.e., timepoint 4) ($M_{\text{timepoint 4 – timepoint 3}} = 27.359$, $SE = 4.165$, $p < .001$) and completion of the math task (i.e., timepoint 5) ($M_{\text{timepoint 5 – timepoint 3}} = 28.410$, $SE = 4.551$, $p < .001$) relative to before speech preparation (i.e., timepoint 3). Following the article reading/social buffering phase at timepoint 6, self-reports significantly declined relative to after speech delivery (i.e., timepoint 4) ($M_{\text{timepoint 6 – timepoint 4}} = -26.154$, $SE = 3.651$, $p < .001$) and completion of the math task (i.e., timepoint 5) ($M_{\text{timepoint 6 – timepoint 5}} = -27.205$, $SE = 4.019$, $p < .001$). Conversely, the *control* group showed no significant differences in self-reported stress and anxiety across any of the four measurement timepoints. These findings demonstrate a significant perceptual effect of the iTSST manipulation in the *stressor* group, with stress and anxiety scores returning to pre-stressor levels following the article reading/social buffering phase of the experiment. The *control* group did not show significant reactivity to the placebo procedures after speech delivery (i.e., timepoint 4) or completion of the math task (i.e., timepoint 5) relative to before speech preparation (i.e., timepoint 3).

As shown in Table 9, both the within-subjects main effect of Time on heart rate [$F(2.508, 132.916) = 2.157$, $p = .107$, $\eta^2_{\text{partial}} = .039$] and the Group x Time interaction for heart rate [$F(2.508, 132.916) = .733$, $p = .511$, $\eta^2_{\text{partial}} = .014$] were not significant. Additionally, a significant between-subjects main effect of Group on heart rate was not found [$F(1, 53) = .143$, $p = .707$, $\eta^2_{\text{partial}} = .003$]. Figure 5b displays the estimated marginal means of heart rate across the four measurement timepoints of interest. Similar to what was observed in Figure 4b, heart rate does appear to be peaking post-math task (i.e., timepoint 5) in the *stressor* group as compared to the *control* group, however, this this difference between groups was not sufficient to reach significance as indicated by the above results. Thus, in focusing on the four measurement timepoints of interest and retaining more participants in the repeated measures ANOVA models, the findings were similar to those observed in the 2 (Group) x 7 (Time) repeated measures analyses.

Effects of Social Buffering at the Group Level

Effects of social buffering at the group level were then examined using 2 (Group) x 4 (Time) repeated measures ANOVA analyses between the *stressor only* and *stressor plus social buffering* groups. Descriptive statistics for self-reported stress and anxiety scores and heart rate for the two stressor groups across the four timepoints of interest are displayed in Table 10 and Table 11, respectively. In addition, findings from a 2 (Group) x 4 (Time) repeated measures ANOVA performed on self-report ratings are displayed in Table 12 and findings from a 2

(Group) x 4 (Time) repeated measures ANOVA performed on heart rate are displayed in Table 13. Mauchly's Test of Sphericity revealed that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(5) = 29.805$, $p < .001$)] and heart rate [$\chi^2(5) = 23.513$, $p < .001$)]. As a result, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .629$) and heart rate ($\varepsilon = .728$) were used to adjust the degrees of freedom for each of the ANOVA models. For self-report ratings of stress and anxiety between the *stressor only* and *stressor plus social buffering* groups, there was a significant within-subjects main effect of Time [$F(1.886, 69.792) = 31.358$, $p < .001$, $\eta^2_{\text{partial}} = .459$], but no Group x Time interaction [$F(1.886, 69.792) = .421$, $p = .646$, $\eta^2_{\text{partial}} = .011$]. There was not a significant between-subjects main effect of Group on self-report ratings [$F(1, 37) = .452$, $p = .506$, $\eta^2_{\text{partial}} = .012$]. As shown in Figure 6a, stress and anxiety averages in the *stressor only* and *stressor plus social buffering* groups were comparable immediately following the iTSST manipulation (i.e., timepoint 5), with the *stressor only* group reporting nominally higher scores. Following the social buffering period (i.e., timepoint 6), the *stressor plus social buffering* group self-reported nominally lower stress and anxiety as compared to the *stressor only* group who participated in a second article reading period. However, the observed effect of social buffering on perceived stress and anxiety in the *stressor plus social buffering* group relative to the *stressor only* group (who did not receive buffering) did not reach statistical significance, as substantiated by the above results.

As for heart rate, there was not a significant within-subjects main effect of Time [$F(2.185, 85.224) = 1.459$, $p = .237$, $\eta^2_{\text{partial}} = .036$] or a significant Group x Time interaction [$F(2.185, 85.224) = .533$, $p = .604$, $\eta^2_{\text{partial}} = .013$] between the *stressor only* and *stressor plus social buffering* groups. Furthermore, a significant between-subjects main effect of Group on heart rate was not observed [$F(1, 39) = .077$, $p = .783$, $\eta^2_{\text{partial}} = .002$]. Figure 6b shows the estimated marginal means of heart rate across timepoints 3 to 6 during the experiment. The line graph appears to show a slight acceleration in heart rate in the *stressor plus social buffering* group relative to the *stressor only* group immediately after the iTSST manipulation (i.e., timepoint 5), however, heart rate returned to pre-stressor levels following the social buffering period. These variations in heart rate across timepoints 3 to 6 between the two stressor groups did not reach statistical significance, as confirmed by the above results.

Post Hoc Analyses: Addition of Covariates and Participant Omissions

Planned post hoc 2 (Group) x 4 (Time) repeated measures ANCOVA analyses were then conducted to examine the effects of social buffering at the group level with Parent Age included as a covariate. Mauchly's Test of Sphericity revealed that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(5) = 22.085$, $p < .001$)] and heart rate [$\chi^2(5) = 35.914$, $p < .001$)]. As a result, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .680$) and heart rate ($\varepsilon = .644$) were used to correct the degrees of freedom for each of the ANCOVA models. For self-reported stress and anxiety scores, a significant within-subjects main effect of Time [$F(2.039, 71.366) = 5.393$, $p = .006$, $\eta^2_{\text{partial}} = .134$] remained, but no between-subjects main effects of Parent Age or Group, Group x Time interaction, or Parent Age x Time interaction were observed (all p's $\geq .117$; see Table 14 for a full summary of results). In terms of heart rate, no significant within-subjects main effect of Time, between-subjects main effects of Parent Age or Group, Group x Time interaction, or Parent Age x Time interaction emerged (all p's $\geq .118$; see Table 15 for a full summary of results). Although Parent Age did appear to account for some of the variability in heart rate and self-reported stress and anxiety averages from timepoints 3 to 6 for the *stressor only* and *stressor* *plus social buffering* groups, it was not a significant predictor of the dependent variables, nor was there an interaction effect of Parent Age and Time on either of the dependent variables.

A second set of planned post hoc 2 (Group) x 4 (Time) repeated measures ANCOVA analyses were run to examine the effects of social buffering at the group level with Parent Relationship to Child included as a covariate. Mauchly's Test of Sphericity revealed that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(5) = 28.250$, $p < .001$)] and heart rate [$\chi^2(5) = 22.599$, $p < .001$)]. As a result, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .634$) and heart rate ($\varepsilon = .732$) were used to correct the degrees of freedom for each of the ANCOVA models. There was no significant within-subjects main effect of Time, between-subjects main effect of Group, Group x Time interaction, or Relationship to Child x Time interaction on heart rate (all p's $\geq .558$; see Table 16 for a full summary of results). There was, however, a significant between-subjects main effect of Relationship to Child on heart rate [$F(1, 38) = 6.979$, $p = .012$, $\eta^2_{partial} = .155$]. This suggests that Relationship to Child (i.e., whether participants self-identified as a mother or father) was a significant predictor of heart rate from timepoints 3 to 6 for the two stressor groups. As indicated in Table 17, mothers had higher heart rate averages than fathers across timepoints, regardless of stressor condition. Regarding stress and anxiety ratings, there was once again a significant within-subjects main effect of Time [$F(1.901, 68.445) = 8.430$, $p < .001$, $\eta^2_{partial} = .190$], but no between-subjects main effects of Relationship to Child or Group, Group x Time interaction, or Relationship to Child x Time interaction were observed (all p's $\geq .251$; see Table 18 for a full summary of results).

As an additional control analysis, the 2 (Group) x 4 (Time) repeated measures ANOVA analyses between the *stressor only* and *stressor plus social buffering* groups were re-run with suspicious participants omitted. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(5) = 23.043$, $p < .001$)] and heart rate [$\chi^2(5) = 23.198$, $p < .001$)]. Thus, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .637$) and heart rate ($\varepsilon = .699$) were used to correct the degrees of freedom for each of the ANOVA models. Findings for self-reported stress and anxiety aligned with what was observed in the model that retained all participants. The within-subjects main effect of Time on self-report ratings remained significant [$F(1.910, 57.285) = 23.424$, $p < .001$, $\eta^2_{partial} = .438$], however, no significant Group x Time interaction [$F(1.910, 57.285) = .469$, $p = .619$, $\eta^2_{partial} = .015$] or between-subjects main effect of Group [$F(1, 30) = 1.154$, $p = .291$, $\eta^2_{partial} = .037$] on self-report ratings was found. Similar to the model that retained all participants, there was not a significant within-subjects main effect of Time [$F(2.098, 65.025) = 1.290$, $p = .283$, $\eta^2_{partial} = .040$], Group x Time interaction [$F(2.098, 65.025) = 1.137$, $p = .329$, $\eta^2_{partial} = .035$], or between-subjects main effect of Group [$F(1, 31) = .088$, $p = .769$, $\eta^2_{partial} = .003$] on heart rate for the two stressor groups.

As a final control analysis, the 2 (Group) x 4 (Time) repeated measures ANOVA analyses between the *stressor only* and *stressor plus social buffering* groups were re-run with participants who experienced interruptions between timepoints 3 and 6 omitted. The assumption of sphericity was violated for main effects of self-reported stress and anxiety [$\chi^2(5) = 35.010$, $p < .001$)] and heart rate [$\chi^2(5) = 30.295$, $p < .001$)] according to Mauchly's Test of Sphericity. Therefore, Greenhouse-Geisser estimates of sphericity for self-reported stress and anxiety ($\varepsilon = .561$) and heart rate ($\varepsilon = .610$) were used to correct the degrees of freedom for each of the ANOVA models. For self-reported stress and anxiety, the significant within-subjects main effect of Time persisted [$F(1.682, 47.094) = 30.510$, $p < .001$, $\eta^2_{partial} = .521$], but no Group x Time interaction [$F(1.682, 47.094) = .889$, $p = .402$, $\eta^2_{partial} = .031$] or between-subjects main effect of Group [$F(1, 28) = .027$, $p = .872$, $\eta^2_{partial} = .001$] on self-report ratings emerged. As in the model that retained all participants, no significant within-subjects main effect of Time [$F(1.830, 54.911) = 1.307$, $p = .277$, $\eta^2_{partial} = .042$], Group x Time interaction [$F(1.830, 54.911) = .226$, $p = .779$, $\eta^2_{partial} = .007$], or between-subjects main effect of Group [$F(1, 30) = .847$, $p = .365$, $\eta^2_{partial} = .027$] on heart rate was observed for the two stressor groups.

Discussion

A primary aim of this study was to replicate and extend Harvie et al.'s (2021) findings, which showed the iTSST manipulation induced significant elevations in heart rate and self-reported stress and anxiety relative to placebo procedures experienced by a control group, in a sample of parents. This study also sought to assess the impact of social buffering on parents' cardiac and self-reported stress recovery following exposure to a novel, internet-delivered version of the TSST. It was hypothesized that Harvie et al.'s findings would replicate in the current sample of parents given the ability of the TSST procedures to reliably induce acute psychosocial stress (Helminen et al., 2021) and identical versions of the iTSST manipulation being used in both studies. Additionally, it was hypothesized that parents who engaged in a brief period of interaction with a close friend or family member following exposure to the iTSST would exhibit accelerated recovery from the psychosocial stress manipulation relative to parents who engaged in an article reading period post-iTSST. Specifically, it was predicted that this interaction period would facilitate a quicker return to pre-iTSST levels of perceived and biological stress, such that participants in the *stressor plus social buffering* group would report greater reductions in heart rate and perceived stress and anxiety at timepoint 6 (i.e., immediately following the buffering period) as compared to participants in the *stressor only* group. The results of the present study partially supported my hypotheses. Findings revealed significant self-reported reactivity to the iTSST procedures, which is consistent with Harvie et al.’s work. However, no evidence of reactivity effects to the iTSST on heart rate were observed. Also, no evidence of a social buffering effect on heart rate or self-reported stress and anxiety emerged. A detailed discussion of how these results compare with Harvie et al.’s findings is presented below, along with possible explanations for inconsistencies in results.

The results of the present study partially replicated Harvie et al.’s (2021) findings. Parents in the *stressor* group showed significant elevations in self-reported stress and anxiety to the iTSST manipulation. In addition, self-reported stress and anxiety remained elevated during and immediately following completion of the iTSST, as compared to parents in the *control* group who completed a placebo version of the iTSST. Given the large effect sizes associated with self-report indices of stress reactivity to the TSST in both traditional and virtual environments (Helminen et al., 2021), it was expected that this effect would replicate in a sample of parents as well. In Harvie et al.’s study, the *stressor* group’s self-reported stress and anxiety scores remained elevated post-iTSST until the end of the experiment. In the present study, the *stressor* group’s self-reported stress and anxiety were observed to return to pre-iTSST levels upon completion of the social buffering/article reading period.

Contrary to Harvie et al.’s findings, parents in the *stressor* group did not show significant elevations in heart rate to the iTSST procedures, although heart rate did peak immediately after completion of the iTSST. Heart rate did remain slightly elevated at timepoints 5 and 6, following completion of the iTSST and social buffering/article reading period, respectively, relative to parents in the *control* group. Although heart rate reactivity to the iTSST between the *stressor* and *control* groups was not significantly different, the results were trending in the expected direction.

There are several potential explanations for the lack of evidence supporting reactivity effects on heart rate in the present study. Unlike self-report measures of stress reactivity, PPG indices of stress reactivity are associated with small effect sizes; thus, it is likely that a larger sample size was needed to observe the predicted effects. Differences in the racial composition of the samples in Harvie et al.'s study and the present study may have also contributed to inconsistencies in findings. The present study's sample was predominantly Black (31.7%) and Asian (30%), whereas the sample in Harvie et al.'s study was predominantly White/European (60.6%). Prior research examining racial differences in cardiovascular reactivity to laboratory-induced psychological stress (e.g., a mental arithmetic task) has found that White individuals exhibit greater increases in heart rate to mental stress than Black individuals (Anderson et al., 1988; Arthur et al., 2004), who typically respond with greater vascular reactivity (e.g., increases in blood pressure; Light et al., 1993). Given the greater racial diversity of the sample in the present study, it is also important to consider how skin tone might impact the accuracy of PPG measures of heart rate. There is some evidence to suggest that darker skin tones may be linked to less accurate heart rate measurements obtained from wearable devices (Koerber et al., 2022); however, it is difficult to speculate further on this effect in the present study as skin tone data was not collected from participants. Lastly, research has indicated that mixed gender TSST panels elicit stronger cortisol responses in participants than all female TSST panels (Goodman et al., 2017). The present study utilized an all-female panel for the majority (77.3%) of assessments administering the iTSST, and although cortisol was not measured here, it is possible that the lack of mixed gender panels reduced heart rate reactivity to the stressor.

Harvie et al.'s (2021) finding that individuals in a *control* group exhibited significant perceived reactivity to a placebo version of the iTSST was not supported by the present study's results. In contrast, it was observed that parents in a *control* group did not show significant elevations in self-reported stress and anxiety to the placebo procedures. There are several possible explanations for this discrepancy in results. Considering that Harvie et al.'s study was conducted during the height of the COVID-19 pandemic and global lockdowns, they cited potential psychosocial stress linked to the novelty of assessments conducted over Zoom, or video chats in general, as one possible explanation for these findings. Harvie et al. also speculated that pandemic-related increases in stress and anxiety may have contributed to general elevations in stress reactivity across groups. Although data collection for the present study began when certain social distancing orders were still in place, it had been over a year since global lockdowns went into effect and individuals were required to familiarize themselves with various video chatting platforms to continue working, learning, and socializing with one another. Thus, it is possible that the effect of psychosocial stressors associated with using video chatting platforms at the beginning of the pandemic had become less potent by the time the current study was conducted due to their widespread use. Relatedly, it is possible that general decreases in stress and anxiety levels relative to early in the pandemic (Manchia et al., 2022) also contributed to the lack of perceived reactivity to the placebo iTSST in the *control* group, despite the use of identical procedures in both studies.

Contrary to my hypothesis and extant research demonstrating the ability of social supports to facilitate accelerated recovery to baseline levels of stress (Hennessy et al., 2009; Hostinar et al., 2014), the present study found no significant differences in heart rate and self-reported stress and anxiety declines at timepoint 6 for the *stressor plus social buffering* and *stressor only* groups. A slight (non-significant) elevation in heart rate was observed following completion of the iTSST in the *stressor plus social buffering* group relative to the *stressor only* group, however, heart rate for both groups had returned to pre-iTSST values after the social buffering/article reading period. In terms of self-reported stress and anxiety, it is notable that parents who interacted with a close friend or family member post-iTSST showed a non-significant trend of lower self-reported ratings relative to parents who engaged in article reading post-stressor. Given that results were trending in the expected direction, it is possible that a significant buffering may have emerged had the buffering interactions been more salient. That is, the majority of parents who interacted with a close friend or family member during the experiment, did so via a phone call (i.e., the interaction was limited to solely verbal communication). Although there is some evidence to support the stress-attenuating effects of messaging and audio-based forms of social support (Seltzer et al., 2010; Wright & Bell, 2003), studies that have experimentally manipulated the type of social support individuals receive before or after an acute psychosocial stressor have demonstrated that face-to-face interaction often leads to lower self-reported affect as compared to other forms of social support (Kothgassner et al., 2019; Seltzer et al., 2010). Thus, it is possible that face-to-face interactions over Zoom or in-person interactions with a family member living in the household following completion of the iTSST, may have strengthened buffering effects on self-reported stress and anxiety. Additionally, given the increased number of participants who experienced environmental disruptions in this study, it is possible that the mere presence of another person or pet in the room elicited an inadvertent buffering effect for those in the *stressor only* group. Although results indicated that effects of social buffering at the group level were not significantly altered when (n = 15) participants who experienced disruptions were excluded from analyses, it may be useful to code the recorded sessions for environmental disruptions to elucidate the extent to which different degrees of disruption accounted for variance in self-reported and heart rate measures post social buffering/article reading.

Participants' self-identification as a mother or father emerged as a significant predictor of heart rate from the pre-iTSST to post social buffering/article reading timepoints. Mothers reporting higher heart rate averages than fathers, *regardless* of stressor condition, can likely be attributed to typical sexual dimorphism, wherein the female heart is required to beat faster to compensate for its smaller size and lower output relative to the male heart (Prabhavathi et al., 2014). This finding is also consistent with previous literature showing that females had higher heart rate during TSST exposure than males (Kudielka et al., 2004; Liu & Zhang, 2020). However, because mothers greatly outnumbered fathers in the current sample, it is difficult to speculate further on the main effect of gender.

A secondary, more exploratory aim of the present study was to examine whether self-reported depression severity scores were associated with cardiac responsivity to the iTSST. Extant research provides support for a relationship between these two variables, but evidence is mixed regarding the directionality of this relationship (Brindle et al., 2013). Although the present study did not specify any predictions about how these variables would interact, it was hypothesized that heart rate reactivity to the stressor (as indexed by raw heart rate values between timepoints 3 to 6 and *reactivity* scores for heart rate) would be related to depression severity scores. This hypothesis was not supported by results from the correlational analysis, which indicated no significant associations between parents' depression severity scores and heart rate responses across the experiment. Inclusionary criteria for the current study permitted parents scoring in the minimal, mild, and moderate depression severity ranges to participate; however, parents in the current sample averaged scores on the BDI-II that fell into the minimal severity range. Thus, it is possible that there was not enough variability in depression severity scores amongst parents in the sample to pick up on any associations between depression severity and heart rate measures.

Strengths and Limitations

The present study had several notable strengths. First, this was the first study to my knowledge to investigate effects of an online variant of the TSST and subsequent social buffering on stress responsivity in a sample of exclusively parents. Extant studies utilizing online variants of the TSST have validated its effectiveness in eliciting an acute psychosocial stress response in adolescents and adults. Thus, the present study’s findings add to the growing body of literature supporting the efficacy of online variants of the TSST to induce significant self-reported stress reactivity. Second, the present study implemented a novel, entirely-online experimental design, which allowed for increased accessibility as parents were not required to leave their homes to participate. Parents of young children often face unique challenges (e.g., lack of childcare) when it comes to engaging with laboratory-based research studies. Therefore, by utilizing entirely-online experimental designs, these barriers, along with those related to the cost of delivering materials, are mitigated. Additionally, the nature of such an experimental design allows for the advancement of our understanding of acute stress responsivity and social buffering in a naturalistic environment, as opposed to the highly controlled laboratory settings that are often utilized in traditional TSST research studies. The experimental design was also strengthened by the addition of a placebo control group who completed a placebo version of the iTSST that controlled for task demands. Aside from Harvie et al. (2021), many extant studies investigating the validity of online variants of the TSST have failed to employ a control group and thus raise questions about the specificity of observed reactivity to iTSST manipulation.

Finally, the racial diversity of the current sample warrants mentioning. The majority of participants in this study self-identified as non-White Canadian/American/European. This is notable given persistent trends of racial inequality in psychological research (Roberts et al., 2020). This outcome also suggests that entirely-online experimental designs, along with the recruitment methods utilized in this study, hold promise for increasing the diversity of samples in psychological research.

However, the present study was not without limitations. As already mentioned, recruitment of our target sample of parents was found to be quite challenging. Due to increased accessibility of the study, we quickly ran into problems with individuals, who we suspected were not parents, responding to questions on our eligibility screener in a way that made them indistinguishable from our target sample of parents and participating in assessments that involved consistent technical challenges (e.g., poor internet connectivity, troubles with audio or video mechanisms, participants dropping out of Zoom sessions) paired with questionable, and at times disinterested, behaviour. Also, despite a long recruitment effort that spanned approximately 1.5 years, we were still unable to reach the intended sample size of $N = 90$ participants. The small sample size impacts interpretability of the study’s results as the statistical analyses that were conducted were underpowered. These experiences highlight the unique difficulties associated with using the Internet to broadly recruit parents for a one-off study. It is also likely that our target sample of parents (i.e., self-reporting under severe clinical cut-offs for anxiety and depression, no diagnoses or treatment for a psychological disorder in the last year) is generally less engaged in psychological research than a sample of parents seeking to improve family quality of life through participation in intervention programs. Despite the novelty of the present study’s approach to measuring biological reactivity to the iTSST using smartphone measures of PPG, it is likely that these measures are less reliable than PPG measures of heart rate obtained from wrist-worn devices, such as Fitbits or Apple Watches. Similarly, the current study did not employ measures of cortisol to quantify HPA axis activation, which is often used to validate the initiation of a stress response. Future directions for research that address these limitations are discussed below.

Implications and Future Directions

The present study was the first to examine whether an internet-delivered version of the TSST could induce significant self-reported and heart rate reactivity in a sample of parents with young children. Findings provide support for significant self-reported reactivity to the iTSST in a sample of mostly mothers. Significant reactivity effects on heart rate did not emerge, nor did a significant buffering effect. Taken together, these results add to the growing body of literature validating the effectiveness of online variants of the TSST and provide avenues for future research. First, future similar research that aims to conduct entirely-online studies with parents should consider embedding the study within a larger intervention study that addresses topics such as family well-being, parent-child mental health, and stress regulation. Doing so would likely increase engagement from parents who are seeking out such opportunities. Considering the lack of support for significant heart rate reactivity to the iTSST in the current sample and the small effect sizes associated with PPG measures of stress reactivity, it would be useful for future iTSST studies to incorporate measurements from wearable devices that employ similar PPG technology to continuously monitor heart rate in order to validate smartphone measures of PPG. Additionally, future iTSST studies aiming to recruit increasingly diverse samples should consider incorporating measures of vascular reactivity and collecting skin tone data from participants to better understand and address racial differences in cardiovascular reactivity to acute psychosocial stress. Utilizing a mixed gender iTSST panel in future studies may also strengthen the effectiveness of the stressor in eliciting significant heart rate reactivity. Given the non-significant trend of lower self-reported stress and anxiety in parents who interacted with a close family member or friend after completion of the iTSST, it would be interesting to assess whether face-to-face interactions over Zoom or in-person interactions with family members in the household increase the salience of a social buffering effect. Thus, future research should attempt to experimentally manipulate the type of social support (i.e., via phone call, over Zoom, or in-person) individuals receive pre- or post-stressor to identify the social buffering effect associated with each of these interaction types. In addition, it would be valuable to employ behavioural coding of the recorded interactions to further elucidate which aspects of an interaction reliably facilitate a social buffering effect. This research could inform treatment and intervention programs aimed at improving family quality of life through fostering effective stress regulation and coping strategies.

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Table 1.

Sample Characteristics

	Total Sample (*N* = 60)	Group: Placebo Control (*n* = 16)	Group: Stressor No Buffer (*n* = 24)	Group: Stressor Plus Buffer (*n* = 20)
Socio-demographics				
***M* (*SD*)**				
Age of parent (years)	32.14 (5.53); *n* = 59	32.19 (6.09)	31.26 (5.77)	33.22 (4.77); *n* = 19
Age of youngest child (months)	16.76 (12.06)	15.91 (13.13)	16.48 (9.86)	17.78 (14.01)
***n* (%)**				
Mothers[a]	44 (73.3)	11 (68.8)	17 (70.8)	16 (80.0)
Number of children				
1	28 (46.7)	8 (50.0)	9 (37.5)	11 (55.0)
2	24 (40.0)	6 (37.5)	11 (45.8)	7 (35.0)
3+	8 (13.3)	2 (12.5)	4 (16.7)	2 (10.0)
Highest educational level				
Some high-school	1 (1.7)	1 (6.3)	0 (0.0)	0 (0.0)
High school diploma	4 (6.7)	0 (0.0)	3 (12.5)	1 (5.0)
College/Technical school	12 (20.0)	5 (31.3)	5 (20.8)	2 (10.0)
Bachelor's degree	29 (48.3)	8 (50.0)	10 (41.7)	11 (55.0)
Graduate or professional degree	14 (23.3)	2 (12.5)	6 (25.1)	6 (30.0)
Marital status				
Married/Common Law	56 (93.3)	14 (87.5)	22 (91.7)	20 (100.0)
Divorced or separated	4 (6.6)	2 (12.6)	2 (8.4)	0 (0.0)
Employment status				
Full-time or part-time	41 (68.3)	10 (62.5)	19 (79.2)	12 (60.0)
On some type of leave	14 (23.3)	5 (31.3)	3 (12.5)	6 (30.0)
Not employed	5 (8.3)	1 (6.3)	2 (8.3)	2 (10.0)
Annual household income (CAD)				
< $30,000	2 (3.3)	0 (0.0)	2 (8.3)	0 (0.0)
$30,001 - $60,000	11 (18.3)	2 (12.5)	6 (25.0)	3 (15.0)
$60,001 – $100,000	26 (43.4)	9 (56.3)	6 (25.0)	11 (55.0)
$100,000+	20 (33.1)	5 (31.3)	10 (41.7)	5 (25.0)
Declined to respond	1 (1.7)	0 (0.0)	0 (0.0)	1 (5.0)
Racial background[b]				

	Total Sample (*N* = 60)	Group		
		Placebo Control (*n* = 16)	Stressor No Buffer (*n* = 24)	Stressor Plus Buffer (*n* = 20)
Indigenous	2 (3.3)	1 (6.3)	1 (4.2)	0 (0.0)
Latin American	1 (1.7)	0 (0.0)	0 (0.0)	1 (5.0)
East Asian	5 (8.3)	1 (6.3)	2 (8.3)	2 (10.0)
Black Caribbean	1 (1.7)	1 (6.3)	0 (0.0)	0 (0.0)
South Asian	6 (10.0)	1 (6.3)	2 (8.3)	3 (15.0)
Southeast Asian	7 (11.7)	2 (12.5)	1 (4.2)	4 (20.0)
White Canadian/American or White European	24 (40.0)	5 (31.3)	14 (58.3)	5 (25.0)
Black Canadian or African American	13 (21.7)	3 (18.8)	7 (29.2)	3 (15.0)
Black African	5 (8.3)	3 (18.8)	1 (4.2)	1 (5.0)
Other	2 (3.3)	0 (0.0)	0 (0.0)	2 (10.0)
Country of residence				
Canada	48 (80.0)	12 (75.0)	19 (79.2)	17 (85.0)
United States	12 (20.0)	4 (25.0)	5 (20.8)	3 (15.0)
Province/State of residence				
Manitoba	17 (28.3)	4 (25.0)	4 (16.7)	9 (45.0)
Alberta	8 (13.3)	1 (6.3)	5 (20.8)	2 (10.0)
Nova Scotia	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Ontario	6 (10.0)	1 (6.3)	3 (12.5)	2 (10.0)
Quebec	1 (1.7)	1 (6.3)	0 (0.0)	0 (0.0)
California	1 (1.7)	0 (0.0)	0 (0.0)	1 (5.0)
Georgia	4 (6.7)	1 (6.3)	2 (8.3)	1 (5.0)
Pennsylvania	1 (1.7)	0 (0.0)	0 (0.0)	1 (5.0)
Texas	3 (5.0)	2 (12.5)	1 (4.2)	0 (0.0)
Virginia	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Washington	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Declined to respond	16 (26.7)	6 (37.5)	6 (25.0)	4 (20.0)
Treatment/Diagnostic history (1+ years ago) ***n*** **(%)**				
Reported treatment/diagnosis of at least one DSM-V psychological disorder in the past 1+ years	9 (15.0)	2 (12.5)	6 (25.0)	1 (5.0)

	Total Sample (*N* = 60)	Group		
		Placebo Control (*n* = 16)	Stressor No Buffer (*n* = 24)	Stressor Plus Buffer (*n* = 20)
Major depressive disorder	2 (3.3)	1 (6.3)	0 (0.0)	1 (5.0)
Panic disorder	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Social anxiety disorder	4 (6.7)	0 (0.0)	3 (12.5)	1 (5.0)
Generalized anxiety disorder	5 (8.3)	1 (6.3)	3 (12.5)	1 (5.0)
Post-traumatic stress disorder	2 (3.3)	0 (0.0)	2 (8.3)	0 (0.0)
Anorexia nervosa	2 (3.3)	1 (6.3)	1 (4.2)	0 (0.0)
Bulimia nervosa	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Binge eating disorder	1 (1.7)	0 (0.0)	1 (4.2)	0 (0.0)
Attention-deficit hyperactivity disorder	4 (6.7)	1 (6.3)	3 (12.5)	0 (0.0)
Mental health measures				
***M* (*SD*)**				
Depression (BDI-II)	10.50 (8.61)	9.27 (8.25)	12.22 (9.61)	9.42 (7.66)
Anxiety (GAD-7)	4.28 (3.81)	3.44 (3.54)	4.96 (4.10)	4.15 (3.69)
Parenting stress (PSI-SF)	80.72 (27.49)	90.44 (30.97)	82.71 (27.56)	70.55 (21.83)

Note. DSM-V = Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; BDI-II = Beck Depression Inventory II; GAD-7 = Generalized Anxiety Disorder 7-Item Scale; PSI-SF = Parenting Stress Index Short Form.

[a] Remainder of sample identified as fathers.

[b] Participants were able to select more than one option.

Table 2.

Results of a 2 (Group) by 7 (Time) Repeated Measures ANOVA Examining Self-Reported Stress and Anxiety for the Control and Stressor Groups

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Group	1	.001	.973	< .001
Error (Group)	40			
Within-subjects effects				
Time	3.169	10.240	< .001***	.204
Time x Group	3.169	3.632	.013*	.083
Error (Time)	126.773			

Note. $N = 42$. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 3.

Results of a 2 (Group) by 7 (Time) Repeated Measures ANOVA Examining Heart Rate for the Control and Stressor Groups

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Group	1	.162	.689	.004
Error (Group)	40			
Within-subjects effects				
Time	4.466	3.335	.009**	.077
Time x Group	4.466	.885	.483	.022
Error (Time)	178.629			

Note. N = 42. *p < .05, **p < .01, ***p < .001. Units are beats per minute for heart rate.

Table 4.

Pairwise Comparisons of Self-Reported Stress and Anxiety by Timepoint for the Control and Stressor Groups (Throughout the Experiment)

Group	(I) Timepoint	(J) Timepoint	*MD* (I-J)	*SE*	*p*
Control	1	2	8.500	4.451	1.000
		3	5.636	5.763	1.000
		4	-.409	7.490	1.000
		5	6.727	8.528	1.000
		6	13.182	6.848	1.000
		7	17.773	6.670	.232
	2	1	-8.500	4.451	1.000
		3	-2.864	5.292	1.000
		4	-8.909	8.576	1.000
		5	-1.773	9.416	1.000
		6	4.682	5.792	1.000
		7	9.273	5.341	1.000
	3	1	-5.636	5.763	1.000
		2	2.864	5.292	1.000
		4	-6.045	7.824	1.000
		5	1.091	8.941	1.000
		6	7.545	5.474	1.000
		7	12.136	6.120	1.000
	4	1	.409	7.490	1.000
		2	8.909	8.576	1.000
		3	6.045	7.824	1.000
		5	7.136	5.407	1.000
		6	13.591	6.680	1.000
		7	18.182	6.342	.138
	5	1	-6.727	8.528	1.000
		2	1.773	9.416	1.000
		3	-1.091	8.941	1.000
		4	-7.136	5.407	1.000
		6	6.455	7.825	1.000
		7	11.045	7.594	1.000
	6	1	-13.182	6.848	1.000
		2	-4.682	5.792	1.000
		3	-7.545	5.474	1.000

Group	(I) Timepoint	(J) Timepoint	*MD* (I-J)	*SE*	*p*
		4	-13.591	6.680	1.000
		5	-6.455	7.825	1.000
		7	4.591	3.558	1.000
	7	1	-17.773	6.670	.232
		2	-9.273	5.341	1.000
		3	-12.136	6.120	1.000
		4	-18.182	6.342	.138
		5	-11.045	7.594	1.000
		6	-4.591	3.558	1.000
Stressor	1	2	8.790*	2.651	.041
		3	10.290	3.433	.098
		4	-15.935*	4.462	.020
		5	-19.339*	5.080	.010
		6	9.968	4.079	.400
		7	12.177	3.973	.082
	2	1	-8.790*	2.651	.041
		3	1.500	3.152	1.000
		4	-24.726***	5.108	< .001
		5	-28.129***	5.609	< .001
		6	1.177	3.450	1.000
		7	3.387	3.182	1.000
	3	1	-10.290	3.433	.098
		2	-1.500	3.152	1.000
		4	-26.226***	4.661	< .001
		5	-29.629***	5.326	< .001
		6	-.323	3.261	1.000
		7	1.887	3.646	1.000
	4	1	15.935*	4.462	.020
		2	24.726***	5.108	< .001
		3	26.226***	4.661	< .001
		5	-3.403	3.221	1.000
		6	25.903***	3.979	< .001
		7	28.113***	3.778	< .001
	5	1	19.339*	5.080	.010
		2	28.129***	5.609	< .001
		3	29.629***	5.326	< .001
		4	3.403	3.221	1.000

Group	(I) Timepoint	(J) Timepoint	*MD* (I-J)	*SE*	*p*
		6	29.306***	4.661	< .001
		7	31.516***	4.524	< .001
	6	1	-9.968	4.079	.400
		2	-1.177	3.450	1.000
		3	.323	3.261	1.000
		4	-25.903***	3.979	< .001
		5	-29.306***	4.661	< .001
		7	2.210	2.119	1.000
	7	1	-12.177	3.973	.082
		2	-3.387	3.182	1.000
		3	-1.887	3.646	1.000
		4	-28.113***	3.778	< .001
		5	-31.516***	4.524	< .001
		6	-2.210	2.119	1.000

Note. Pairwise comparisons are based on estimated marginal means. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 5.

Descriptive Statistics for Self-Reported Stress and Anxiety for the Control and Stressor Groups

	Group	
	Control (n = 14)	Stressor (n = 39)
Timepoint	*M (SD)*	*M (SD)*
Before speech preparation (3)	36.79 (24.32)	22.65 (18.43)
After speech delivery (4)	41.57 (22.95)	50.01 (28.64)
After math task (5)	37.36 (21.52)	51.06 (29.75)
After post-stressor task (6)	32.39 (22.20)	23.86 (18.19)

Table 6.

Descriptive Statistics for Heart Rate for the Control and Stressor Groups

	Group	
	Control (n = 14)	Stressor (n = 41)
Timepoint	*M (SD)*	*M (SD)*
Before speech preparation (3)	76.00 (7.20)	74.83 (11.24)
After speech delivery (4)	72.57 (6.43)	73.56 (12.03)
After math task (5)	73.14 (6.20)	75.76 (14.10)
After post-stressor task (6)	71.14 (6.43)	73.22 (11.12)

Note. Units are beats per minute for heart rate.

Table 7.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANOVA Examining Self-Reported Stress and Anxiety for the Control and Stressor Groups

Source	*df*	*F*	*p*	η^2_{partial}
Between-subjects effects				
Group	1	< .001	.983	< .001
Error (Group)	51			
Within-subjects effects				
Time	2.031	13.407	< .001***	.208
Time x Group	2.031	6.826	.002**	.118
Error (Time)	103.572			

Note. $N = 53$. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 8.

Pairwise Comparisons of Self-Reported Stress and Anxiety by Timepoint for the Control and Stressor Groups (Pre-Stressor to Post-Stressor Task)

Group	(I) Timepoint	(J) Timepoint	*MD* (I-J)	*SE*	*p*
Control	3	4	-4.786	6.952	1.000
		5	-.571	7.595	1.000
		6	4.393	4.548	1.000
	4	3	4.786	6.952	1.000
		5	4.214	4.517	1.000
		6	9.179	6.094	.829
	5	3	.571	7.595	1.000
		4	-4.214	4.517	1.000
		6	4.964	6.708	1.000
	6	3	-4.393	4.548	1.000
		4	-9.179	6.094	.829
		5	-4.964	6.708	1.000
Stressor	3	4	-27.359***	4.165	<.001
		5	-28.410***	4.551	<.001
		6	-1.205	2.725	1.000
	4	3	27.359***	4.165	<.001
		5	-1.051	2.706	1.000
		6	26.154***	3.651	<.001
	5	3	28.410***	4.551	<.001
		4	1.051	2.706	1.000
		6	27.205***	4.019	<.001
	6	3	1.205	2.725	1.000
		4	-26.154***	3.651	<.001
		5	-27.205***	4.019	<.001

Note. Pairwise comparisons are based on estimated marginal means. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 9.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANOVA Examining Heart Rate for the Control and Stressor Groups

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Group	1	.143	.707	.003
Error (Group)	53			
Within-subjects effects				
Time	2.508	2.157	.107	.039
Time x Group	2.508	.733	.511	.014
Error (Time)	132.916			

Note. $N = 55$. $*p < .05$, $**p < .01$, $***p < .001$. Units are beats per minute for heart rate.

Table 10.

Descriptive Statistics for Self-Reported Stress and Anxiety for the Stressor Only and Stressor Plus Social Buffering Groups

	Group	
	Stressor Only (*n* = 21)	Stressor Plus Social Buffering (*n* = 18)
Timepoint	*M (SD)*	*M (SD)*
Before speech preparation (3)	25.71 (18.82)	19.08 (17.81)
After speech delivery (4)	50.83 (28.76)	49.06 (29.31)
After math task (5)	51.19 (29.49)	50.92 (30.90)
After post-stressor task (6)	27.50 (18.76)	19.61 (17.04)

Table 11.

Descriptive Statistics for Heart Rate for the Stressor Only and Stressor Plus Social Buffering Groups

	Group	
	Stressor Only (n = 23)	Stressor Plus Social Buffering (n = 18)
Timepoint	*M (SD)*	*M (SD)*
Before speech preparation (3)	74.52 (10.47)	75.22 (12.46)
After speech delivery (4)	73.74 (10.86)	73.33 (13.70)
After math task (5)	74.39 (11.75)	77.50 (16.84)
After post-stressor task (6)	73.04 (9.96)	73.44 (12.74)

Note. Units are beats per minute for heart rate.

Table 12.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANOVA Examining Self-Reported Stress and Anxiety for the Stressor Only and Stressor Plus Social Buffering Groups

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Group	1	.452	.506	.012
Error (Group)	37			
Within-subjects effects				
Time	1.886	31.358	< .001***	.459
Time x Group	1.886	.421	.646	.011
Error (Time)	69.792			

Note. $N = 39$. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 13.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANOVA Examining Heart Rate for the Stressor Only and Stressor Plus Social Buffering Groups

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Group	1	.077	.783	.002
Error (Group)	39			
Within-subjects effects				
Time	2.185	1.459	.237	.036
Time x Group	2.185	.533	.604	.013
Error (Time)	85.224			

Note. $N = 41$. $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$. Units are beats per minute for heart rate.

Table 14.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANCOVA Examining Self-Reported Stress and Anxiety for the Stressor Only and Stressor Plus Social Buffering Groups While Controlling for Parent Age

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Parent Age	1	.721	.402	.020
Group	1	.322	.574	.009
Error (Parent Age)	35			
Within-subjects effects				
Time	2.039	5.393	.006**	.134
Time x Parent Age	2.039	2.200	.117	.059
Time x Group	2.039	.314	.735	.009
Error (Time)	71.366			

Note. N = 38. *p < .05, **p < .01, ***p < .001.

Table 15.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANCOVA Examining Heart Rate for the Stressor Only and Stressor Plus Social Buffering Groups While Controlling for Parent Age

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Parent Age	1	2.555	.118	.065
Group	1	.419	.521	.011
Error (Parent Age)	37			
Within-subjects effects				
Time	1.932	.443	.723	.012
Time x Parent Age	1.932	.349	.699	.009
Time x Group	1.932	.537	.581	.014
Error (Time)	71.494			

Note. N = 40. **p* < .05, ***p* < .01, ****p* < .001. Units are beats per minute for heart rate.

Table 16.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANCOVA Examining Heart Rate for the Stressor Only and Stressor Plus Social Buffering Groups While Controlling for Parent Relationship to Child

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Relationship to Child	1	6.979	.012*	.155
Group	1	< .001	.998	< .001
Error (Relationship to Child)	38			
Within-subjects effects				
Time	2.195	.124	.900	.003
Time x Relationship to Child	2.195	.338	.734	.009
Time x Group	2.195	.614	.558	.016
Error (Time)	83.405			

Note. $N = 41$. *$p < .05$, **$p < .01$, ***$p < .001$. Units are beats per minute for heart rate. Relationship to Child reflects participants' self-identification as a mother or father.

Table 17.

Descriptive Statistics for Heart Rate for Mothers and Fathers in the Stressor Only and Stressor Plus Social Buffering Groups (Pre-Stressor to Post-Stressor Task)

Group	Timepoint	Relationship to Child	*N*	*M*	*SD*
Stressor Only	Before speech preparation (3)	Mother	17	77.94	8.48
		Father	7	67.00	10.77
	After speech delivery (4)	Mother	17	77.00	9.92
		Father	7	66.00	8.37
	After math task (5)	Mother	17	76.59	11.36
		Father	7	69.43	11.00
	After post-stressor task (6)	Mother	17	75.53	9.02
		Father	6	66.00	9.78
Stressor Plus Social Buffering	Before speech preparation (3)	Mother	16	75.31	13.55
		Father	3	69.33	4.51
	After speech delivery (4)	Mother	15	74.87	14.44
		Father	3	65.67	5.51
	After math task (5)	Mother	16	78.63	16.37
		Father	3	71.33	18.23
	After post-stressor task (6)	Mother	15	75.47	12.98
		Father	3	63.33	4.04

Note. Units are beats per minute for heart rate.

Table 18.

Results of a 2 (Group) by 4 (Time) Repeated Measures ANCOVA Examining Self-Reported Stress and Anxiety for the Stressor Only and Stressor Plus Social Buffering Groups While Controlling for Parent Relationship to Child

Source	*df*	*F*	*p*	$\eta^2_{partial}$
Between-subjects effects				
Relationship to Child	1	.222	.640	.006
Group	1	.430	.516	.012
Error (Relationship to Child)	36			
Within-subjects effects				
Time	1.901	8.430	< .001**	.190
Time x Relationship to Child	1.901	1.411	.251	.038
Time x Group	1.901	.398	.663	.011
Error (Time)	68.445			

Note. $N = 39$. $*p < .05$, $**p < .01$, $***p < .001$. Relationship to Child reflects participants' self-identification as a mother or father.

Figure 1.

General Overview of Online Assessment Protocol

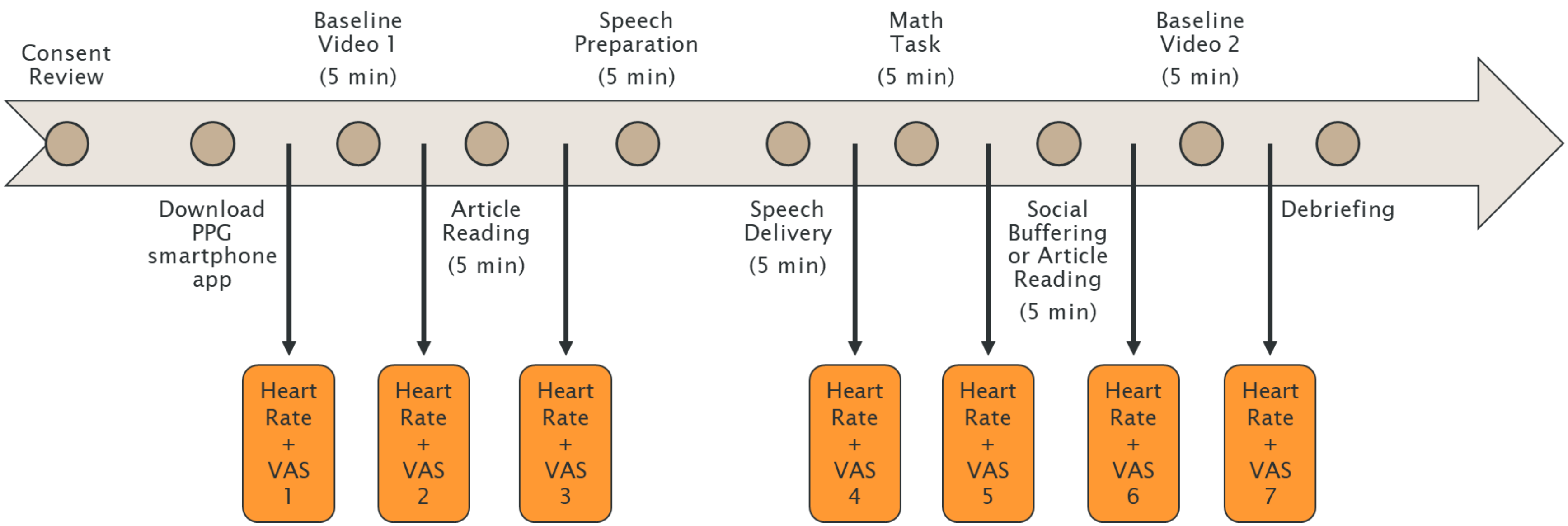


Figure 2.

Overview of iTSST Protocol for the Stressor Only and Stressor Plus Social Buffering Groups

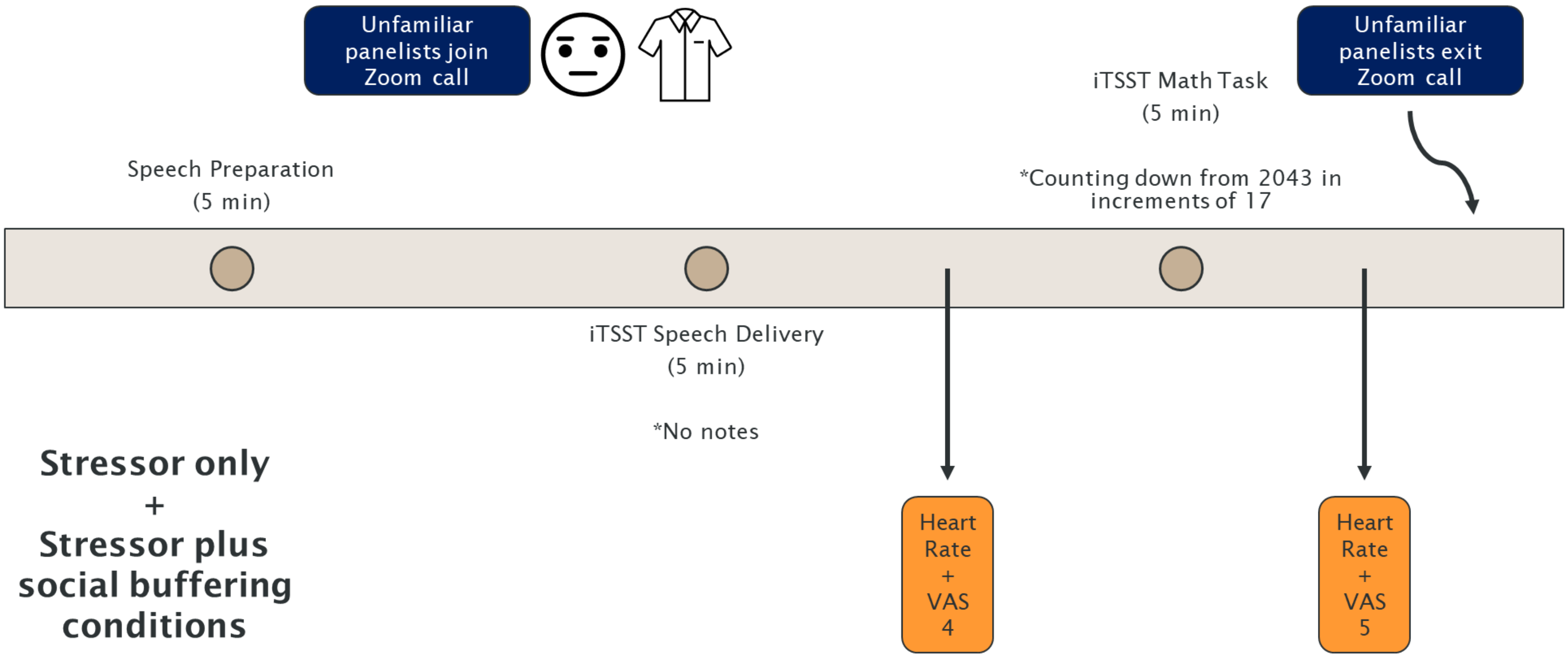


Figure 3.

Overview of Placebo Version of iTSST for the Control Group

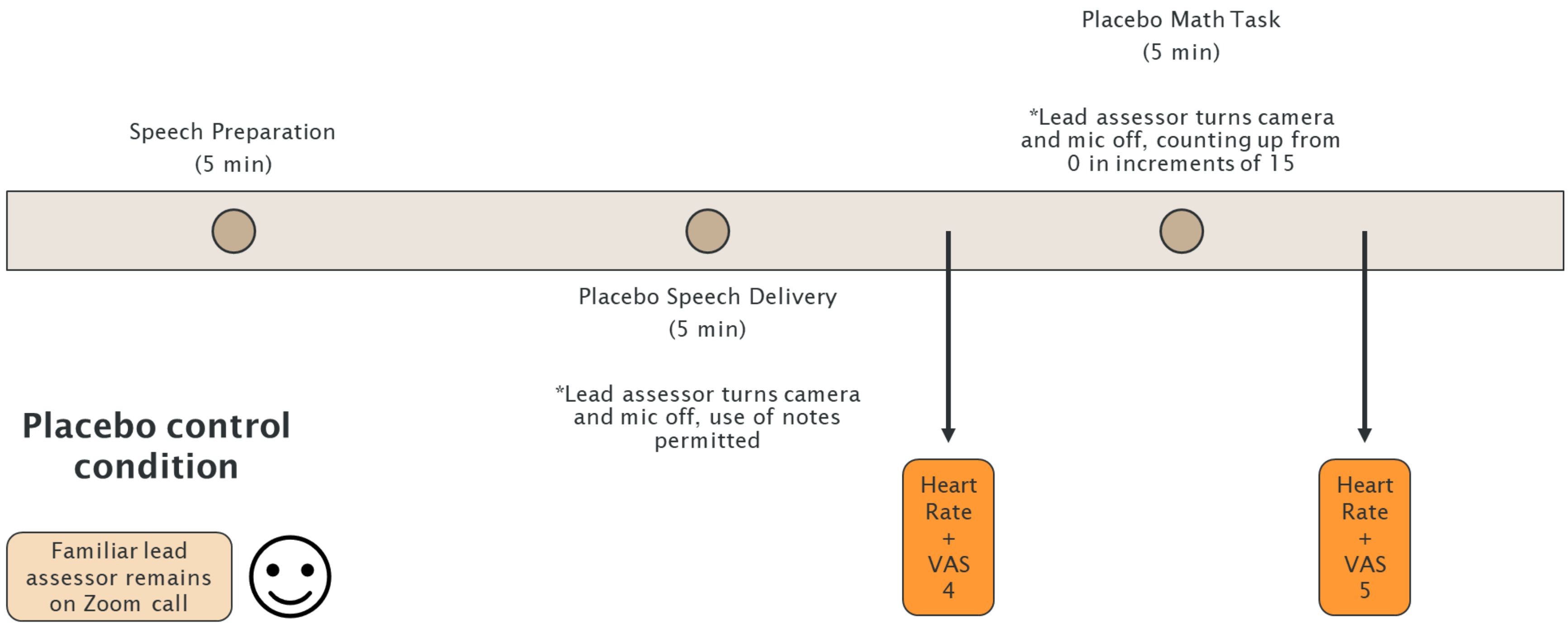
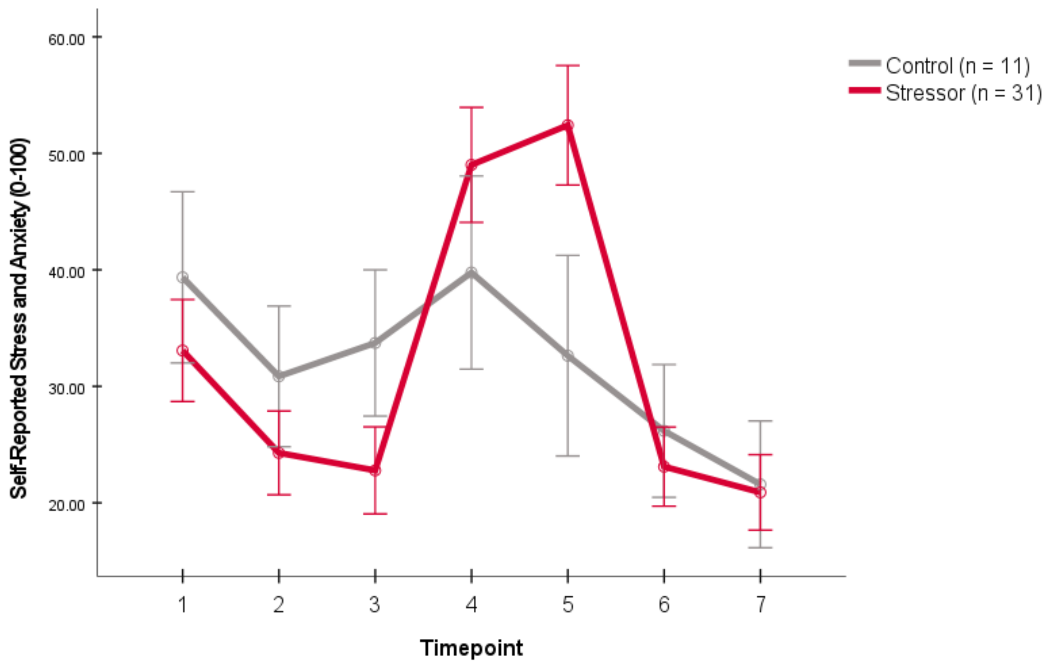


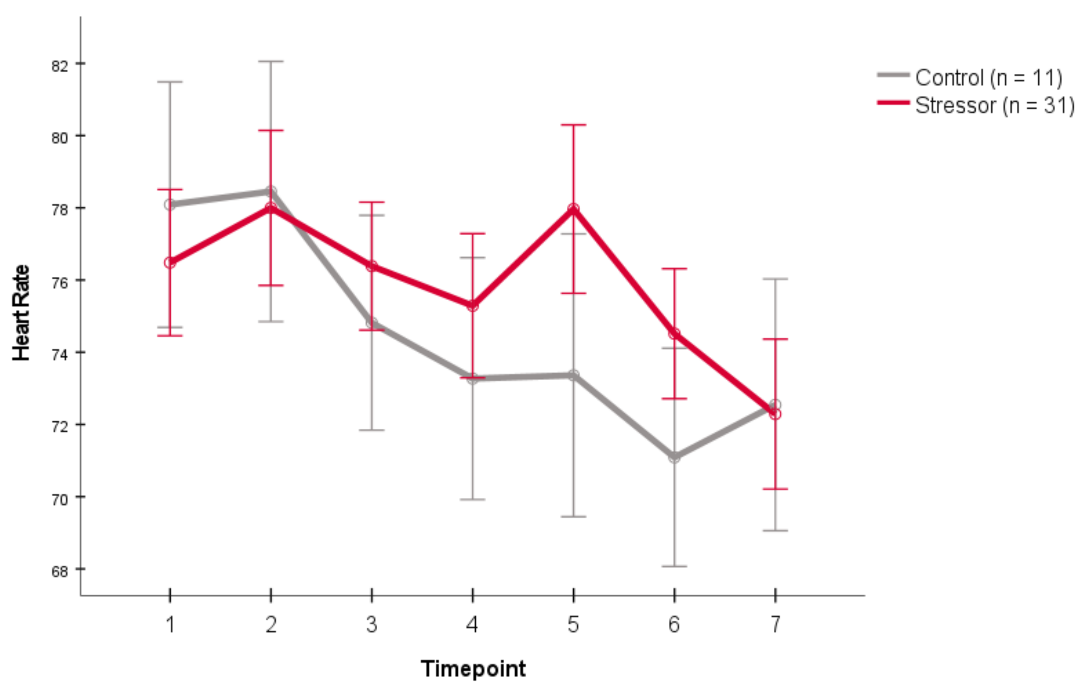
Figure 4.

Line Graphs Depicting Measured (A) Self-Reported Stress and Anxiety and (B) Heart Rate Throughout the Experiment for the Control and Stressor Groups

A.



B.

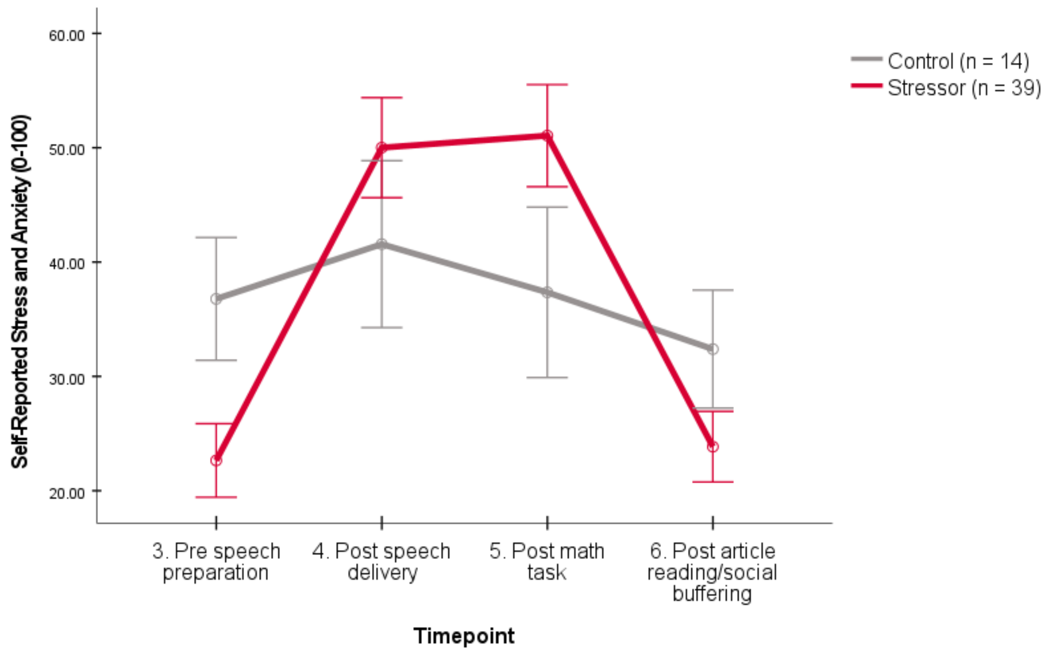


Note. Error bars reflect ± 1 standard error. Units are beats per minute for heart rate.

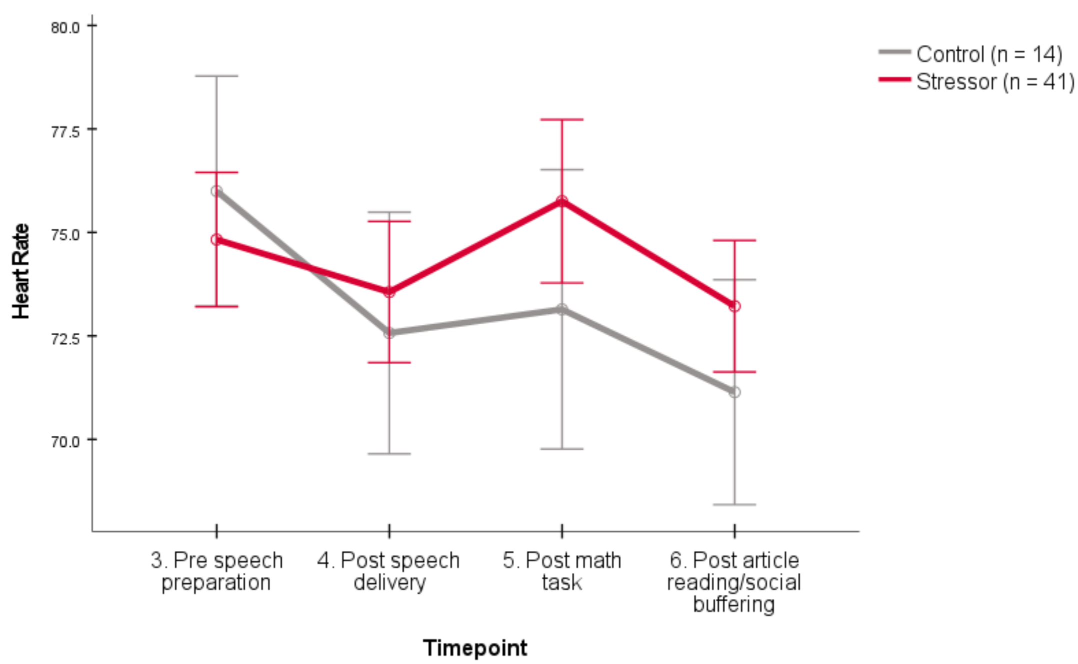
Figure 5.

Line Graphs Depicting Measured (A) Self-Reported Stress and Anxiety and (B) Heart Rate Between Timepoints 3 and 6 for the Control and Stressor Groups

A.



B.

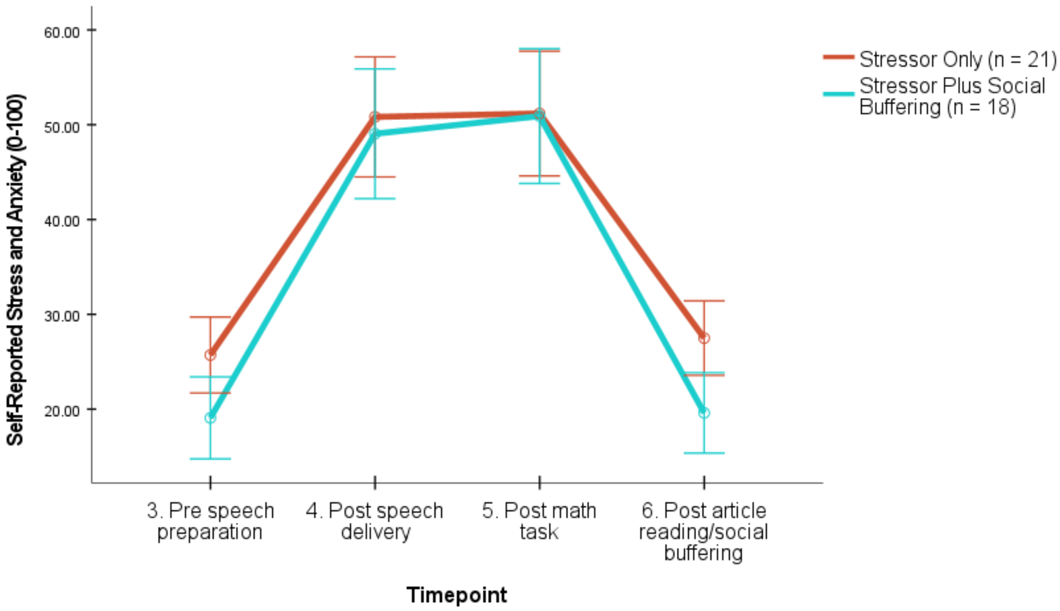


Note. Error bars reflect ± 1 standard error. Units are beats per minute for heart rate.

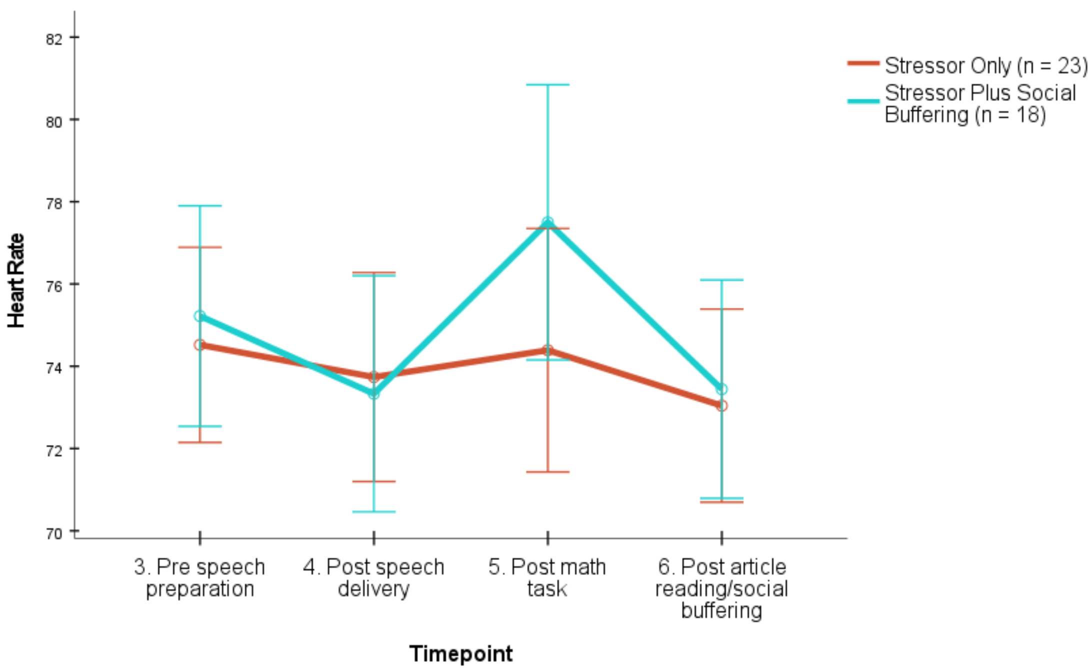
Figure 6.

Line Graphs Depicting Measured (A) Self-Reported Stress and Anxiety and (B) Heart Rate Between Timepoints 3 and 6 for the Stressor Only and Stressor Plus Social Buffering Groups

A.



B.



Note. Error bars reflect ± 1 standard error. Units are beats per minute for heart rate.