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The Vulnerability of Chronic Stress: Implications for Feeling Like Giving Up

Miranda Jany
University of Missouri-St. Louis, mnjd45@mail.umsl.edu

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Miranda N. Jany

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Carissa Philippi, Ph.D.
Chairperson

Michael Griffin, Ph.D.

George Taylor, Ph.D.

Abstract

The feeling of learned helplessness has been associated with prolonged stress and trauma. Additionally, many previous studies have examined the relationship between stress and decreased feelings of control, such as self-efficacy and locus of control. However, these forms of control have been primarily self-reported. The present study aimed to investigate the relationships among learned helplessness, chronic stressors, and self-agency using a computer-based task. We also measured heart rate variability (HRV) during the self-agency task to assess psychophysiological correlates of these variables. Seventy-four participants completed a series of questionnaires that were used to assess lifelong stressors (e.g., exposure to natural disasters, adoption, abuse, and neglect), and measures related to mental health symptoms (i.e. depression, anxiety, and posttraumatic stress disorders). Participants were then randomly assigned to a learned helplessness task comprised of either solvable (n = 34) or unsolvable anagrams (n = 40). Finally, participants completed a computer-based self-agency task, where they were asked to rate their level of perceived control when moving boxes around on a computer screen. A 2x2 mixed-model ANOVA that examined the effect of stress (high, low) and learned helplessness condition (unsolvable, solvable) on self-agency ratings indicated there was no main effect or interaction. Furthermore, independent samples t-test revealed there was no effect of stress group on HRV. Findings from this study could have implications for the role of resiliency in those who have endured chronic stress.

Keywords: learned helplessness, chronic stress, self-agency, perceptions of control, heart rate variability, posttraumatic stress disorder

Introduction

Stress is inevitable. People often encounter daily stressful experiences, such as rushing to meet an important deadline, taking an exam or giving a presentation. Selye (1980) first defined stress as the "non-specific response of the body to any demand placed upon it". Although a moderate amount of stress is imperative for the survival of humans, prolonged or chronic stress can have detrimental effects on an individual's cognitive, psychological, and physical well-being. For instance, chronic stress can impair executive functions, such as working memory and decision making (Marin et al., 2011; Mizoguchi et al., 2000). Previous studies have also shown that prolonged exposure to stressors can contribute to the development of psychiatric disorders, such as depression and anxiety (Mineur et al., 2006; Zhu et al., 2014). Persistent stress can also affect a person's body, leading to the development of cardiovascular disease and deficits in the immune system (Rainforth et al., 2007; Robles et al., 2005). Stress has a powerful impact on nearly all aspects on a person's life, and by studying the many effects of stress, researchers are able to better understand the cognitive and psychological constructs associated with it.

One of the most notable psychological effects of exposure to repeated and prolonged negative stimuli is the expression of learned helplessness. Learned helplessness is the failure to escape from repeated, negative uncontrollable events, or simply put "giving up." Seligman (1975) first discovered the feeling of learned helplessness in his experiments where dogs were restrained by a harness and repeatedly shocked. Once the dogs were given an escape route (i.e. released from the harnesses), they did not move to avoid the shock. It was quickly realized that this phenomenon of learned helplessness could be expanded to other animals (e.g. rats) and even humans (Maier & Seligman,

1976). In laboratory settings with human participants, one of the most common learned helplessness paradigms is an anagram task (Aspinwall & Richter, 1999; Kim, 2006; Starcke et al., 2017). In this task, participants are given either solvable or unsolvable anagrams and asked to solve them, with the unsolvable condition being used to assess manipulated learned helplessness.

In addition to the basic learned helplessness response, the learned helplessness theory suggests that the exposure to repeated and unavoidable negative stimuli can also cause a variety of psychological deficits (Abramson, Seligman, & Teasdale, 1978). The original theory states that the exposure to these prolonged unavoidable situations causes impairments in cognition and motivation. For example, an individual exposed to inescapable stimuli begins to have decreased cognitive abilities, and this sets the foundation for the exposure to the repeated negative stimuli is uncontrollable. Furthermore, the individual's motivation begins to decrease, which in turn makes them less likely to leave the unavoidable stimuli. The theory continues to propose that learned helplessness can lead to deficits in emotion. Specifically, individuals who have greater attributions of learned helplessness to everyday stressors have increased depressive symptoms (e.g. flattened effect, loss of interest; Alloy, Alloy, & Abramson, 1982), thus setting the foundation for the link between learned helplessness and depression (Miller & Seligman, 1975). The psychological deficits related to learned helplessness have also been associated with a greater risk of post-traumatic stress disorder (PTSD; Bargai et al., 2007; Maier, 2001). Yet these deficits in cognition, motivation, and emotion all appear to stem from one key factor – the lack of control individuals have over the negative events.

Decreased control has been associated with both learned helplessness and prolonged stress. One well-established form of control is self-efficacy, which describes the belief than an individual has the ability to succeed in a situation (Bandura, 1977). Previous research has shown that increased attributions of learned helplessness are associated decreased self-efficacy (Hommel et al., 2006; Hsieh & Schallert; 2008). Similarly, elevated chronic stress has been shown to reliability impair self-efficacy (Benight & Bandura, 2004; Luszcynska et al., 2009). Another form of control is locus of control, which is divided into two types: internal and external (Rotter, 1954). Internal locus of control states that a person is responsible for events (e.g. I failed the test because I did not study enough), whereas external locus of control states that outside forces or luck are responsible for events (e.g. I failed the test because the teacher made the test hard). Elevated chronic stress has been shown to increase levels of external locus of control (Mellon et al., 2009; Weindl et al., 2018). Additionally, high external locus of control is a risk factor for developing PTSD after experiencing stressful events (Zhang et al., 2014). Together, these findings for decreased self-efficacy and increased external locus of control suggest that individuals may feel less in control of their own actions when experiencing chronic stress or learned helplessness. However, one important measure of control that is not well understood in terms of its relationship with chronic stress is self-agency.

Self-agency describes the feeling that an individual is in control of their own actions and/or thoughts (Gallagher, 2000). Self-agency has been shown to be altered in a variety of mental health conditions relating to stress and learned helplessness including depression (Hobbs & McLaren, 2009) and PTSD (Ataria, 2015; Huang & Kashubeck-

West, 2015). Although one specific stressful and traumatic event, such as surviving a natural disaster, can impair the sense of agency (Ataria, 2015), the relationship between prolonged chronic stress and agency remains unclear. Previous studies of agency have primarily used self-report measures to examine links between stress and agency (e.g. Hobbs & McLaren, 2009; Huang & Kashubeck-West, 2015). However, no studies to our knowledge have examined the role of self-agency using a computer based-task in individuals experiencing chronic stress after manipulating learned helplessness.

Another key factor that has been linked to control is resilience, or the ability to cope positively in times of high stress (Wu et al., 2013). Individuals who have more resilience factors (e.g. familial support, positive attitude) experience fewer psychological effects of learned helplessness (i.e. deficits in cognition, motivation, and emotion), and in turn can feel more in control when experiencing uncontrollable, negative stimuli (Kim, 2006). This has been demonstrated in studies where individuals who have increased resilience factors report feeling more control in general, such as higher levels of self-efficacy or decreased external locus of control (Hong et al., 2018; Karstoft et al., 2015). Overall, resiliency factors have a significant impact on how individuals cope with sustained stressors and corresponding feelings of control.

Beyond the cognitive and psychological effects, chronic stress has also been shown to produce important physiological alterations within the body, including increased glucocorticoids (Carpenter et al., 2011, Staufenbiel et al., 2012) and decreased immunity (Robles et al., 2005). One of the most prominent bodily changes resulting from chronic stress stems from the cardiovascular system. A common way to measure changes of the cardiovascular system is by heart rate variability (HRV), or the fluctuation in length

between individual heartbeats (Kim et al., 2018; Thayer et al., 2012). Using an electrocardiogram (ECG), a normal heartbeat uses the QRS complex, and HRV measures the average length in-between the R-R intervals.

HRV has been studied with both short-term and long-term stressors (Schubert et al., 2009). Research has reliably demonstrated relationships between HRV and acute stress paradigms, suggesting that short-term stressors can reduce average R-R intervals (e.g. Brugnera et al., 2018; Pakarinen et al., 2016). For example, participants completing an acute social stressor consisting of a speech and arithmetic task showed decreased HRV when compared to a control group (Boesch et al., 2014). However, HRV's role has been debated within the chronic stress literature. A meta-analysis by Kim and colleagues (2018) suggests that HRV may not be a reliable measure of chronic psychological stress. They propose this because HRV is fundamentally controlled by the body's involuntary nervous system, the autonomic nervous system. This division is very sensitive to acute changes, and they suggest that HRV may be a better marker for acute stress. Nevertheless, many studies have demonstrated that similar to acute stress, increased chronic stress also reduces R-R intervals (Lucini et al., 2005; Wahbeh & Oken, 2013). In the present study, we sought to better understand the relationships among HRV, chronic stress, and control in a healthy population.

The primary aim of this study was to investigate the relationships among chronic stress, the feeling of learned helplessness, and self-agency on a computer task. Secondarily we aimed to explore relationships between these variables and HRV collected before, during, and after a learned helplessness task.

Aims and Hypotheses

Aim 1: To investigate the relationships among chronic stress, learned helplessness, and self-agency using a computer-based task.

Hypothesis 1.1: There will be a main effect of chronic stress on self-agency, such that participants in the high chronic stress group will have lower ratings of control on the self-agency task conditions than those with low chronic stress.

Hypothesis 1.2: There will be a main effect of learned helplessness on self-agency, such that participants in the unsolvable anagram task group will have lower ratings of control on the self-agency task conditions than those in the solvable anagram task group.

Hypothesis 1.3: There will be an interaction between chronic stress, learned helplessness, and self-agency, such that the participants in the high chronic stress and the unsolvable anagram task groups will have lower ratings of control on the self-agency task conditions than any other group.

Aim 2: To better understand the role of psychopathology and resiliency factors in the chronic stress and control literature.

Hypothesis 2.1: There will be a moderation effect for psychopathology measures on the main effect of chronic stress on self-agency, such that increasing psychological symptoms will increase the effect of chronic stress on ratings of control on the self-agency task conditions.

Hypothesis 2.2: There will be a moderation effect for resilience measures on the main effect of chronic stress on self-agency, such that higher ratings of resiliency will

decrease the effect of chronic stress on ratings of control on the self-agency task conditions.

Aim 3: To explore the role of HRV in the chronic stress literature.

Hypothesis 3.1: There will be a group difference for chronic stress on HRV, such that participants with high chronic stress will have shorter R-R intervals than those in the low chronic stress group.

Aim 4: To replicate previous studies on chronic stress using self-reported control measures.

Hypothesis 4.1: There will be a group difference for chronic stress on self-reported control measures, such that participants in the high chronic stress group will have lower ratings of control on self-reported control measures than those with low chronic stress.

Method

Participants

Seventy-five total participants were recruited for the study. Participants were over the age of 18 years old, with no history of psychiatric disorders (e.g. depression), neurological (e.g. epilepsy) disorders, or learning disabilities. One participant was excluded due to incomplete data due to ending data collection early. A total of seventy-four participants were included in the data analysis (Table 1). All analyses were completed using pairwise deletion. Participants were recruited from University of

Missouri-St. Louis (UMSL) and the St. Louis community from flyers and online postings (e.g. Craigslist, ResearchMatch, Facebook). All participants gave informed consent according to a protocol approved by the Institutional Review Board. Participants were awarded course credit (if UMSL students) or were entered in an Amazon gift card lottery for their participation.

Measures

Demographic Information. General demographics, including sex, age, race, education, and income were reported using the demographics questionnaire. This questionnaire was written by the faculty advisor.

Psychopathology Measures.

Depression. Depression assessed using the Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996). The BDI-II is a 21-item questionnaire for self-reported symptoms of depression over the past two weeks. Participants rate items such as "feeling sad" and "discouraged about my future" on a 4-point Likert scale. Scores may range from 0 to 63, where higher scores indicate greater depression symptoms.

Anxiety. Anxiety was assessed using the Beck Anxiety Inventory (BAI; Beck & Steer, 1993). The BAI is a 21-item questionnaire for self-reported symptoms of anxiety over the past month. Participants rate items such as "numbness or tingling" and "unsteady" on a 4-point Likert scale (0= "not at all" to 3 = "severely, it bothered me a lot"). Scores may range from 0 to 63, where higher scores indicate greater anxiety symptoms.

PTSD. PTSD was assessed using the Posttraumatic Stress Disorder Checklist for DSM-5 with Criterion A (PCL-5; Weathers et al., 2013). The PCL-5 is a 20-item

questionnaire for self-reported symptoms of PTSD over the past month. Participants are first asked to briefly describe the worst event that has happened to them, how long ago the event happened, and how they experienced the event. Participants are then asked, "how much they are bothered by" common symptoms of PTSD, such as "avoiding memories, thoughts or feelings related to the stressful event" or "trouble falling or staying asleep," on a 5-point Likert scale (0 = "not at all" to 4 = "extremely"). Scores may range from 0 to 80, where higher scores indicate greater PTSD symptoms.

Chronic Stress Measure. Exposure to chronic stress and traumatic events was assessed using the Life Stressor Checklist-Revised (LSC-R; Wolfe & Kimerling, 1997). The LSC-R includes 30 events, including exposure to natural disasters, physical and sexual abuse, separation from children, and death of a relative. An example question is, "Have you ever been in a serious accident (for example, a bad car wreck or an on-the-job accident?" Participants will either mark "yes" or "no." If participants choose "yes," participants will be asked to list how old they were when this event happened, if they felt like they could be killed or seriously harmed (by choosing "yes" or "no"), feelings of helplessness ("yes" or "no"), and how much they feel like the event has affected them in the past year (5-point Likert scale, 1 = "not at all" to 5 = "extremely"). The LSC-R was used as the measure of chronic stress by a median split.

Control Measures.

Self-Agency. Self-agency was reported using the Sense of Self-Agency Scale (SoSA Scale; Oren et al., 2016). The SoSA Scale is a 13-item questionnaire for self-reported measures of agency. Participants rate items, such as "I am in control of what I do" and "I am in the origin of my actions," on a 7-point Likert scale (0 = "do not agree at

all" to 7 = "absolutely agree"). Scores may range from 0 to 91, where higher scores indicate greater sense of agency.

Locus of Control. Locus of control was assessed using the Locus of Control Scale (Rotter et al., 1966). The Locus of Control Scale is a 29-item measure. Each question has two statements, one statement indicating internal locus of control and one indicating external locus of control. One point is given to responses indicating external locus of control. Scores may range from 0 to 13. Higher scores indicate higher external locus of control, and lower scores indicate higher internal locus of control.

Self-efficacy. Self-efficacy was assessed using the General Self-efficacy Scale (GSE; Schwarzer & Jerusalem, 1995). The GSE is a 10-item questionnaire for self-reported measures of coping abilities. Participants rate statements, such as "I can always manage to solve difficult problems if I try hard enough" and "I can solve most problems if I invest the necessary effort," aa 4-point Likert scale (1= "not true at all" to 4 = "exactly true"). Scores may range from 10 to 40, where higher scores indicate greater generalized sense of self-efficacy.

Resilience Measures. Resiliency was assessed using the Resilience Scale for Adults (RSA; Friborg et al., 2005). The RSA is a 33-item questionnaire designed to measure key features of resilience, such as social competence, access to social resources, perception of one's self and future, and family cohesion. Participants rate statements on a scale on a 5-point Semantic scale, each with one a positive and negative attribution. An example item is "in difficult periods I have a tendency to" either 1 = "view everything gloomy" or 5 = "find something good that helps me thrive." Scores may range from 33-

165, where higher scores indicate greater resilience factors and greater psychological well-being.

HRV Recordings. Using the BIOPAC MP150 system, participants HRV was recorded from an ECG. The ECG uses a 3-lead chest electrode placement: right arm (RA; placed below the right clavicle), left arm (LA; placed below the right clavicle), and left leg (LL; placed on the lower chest and to the left of the umbilicus). ECG data was collected using Acqknowledge 4.4 before, during and after the learned helplessness task. Data was cleaned and analyzed using MindWare 3.0.25 to calculate three measures of HRV: average NN (RR) intervals (AVNN), standard deviation of NN (RR) intervals (SDNN), and the root mean square of successive differences (RMSSD).

Solvable vs. Unsolvable Anagram Task. An anagram is a scrambled set of letters that can be used to make a word when rearranged. Anagrams have been used frequently in the literature to manipulate learned helplessness (Aspinwall & Richter, 1999; Starcke, Agorku, & Brand, 2017; Young & Allin, 1992). Participants were randomly assigned to either a solvable or unsolvable group. Both groups completed a practice round of two solvable anagrams with the researcher, followed by a set of ten anagrams on Qualtrics (adapted from Aspinwall & Richter, 1999). Participants had eight minutes to solve/try to solve the task anagrams. Each group was instructed that their anagrams will be solvable, however, only anagrams in the solvable group will be solvable. During a debriefing session at the end of the study, participants in the unsolvable group were told their anagrams were unsolvable.

Self-Agency Judgment Task. The ability to determine whether one is responsible for one's own actions was assessed in a self-agency judgment task (Philippi

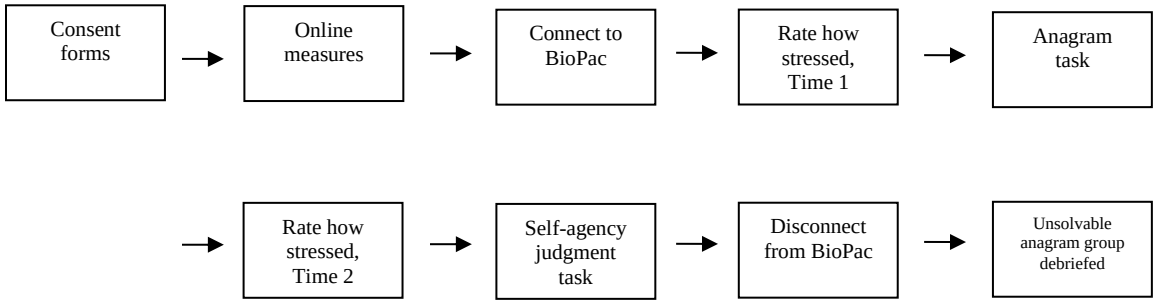
et al., 2012). Using a mouse, the participant's objective was to move a blue box presented at the center of the screen onto a green box presented randomly at one corner of the screen. The participants had 10–seconds to move the blue box into the green box. After each trial, the participants were presented with a screen where they were immediately be asked how much control they felt they had over the blue box. Responses to this question were collected using a visual analogue scale ranging from 0 ''no control'' to 100 ''complete control''. Perceived control was manipulated parametrically by varying the proportion of time the participants had control over the blue box during a trial, ranging from 0 to 100 percent of the time. Participants first completed a set of 10 practice trials, to ensure they understood the objective of the task. Then, participants completed 2 separate blocks of 25 randomized trials each (for a total of 50 trials). Within each block, there were a total of 5 trials for each of the five different conditions designed to vary perceived control (0, .30, .75, .90, 1.0). Perceived control ratings were averaged for each of the five trials within each block. Ratings were then averaged across the two blocks to get a total average rating for each condition of perceived control.

Procedure

The study design included the following steps: (1) participants completed the consent form, (2) participants completed online measures questionnaires on a computer while in the lab, (3) participants were attached to a 3-lead electrode to measure HRV via the BIOPAC, (4) participants were asked to rate on a scale of 1-10 how stressed they feel at the present moment, (5) participants were randomly assigned to either a solvable or unsolvable group for anagrams to manipulate learned helplessness, (6) participants were asked to rate on a scale of 1-10 how stressed they feel at the present moment, (7)

participants completed a computer-based self-agency judgment task, (8) participants were detached from the HRV electrodes, and finally, (9) participants in the unsolvable anagram group were debriefed.

Figure 1:



Statistical Analyses

Aim 1 examines the effects of chronic stress (LSC-R) and the learned helplessness condition on ratings of control on the self-agency judgment task in each of the five conditions (0, .30, .75, .90, and 1.0). Using a 2 (high chronic stress, low chronic stress) x 2 (unsolvable anagram condition, solvable anagram condition) mixed-model ANOVA with self-agency conditions as the dependent variable, we hypothesized that there will be significant main effects of both stress and learned helplessness and a significant interaction.

Aim 2 hypothesized that psychopathology and resilience scores will moderate the relationship between chronic stress and control ratings on the self-agency task conditions. Following up on the significant main effects in Aim 1, a separate moderation analysis will be performed with composite scores from psychopathology scores (BDI-II, BAI, and PCL-5), and resilience scores (RSA) to investigate their influence.

Aim 3 explored the relationship between chronic stress and HRV. Using an independent samples *t*-test for stress group (high, low) on AVNN, SDNN, and RMSSD,

we hypothesized that there would be a significant simple effect of stress on HRV. A Bonferroni corrected alpha level of 0.02 was used for analyses for Aim 3 (0.05/3 = 0.02).

Aim 4 sought to replicate previous studies involving self-reported measures of chronic stress. Individual independent *t*-tests were conducted for stress group (high, low) on composite scores for all self-report control measures of self-agency, locus of control, and self-efficacy. (i.e. SoSA, Locus of Control Scale, and GSE). A Bonferroni corrected alpha level of 0.02 was used for analyses for Aim 4 (0.05/3 = 0.02).

Results

Participant Characteristics

Participants were randomly assigned to either the unsolvable (n = 40) or solvable (n = 34) learned helplessness condition. We first examined group differences in demographic and psychopathology variables between the learned helplessness groups (Table 1). There were no significant differences in age, race, education, or psychopathology measures (ps = .129 - .871). However, there was a significant difference between the two learned helplessness groups for sex, $X(1) = 4.11$, $p = .043$, with more males in the solvable group and more females in the unsolvable group. Therefore, sex was used as a covariate in all analyses using learned helplessness groups.

A median split (median = 4.0) was used to divide participants into high (n = 36) and low (n = 38) stress groups. Scores ranged from 0 to 15 (out of 30 possible), and the mean number of stressors experienced was 5.46.

Aim 1 Results

For Aim 1, we sought to investigate the relationship between stress, learned helplessness, and self-agency on a computer task. Mauchly's Test of Sphericity indicated that the assumption of sphericity had not been violated, $\chi 2(4) = 25.00$, $p > 0.05$. There was no significant main effect of stress group (high, low) on the five self-agency conditions (Figure 1), ($F(4,67) = .25$, $p = .911$. Similarly, there was no significant main effect of learned helplessness condition (unsolvable, solvable) on the five self-agency conditions, ($F(4,67) = .52$, $p = .719$). Finally, there was no significant interaction between stress group (high, low) and learned helplessness condition (unsolvable, solvable) on self-agency, ($F(4,67) = .29$, $p = .928$).

Aim 2 Results

Given that there were no significant main effects or interaction, we did not perform the moderations from Aim 2 (i.e., with psychopathology and resilience measures).

Aim 3 Results

For Aim 3, three independent samples t-tests were conducted to compare HRV measures (i.e., AVNN, SDNN, and RMSSD) in high ($n = 35$) and low ($n = 37$) stress groups (Figure 2). There were no significant differences in any of the HRV measures between the stress groups ($ps = .406$ - $.763$).

Aim 4 Results

For Aim 4, we sought to determine whether there were differences in the stress groups on self-reported measures of control (Figure 3). There were no significant differences in self-agency, locus of control, or self-efficacy for the high stress group versus the low stress group ($ps = .205$ - $.683$).

Discussion

The primary aim of this study was to investigate the relationships among chronic stress, learned helplessness, and self-agency on both a computer task and self-reported measures. Secondarily, we sought to explore relationships between these variables and HRV collected before, during, and after a learned helplessness task. We found that both chronic stress and learned helplessness had little effect on both self-reported measures and experimental measures of control. Furthermore, our findings suggest that chronic stress has little effect on HRV measures.

First, our findings from Aim 1 and Aim 4 did not confirm our hypotheses. We found that stress group and learned helplessness condition had no effect on the computer-based self-agency task or self-reported control measures. One potential explanation for this finding is the idea of illusion of control, or the phenomenon that individuals tend to overestimate their levels of control despite the event being uncontrollable in the first place (Alloy & Abramson, 1979; Langer, 1975). A previous study by Alloy & Clements (1992) suggested that increased stress, as determined by number of life events, was an important factor when examining illusion of control on a computer-based judgment of control. In that study, individuals who experienced more stressors often overestimated their levels of control. In the present study, increased stress, and thus learned helplessness, was hypothesized to lower agency ratings. However, participants in the high stress group may have experienced the illusion of the control effect, and this may explain why we did not find any differences between groups.

It is also possible that we found no relationship between stress, learned helplessness, and control because of individual differences in resiliency, or being able to cope

positively despite stressors. Resiliency can have positive cognitive effects, including greater psychological well-being and in return, decreased risk of developing psychopathology, such as depression (Ong, Bergeman & Boker; 2009; Steinhardt & Dolbier, 2008). For example, one study showed that individuals with more protective factors, features that help promote resilience (e.g. support systems, access to stable housing and food) felt more in control and having more authority over their life (Levendosky & Graham-Bermann, 2000). While we aimed to examine resiliency in hypothesis 2, our analyses were not conducted due to no significant findings from Aim 1. Future analyses from this study, and subsequent research in general, could consider the role of trait resiliency in order to better understand its role in stress and learned helplessness.

Furthermore, our findings from Aim 3 were inconsistent with our hypothesis. We found that high stress is not associated with decreased HRV (i.e. AVNN, SDNN, RMSDD). This finding is in support of a recent meta-analysis by Kim et al. (2018) that suggests that HRV is controlled by acute changes of the body's division of the autonomic nervous system, and not so much of longer, chronic stressors that have an effect of the body's HRV changes. However, many previous studies have shown the association between chronic stress and HRV changes with frequency measures (Lucini et al., 2005; Wahbeh & Oken, 2013). Nonetheless, our finding is more consistent with the meta-analysis by Kim et al., (2018), suggesting that chronic stress measures have little effect on various measures of HRV.

However, our study has several limitations. First, our study had a concern with power. An initial *a priori* power analysis suggested that a sample size of 106 participants

would be needed to achieve a power of 0.80 for our 2x2 repeated measures ANOVA analysis, and we only included 74 total participants in this sample. Therefore, we may not have had enough power in order to find significant results in some of our analyses.

A second limitation of the study is that we used a relatively healthy population and excluded participants with any history of psychiatric or neurological conditions. Moreover, the range of the stressful events on the LSC-R was low. Our sample ranged from 0-15 stressors experienced, out of 30 possible stressors. Individuals who are psychologically healthy may respond differently to psychopathology questionnaires or the learned helplessness paradigm, and this may not be a true representation of the normal population.

Another limitation of the study includes the HRV analysis protocol. HRV was averaged across before, during, and after the learned helplessness task to obtain HRV measures, and thus, we did not get a baseline reading for those within the high and low stress group. It is standard to include a baseline reading of HRV in psychophysiology research, especially in stress related research to obtain any differences between groups (e.g., Tan et al., 2011; Zucker et al., 2009). This could be a potential reason why we did not find a significant finding for Aim 3.

Nevertheless, our study has potential implications. Our findings suggest that individuals who are psychologically healthy may be able to control their own actions and thoughts following a relatively short learned helplessness manipulation (i.e. 10 minutes), as indicated by the self-reported and computer-based agency measures, and hopefully suggest resiliency. Furthermore, individuals who are in high stress may not have any differences in HRV, and this could provide evidence for sustained improvement for

cardiovascular health. However, data collection for this study is still on-going and we hope to continue to collect data to further investigate the relationship between stress, learned helplessness, feelings of control, and HRV in a larger sample.

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TABLES

Table 1

Group demographics and characteristics

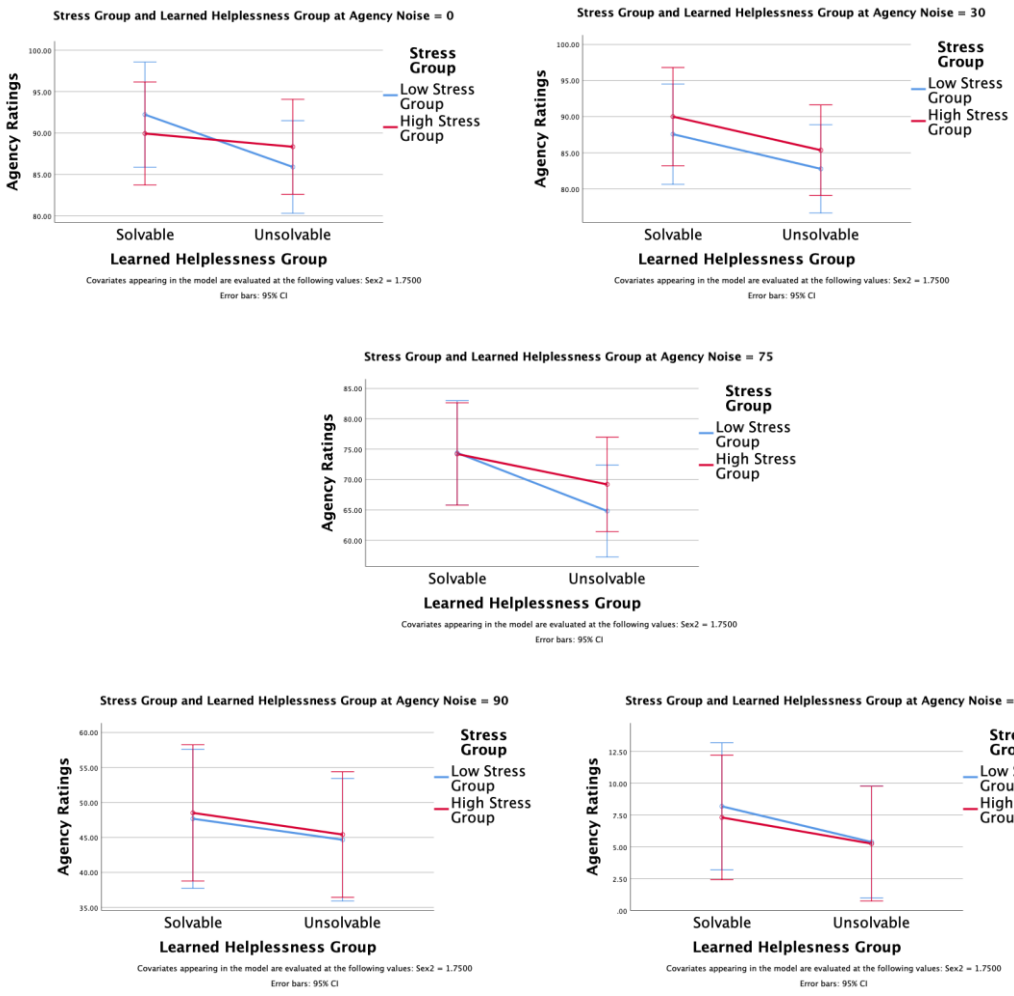
	Unsolvable (n = 40)	Solvable (n = 34)	Significance
Demographics			
Age	32.62 (19.33)	28.52 (15.71)	---
Sex (% Female)*	85.0%	64.7%	p = 0.043
Education			
High school	17.5%	11.8%	---
Some college credits	42.5%	38.2%	---
Trade school	0%	2.9%	---
Associate degree	20.0%	26.5%	---
Bachelor's degree	7.5%	11.8%	---
Master's degree	12.5%	5.9%	---
Doctoral degree	0%	2.9%	---
Race			
White	60.0%	67.6%	---
Black or African American	20.0%	26.5%	---
Asian	7.5%	5.9%	---
Multiracial	10.0%	0%	---
Psychopathology measures			
BDI	8.80 (7.55)	6.65 (4.26)	---
BAI	8.75 (8.14)	7.24 (7.04)	---
PCL-5	15.80 (16.64)	15.18 (16.11)	---

Notes: BDI = Beck Depression Inventory, BAI = Beck Anxiety Inventory, PCL-5 = PTSD Checklist for DSM-V

*Sex was significantly difference between groups (Chi-squared test for sex, $X^2(1) = 4.11$, $p = .043$), and sex was included as a covariate for all analyses that included the learned helplessness groups.

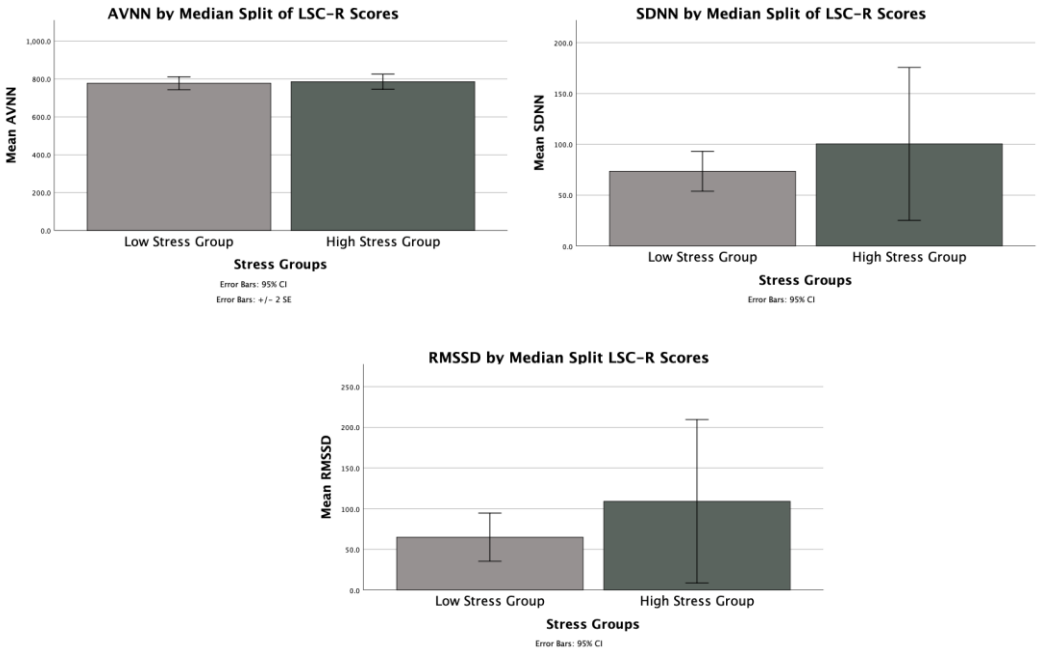
FIGURES

Figure 1. Agency Ratings by Stress and Learned Helplessness Groups



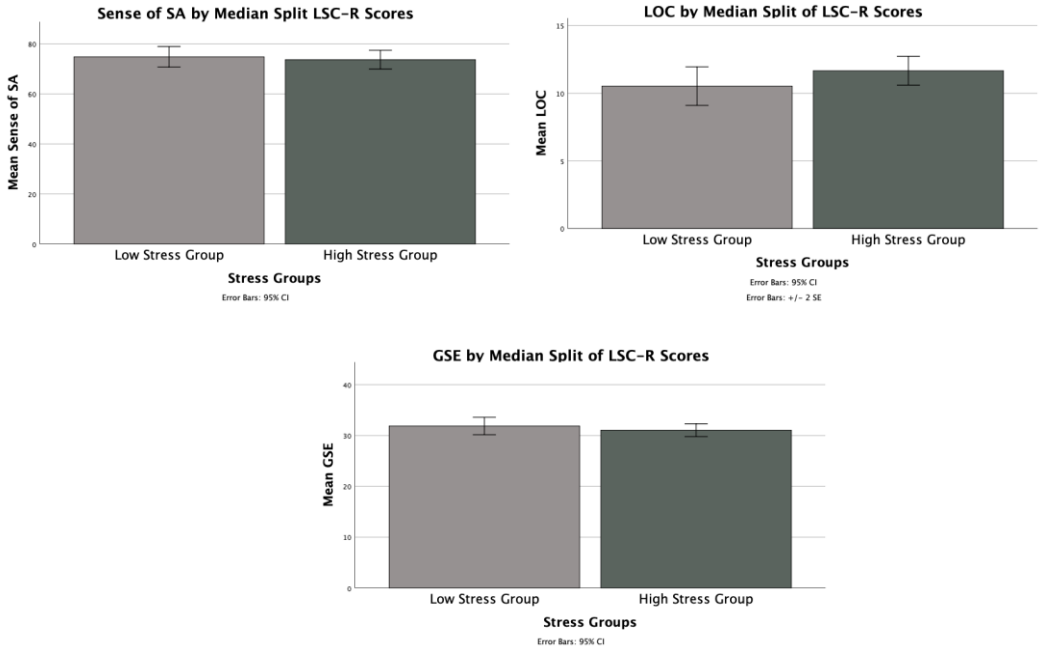
Mean self-agency ratings for stress and learned helplessness groups, error bars indicate +/- 2 standard errors of the mean.

Figure 2. HRV by Stress Group



Mean HRV analysis for stress groups, error bars indicate +/- 2 standard errors of the mean.
Notes: LSC-R = Life Stressor Checklist- Revised, AVNN = average NN (RR) intervals, SDNN = standard deviation of NN (RR) intervals, RMSSD = root mean square of successive differences

Figure 3. Self-Reported Control Measures by Stress Group



Mean self-report control ratings for stress group, error bars indicate +/- 2 standard errors of the mean.
Notes: LSC-R = Life Stressor Checklist- Revised, Sense of SA = Sense of Self-agency, LOC= Locus of Control Scale, GSE = General Self-efficacy Scale