CULTURAL DIFFERENCES IN HEART RATE VARIABILITY AND STRESS RESPONSE

by

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THESIS

Presented to the Faculty of

The University of Houston-Clear Lake

In Partial Fulfillment

Of the Requirements

For the Degree

MASTER OF SCIENCE

in Psychology

THE UNIVERSITY OF HOUSTON-CLEAR LAKE

AUGUST, 2022

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Dedication

I would like to dedicate this thesis to Holden, who believed in me when I didn't think I could do it and supported me when I needed it most. To my parents and family, who helped build me into the person I am today. Lastly, to my best friends, who were there for me to lean on or when I just needed a laugh. This is for you.

Acknowledgements

This endeavor would not have been possible without the help and guidance of Dr. Georgina Moreno. Thank you for being such an inspiration and mentor to me during my time at UHCL. All of my great experiences and opportunities at UHCL have been because you took it upon yourself to make sure every one of your students felt cared for and supported. You have made such a positive impact on my graduate career and life I cannot thank you enough.

I am grateful for Lily, Pierce, and Zöe. Their help during my data collection was instrumental in the completion of this study and without them I could not have done it. Thank you for helping me stress out my participants for the sake of this study.

Additionally, I would like to thank Dr. Desdamona Rios for offering her time, advice, and expertise as a committee member during the process of this thesis.

ABSTRACT

CULTURAL DIFFERENCES IN HEART RATE VARIABILITY AND STRESS RESPONSE

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It is well established that cultural values influence stress, however, very little research has investigated the psychophysiological underpinnings of these processes. The current study investigated whether differences due to individualist and collectivist culture traits (i.e., independence, interdependence) exist in psychophysiological processing (i.e., heart rate variability) and during the stress response. Aim 1 investigated whether there was a difference in resting heart rate and resting heart rate variability measurements between individualist and collectivist orientations. It was hypothesized that collectivists would display a decrease in heart rate variability measurements compared to their individualistic counterparts. Aim 2 investigated if there was a difference in the heart rate variability

measurements between individualists and collectivists during an acute stressor, the Trier Social Stress Test. It was hypothesized that, when presented with an acute stressor, collectivists would display a decrease in heart rate variability. A sample of 28 healthy adults were included in these analyses. Participants completed the Self-Construal Scale (SCS) and were categorized into collectivist (N=11) or individualist (N=14) groups based on their scores. Beats-per-minute recordings were taken during a ten-minute baseline period prior to completion of the stressor and taken throughout the duration of the stressor. A significant difference was found between collectivist and individualist orientations at rest (i.e., during baseline measurements) for average heart rate and average R-R interval, with collectivists having higher heart rates but smaller R-R intervals as compared to individualists. A significant difference was also found between collectivist and individualist orientations for average heart rate and average R-R intervals during the acute stressor, however, there was no interaction between collectivistic/individualistic orientation and stress. These results suggest that cultural constructs of individualism and collectivism may affect heart rate and R-R intervals during resting and stressed conditions. This work highlights the importance of better understanding the effect of culture on psychophysiological processes within an individual.

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CHAPTER I:

BACKGROUND

Cultural Constructs of Collectivism and Individualism

Collectivism and individualism are two cultural constructs that are based on different values within an individual's social group. They are constructs often used in the social sciences to describe cultural patterns related to how individuals view themselves in relation to their cultural group and the independence and interdependence among group members (Triandis & Gelfand, 2012). Collectivists are described as more interdependent, as giving priority and focus on the goals of the group and behave in a way that is representative of the accepted norms of the group. On the other end of the spectrum, individualists often maintain a sense of autonomy and independence from their group. They will prioritize their goals above the group's and will behave in a way that is independent of the group and its' expectations (Triandis, 2001). A similar variation of this construct, coined by Markus and Kitayama (1991), is independent and interdependent self-construal. This is how the individual views themself and how they interact with their surrounding group. Those who are independent view themselves in the similar fashion of those who identify with the individualistic culture trait of autonomic and unique values, whereas those who identify with interdependent self-construal are described as interconnected with their group.

Cultural values have often been considered a psychological buffer, while cultural worldviews provide a set of normative standards or values (Pyszczynski & Kesebir, 2011). When an individual satisfies those set standards they can maintain their image of self-worth, therefore they decrease any likelihood of anxiety or depression. When the cultural worldview standard is not maintained, then a person is more likely to lose that

anxiety-buffering mechanism. Therefore, there is a higher chance for the manifestation of a stress disorder (Pyszczynski & Kesebir, 2011; Du, et al., 2016). Additionally, emotion regulation has been shown to be affected by the influence of culture. It can either push for independence by affecting other people within the social group or they can follow with its interdependent need to provide social harmony by regulating their emotional response (Ford & Mauss, 2015). Including the influence on emotion regulation, a meta-analysis was performed comparing self-esteem between Western and Eastern groups; it found that Western societies had a much higher self-esteem rating than their Eastern counterparts (Heine & Hamamura, 2007).

Heart Rate Variability

Heart Rate Variability (HRV) is a commonly measured psychophysiological response linked to stress, general well-being, and mental health. HRV is the variability between heart beats over time, or more specifically the duration between inter-beat intervals as denoted by R-R intervals (Singh et al., 2018). HRV is modulated through the two autonomic nervous system branches: the sympathetic and parasympathetic nervous system. The parasympathetic nervous system influences heart rate by the release of acetylcholine from the vagus nerve, while the sympathetic nervous system mediates heart rate through the release of epinephrine and norepinephrine. The parasympathetic nervous system withdraws its inhibitory effect to allow the sympathetic nervous system to elicit a fight or flight response during times of stress (Kim, et al., 2019). Heart rate and HRV consist of an inverse relationship: as the heart rate increases there is less time for variability to occur between R-R intervals therefore decreasing the instance of heart rate variability. The opposite will occur when the heart rate decreases, leading to an increase in heart rate variability (McCraty & Schaffer, 2015). It was once believed that the heart would beat in a metronomic manner (Schaffer & McCraty, 2014), however, it was

discovered that respiration, at a certain frequency (0.25 Hz), affected the time between heartbeats. This phenomenon is due to respiratory sinus arrhythmia (RSA), which is the shortening of inhalation and the elongation of exhalation (Draghici & Taylor, 2016).

There are a multitude of metrics involved in HRV recordings dependent on the purpose of the study. A time-domain index of HRV is used to quantify the R-R interval variability and PNS input. The frequency-domain measurement is used to determine the estimated distribution of the absolute and/or relative frequency bands associated with heart rate oscillations by separating SNS and PNS activity (Shaffer & Ginsberg, 2017) This frequency-domain measurement has been shown to provide information regarding both the sympathetic and parasympathetic output of an individual using frequency ranges (Cha, et al., 2018).

Stress

Stress is defined as a state in which the individual experiences an overactivated nervous system, which can lead to acute or chronic physical, psychological, and behavioral effects (Campkin, 2000). Acute stress is a short-term stressor that is quickly alleviated once the situation has passed, for example slamming on the brakes to avoid an accident, while chronic stress is the repeated exposure of a stressor that lasts for weeks or months. This autonomic response is what allows an individual to manage emotionally salient or dangerous situations (NLM, 2020). When an individual experiences an acute stressor there is typically a decrease in their executive and cognitive functioning. When a mild stressor is present, it can cause a decrease in an individual's prefrontal cortex functioning, leading to the depletion of cognitive resources that are typically devoted to working memory and cognitive flexibility (Arnsten, 2009). These resources will then be focused into selective attention so that the individual has an enhanced ability to focus on the stressor (Schoofs, et al., 2009; Plessow, et al., 2011). An additional effect of exposure

to a stressful experience can lead to the diminishment of immune function such as reduced circulation of lymphocytes, inhibition of some lymphocyte functioning, and reduced immune responses (Ader, et al., 2001).

Psychological stress can affect the body through the coordination of the hypothalamic-pituitary-adrenal axis and the autonomic nervous system (ANS) (Rotenberg & McGrath, 2016). The parasympathetic (PNS) and sympathetic nervous system (SNS) branches of the ANS formulate a balance in which they influence heart rate. To increase the heart rate of an individual there must either be increased SNS activity or decreased PNS activity (Archaya, et al., 2006). There are many different methods of measuring stress in an individual through biological markers (i.e., cortisol & amylase), but heart rate variability (HRV) is beginning to be used more throughout research as it can be used to measure SNS and PNS functioning within the ANS.

Heart Rate Variability and Stress

HRV is the variability observed in the fluctuations of time between your heartbeats. There are a variety of activities that affect HRV, such as breathing, physical exercise, mental stress, and other underlying factors (Draghici & Taylor, 2016). Typically, higher HRV has been linked to the ability of the body to adapt to changes (McCraty & Shaffer, 2015). HRV was originally used as a measure for physical fitness, with high HRV linked to better recovery and better overall fitness levels (Stevenson, et al., 2021). More recently, however, HRV has been used as a common measure for psychophysiological functioning. For example, HRV is sensitive and responsive to acute stress and can be lowered when an individual experiences a change in mental load due to stress, such as complex decision making and public speaking (Singh, et al., 2018). HRV has been linked to the concept known as self-regulatory strength, which is the ability to exert self-control and alter one's natural response tendencies (Baumeister & Heatherton,

1996; Segerstrom & Solberg Nes, 2007). HRV can be indicative of healthy function and inherent self-regulatory capacity. For example, it has been observed that individuals who have low HRV are more likely to have symptoms associated with stress and anxiety (McCraty & Schaffer, 2015). During times of mental stress, there can be a higher frequency of HRV, which is prevalent due to the respiration caused by the Respiratory Sinus Arrhythmia (RSA; Singh, et al., 2018). When considering the R-R interval, an increase in stress was associated with an increase in the distance between each R peak (Kim, et al., 2019). Additionally, there are several physical diseases and ailments that are related to chronic psychological stress (e.g., cardiovascular disease, metabolic syndrome, and chronic respiratory disease) that are also associated with low HRV (Prinsloo, et al., 2014). High HRV can be indicative of an individual's ability to better regulate their emotions, while low HRV can be associated with the body's inability to cope with internal and external stressors (Mather & Thayer, 2018; Kim, et al., 2018).

HRV is an index of vagal tone activity, which provides cardiac regulation to self-regulatory behaviors at the cognitive, emotional, social and health level (Laborde, et al., 2017). In social situations, HRV has been found to predict severity of psychosocial stress experienced by an individual based on HRV levels. Individuals with high HRV experienced lower levels of psychosocial stress compared to individuals with low HRV. (Lischke, et al., 2018). It is necessary to study this interaction as lower HRV has been associated with all-cause deaths and a higher risk of cardiovascular events in patients with cardiovascular disease (Fang, et al., 2020).

Culture and Stress Response

While culture is a complex construct, it is not based solely on ethnic or racial backgrounds. Cultural value differences in the stress response have previously been reported. Work by Miller and Kirschbaum (2019) found that when comparing harmony

vs mastery, qualities found within collectivists and individualists, countries prioritizing harmony (peace/unity with the world around them) over mastery (ambition/social recognition) were more likely to have elevated stress levels (i.e., cortisol levels) in response to a psychosocial stressor. Countries that preferred mastery over harmony (e.g., United States) resulted in a decrease in cortisol responses during a stress event (Miller and Kirschbaum, 2019). Moreover, work by O'Connor & Shimizu (2002) found that collectivists (i.e., Japanese participants), experienced higher perceived stress in comparison to individualists (i.e., British participants). It is important to note that although these relationships have been observed, collectivism and individualism was assessed based on country of origin and cultural identification (e.g., self-identified as Japanese, British), which research suggests is not always the best predictor of individualism and collectivism (Chiao et al., 2009).

Culture, HRV, and Stress Response

Other psychophysiological biomarkers have been used to measure the relationship between stress and culture. In a study by Yang and colleagues (2014), they investigated if there was a link between self-esteem and the endocrine stress response in Chinese students. The participant pool all identified as a part of the collectivistic culture, suggesting a high regard for social approval. Participants were exposed to the Trier Social Stress Test (TSST), a social stressor, where they gave a speech and performed mental arithmetic in front of a committee for a ten-minute period. It was found that compared to the baseline measurement there was an increase in salivary cortisol 20 minutes after the TSST. Additionally, there was an increase in heart rate during the TSST stimulation and it immediately dropped back to baseline once the stressor was complete. They found that participants' self-esteem was positively correlated with their heart rate and salivary cortisol stress responses. Another study by Hu and colleagues (2018) compared low

interdependent self-construal to high interdependent self-construal and found that during a social stressor (TSST), individuals that reported higher interdependent self-construal displayed increased heart rate and reported a higher subjective report of stress during the TSST, as compared to those reporting lower interdependent self-construal. Additionally, there was a higher increase in salivary cortisol after the social stressor in those reporting higher interdependence, as compared to those reporting lower interdependence (Hu, et al., 2018).

Culture, HRV, and Stress Response

While stress and culture have been measured through a multitude of different lenses, only a small number of studies have incorporated psychophysiological measurements such as HRV. For example, a study performed by Noah and colleagues (2015) investigated the relationship between stress and level of cooperation between partners while performing a game task. They compared individualist and collectivist groups and their HRV frequency during the task. While the Japanese participants cooperated significantly better than the American participants, even with similar skill levels between the two groups, the Japanese participants displayed a higher level of LF/HF HRV compared to their American counterparts. Psychological stress has been found to be significantly associated with increase in the LF/HF ratio, as this suggests an increase in the SNS activity levels (Kim, et al., 2018).

Although there have been studies measuring the relationship between the culture and psychophysiological biomarkers, there is a lack of data surrounding heart rate variability and the stress response in the context of the cultural constructs of independence and interdependence. Determining if the between cultural trait values can aid in the treatment of stress as it leads to the possibility of disease and death

susceptibility if the stress is prolonged past the individual's capacity (Hey-Geum, et al., 2018) is imperative.

Chapter Summary

It is well established that cultural values influence stress, however, little research has investigated the psychophysiological underpinnings of these processes. Different effects of acute stress on psychophysiological biomarkers have been reported with individuals of different cultures (e.g., cortisol), yet there has been little to no psychophysiological research investigating stress reactivity in the context of cultural self-construal of independent and interdependence, much less investigating heart rate variability. Therefore, the current study investigated whether differences due to individualist and collectivist culture traits (i.e., independence, interdependence) exist in psychophysiological processing (i.e., heart rate variability) and during the stress response.

Aim 1 of the current study was to investigate the relationship between heart rate variability (HRV), a well-known psychophysiological correlate of emotion and stress, and the cultural constructs of collectivism of individualism (i.e., independent and interdependent self-construal traits). It was hypothesized that individuals who are interdependent (collectivistic) will have lower HRV as compared to those who are independent (individualistic). Work by Souza-Talarico and colleagues (2014) found cortisol differences between collectivist and individualist groups before a stressor. Collectivists were found to have higher resting cortisol levels in comparison to individualists. Similarly, it is expected that collectivists in the current study will have intrinsically lower resting HRV as compared to individualists.

Aim 2 of the current study was to investigate if there was a relationship between the HRV response following an acute stressor and independent and interdependent self-construal traits. It was hypothesized that interdependent (collectivist) individuals will

display a smaller HRV response (as measured by R-R interval) compared to their independent (individualist) counterparts. This is based on the work by Kirschbaum and colleagues (2019), which found collectivist values were found to be associated with an increase in cortisol after the stressor.

CHAPTER II:

METHODS

Participants

Twenty-eight adults between the age of 19 and 62 years old (M=28.4, SD=10.8) participated in the current study. Regarding gender, participants identified as either male (17.9%) or female (82.1%). For ethnicity, participants identified themselves as either Hispanic/Latinx (57.1%), White (21.4%), Black/African American (7.1%), Asian (3.6%), or Other (10.7%). Participants were recruited through the University of Houston-Clear Lake SONA online participant pool. Participants were required to pass a health screening to be considered eligible prior to enrollment. Compensation for their participation in the study was through SONA course credit.

Materials

Self-Construal Scale

The Self-Construal Scale (SCS; Singelis, 1994) measures the independence and interdependence traits of an individual and is used as a measure of individualism and collectivism. Self-construal is defined as the individual's cognitive representation of themself; coined to describe the cultural variation in which people conceptualize and understand themselves (Raj, et al., 2018). Work by Chiao and colleagues (2009) determined that cultural identification is not always the best predictor of individualism and collectivism, therefore the self-construal scale was used to measure independence and interdependence as it relates to individualistic and collectivistic traits. The SCS consists of 30 statements of different feelings and behaviors through a variety of situations related to independence and interdependence. The self-construal scale consists of two subscales: independent and interdependent. Independent traits are measured through statements such as "My personality, independent of others, is very important to

me". The interdependent trait subscale consists of statements like "My happiness depends on the happiness of those around me". Participants rate their level of agreement from 1 (strongly disagree) to 7 (strongly disagree) with each item on the scale.

The calculation of the participants' SCS index is a composite score calculated as the total score of the interdependent subscale subtracted from the total score of the independent subscale. Using this equation, SCS will be used as a continuous measure ranging from -X to +Y, with higher scores indicating more independence and lower scores indicating more interdependence. Additionally, participants will also be categorized as belonging either to the individualism or collectivism group. Following Chiao and colleagues (2009), participants who have a positive composite score on the SCS index will be placed in the independent trait (individualist) group. Participants who have a negative composite score will be placed in the interdependent (collectivist) trait group.

Acute Stressor

The Trier Social Stress Test (Kirschbaum, et al., 1993) is a well-validated stressor designed to induce a state of acute psychosocial stress. It consists of a 10-minute anticipation period followed by a 10-minute test period. Within the test period the participant reads a speech prompt and is instructed to deliver a five-minute speech in front of a panel of judges. To increase the individual's stress response, they will be informed that the five-minute speech will be recorded. Following the five-minute speech, the participant will be asked to perform mental arithmetic. Additionally, participants will be informed that the five-minute speech will be recorded.

Short Stress State Questionnaire

The Short Stress State Questionnaire (SSSQ; Helton, 2004) aims to measure task engagement, distress, and worry. It consists of 24-items rated on a Likert scale from 1 (a

little bit) to 5 (extremely). The SSSQ has both pre- and post-test questionnaires that are administered before and after a stressor, respectively. The pre-questionnaire contains statements about how the participant feels at the current moment such as “I am dissatisfied” or “I am irritated”. The post-questionnaire contains statements about how the participant feels about the task they completed, such as “I feel confident in my abilities” and “I feel self-conscious”. It measures three qualities in both the pre and posttest such as, task engagement, task worry, and task distress.

Perception of Stressor

The Perception of Stressor (Shank, 2019) was crafted as a manipulation check for the participants’ rating of the laboratory stressor during the recovery period to determine if they thought the stressor task was stressful. It consists of five questions total, four of which ask how stressed, sad, anxious, and angry they felt during the task. The first four items are rated on a Likert scale from 1-7. The final question asks if they have completed a similar task to the one performed during the laboratory experiment.

HRV Measurements

Recordings of analog arbitrary units (wave function) will be captured through the Polar H10 monitor. Data will then be analyzed with the Kubios HRV software (https://www.kubios.com/scientific-research/) as it provides analyses for time-domain, frequency-domain, and nonlinear HRV parameters. Additionally, Kubios HRV will provide robust beat detection, noise handling, and beat correction algorithms. R-R interval will be used as a metric for HRV, as well as average HR.

Procedure

The protocol was approved by the University of Houston - Clear Lake’s Committee for the Protection of Human Subjects. Upon arrival, participants completed an

informed consent form. Following consent, participants were instructed to rest for 10 minutes. The participants then completed the Self-Construal Scale and other demographic questionnaires. Baseline HRV data was collected continuously for 10 minutes as the participant sat and rested in a seated position. Following baseline HRV data collection, participants were given the pre-test version of the Short-Stress State Questionnaire (SSSQ). Participants were then moved to a testing room to complete the Trier Social Stress Test. HRV measurements were collected continuously for ten minutes during the TSST. Following the cessation of the TSST, participants were placed back into the waiting room for a recovery period. During this recovery period, participants were given the post-test version of the SSSQ to measure how they felt during the TSST. Following the SSSQ, participants were given the Perception of Stressor questionnaire to determine how they felt about the stressor. After participants completed the recovery period, they were debriefed.

Data Analysis

For Aim 1, linear regressions were conducted to assess the relationship between measures of HRV (R-R interval) and SCS index. A linear regression was also used to investigate the relationship between average HR and SCS index. Additionally, using the dichotomized SCS-index, *t*-tests were used to further investigate if there are differences in HRV and HR measurements between collectivists and individualists. For Aim 2, a 2 (collectivist, individualist) x 2 (stress, no stress) mixed-model ANOVA was used to measure the interaction of stress and cultural orientation on HRV and HR measurements following the Trier Social Stress Test. A repeated measure ANCOVA was also used to further determine whether the raw scores for SCS index impact change in HRV after a social stressor. Baseline and stress HRV measurements were entered as the dependent variable with SCS index as the covariate. A repeated measures ANOVA was also used to

determine if there was a difference in pre to post task engagement, worry, and distress dimensions of the Short Stress State Questionnaire.

CHAPTER III:

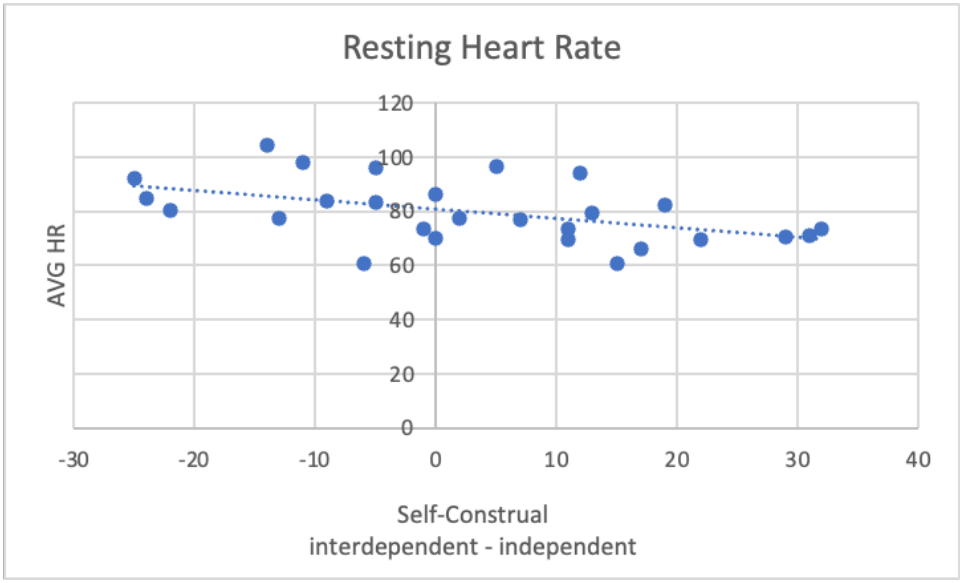
RESULTS

Resting Heart Rate and HRV (Aim 1)

Twenty-eight participants volunteered for the current study, but one participant was excluded due to loss of heart rate data. This left a total of twenty-seven participants for linear regression analyses. A linear regression was used to determine if there was a relationship between HRV and the cultural constructs of individualism and collectivism, as measured by the SCS index. It was found that heart rate (R^2 = .239, F(1,25) = 7.87, p = .010) was predicted by SCS index. Moreover, it was found that R-R intervals (R^2 = .227, F(1,25) = 7.34, p = .012) were significantly predicted by SCS index (See Figures 1 and 2).

Figure 1.

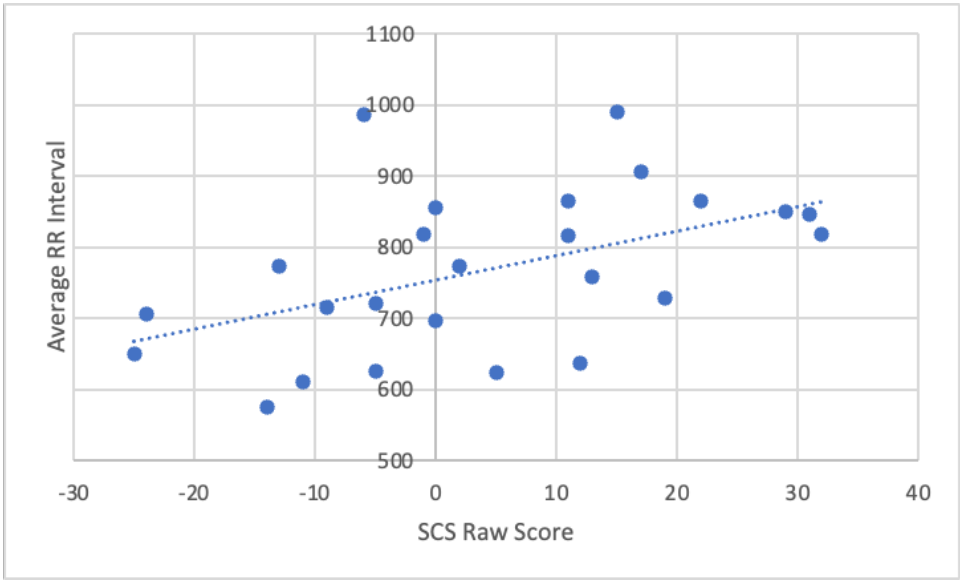
Linear Regression for Resting Heart Rate and SCS



Note: Each dot represents an individual participant.

Figure 2.

Linear Regression for Resting R-R interval and SCS



Note: Each dot represents an individual participant.

Table 1.

Linear Regression Results for Resting HRV Metrics

	R^2	*F*	*p*
Heart rate	.239	7.87	.010
R-R interval	.227	7.34	.012

Independent sample t-tests were used to determine if there were any differences in resting HRV measurements between those categorized as individualists or collectivists based on dichotomized SCS index. Of the twenty-eight participants that volunteered for the current study, two participants were excluded for scoring a zero on the SCS-index and therefore were unable to be categorized into the collectivistic or individualistic groups.

Additionally, one participant was excluded due to loss of heart rate data. This left a total of twenty-five participants for t-test analyses. Of these 25 participants, 11 met the criteria to be categorized as interdependent/collectivists, and 14 met the criteria to be categorized as independent/individualists.

There was a significant difference found between SCS groups (i.e., individualists, collectivist) for average HR ($t(23) = -2.08$, $p = .049$, with collectivists ($M = 85.0$, $SD = 12.3$) having higher baseline heart rates as compared to individualists ($M = 75.8$, $SD = 9.93$). There were no significant differences between individualists and collectivists for resting R-R interval, $t(23) = 1.95$, $p = .063$)

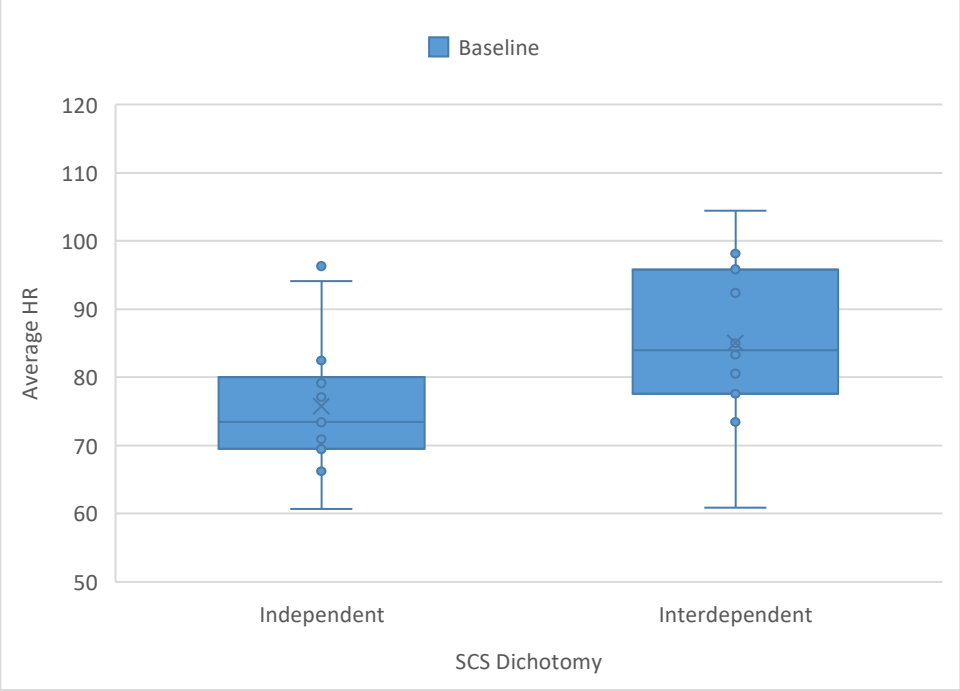
Table 2.

Mean and Standard Deviation Resting Data

Variable	Collectivist		Individualist	
Gender				
Male		0	4	
Female		11	10	
	Mean	SD	Mean	SD
R-R Interval	721	114	804	98.6
Heart Rate	85.02	12.32	75.77	9.93

Figure 3.

Average Heart Rate Between Independent and Interdependent Groups



Acute Stressor (Aim 2)

25 total participants were involved in the acute stressor analysis as participants were categorized as individualists or collectivists based on dichotomized SCS index. A 2 (collectivist, individualist) by 2 (resting, stressor) mixed model ANOVA was performed with heart rate as the dependent variable. There was a significant main effect found for SCS group ($F(1,23) = 6.10$, $p = .021$, $np^2 = .210$) and stress ($F(1,23) = 35.23$, $p < .001$, $np^2 = .605$), however, there was no interaction between stress and SCS ($F(1,23) = 1.35$, $p = .257$, $np^2 = .055$). Post-hoc analyses showed that collectivists ($M = 91.9$; $SE = 3.49$) displayed higher overall heart rates as compared to individualists ($M = 80.4$; $SE = 3.09$), $t(23) = -2.47$, $p = .021$. Additionally, heart rate ($M = 80.4$; $SE = 2.22$) increased after the stressor (M = 91.9; SE = 2.79, $t(23) = -5.94$, $p < .001$.

A 2 (collectivist, individualist) x 2 (resting, stressor) mixed model ANOVA was performed with R-R interval (HRV) as the dependent variable. There was a significant main effect found for SCS group ($F(1,23) = 5.36$, $p = .030$, $np^2 = .189$) and stress ($F(1,23) = 44.32$, $p < .001$, $np^2 = .658$), however, there was no interaction between stress and SCS ($F(1,23) = .263$, $p = .613$, $np^2 = .011$). Post-hoc analyses showed that individualists ($M = 761$; $SE = 25.9$) displayed higher overall R-R intervals as compared to collectivists ($M = 671$; $SE = 29.2$), $t(23) = 2.32$, $p = .030$. Additionally, R-R interval ($M = 762$; $SE = 21.3$) was higher after the stressor ($M = 670$; $SE = 20.0$), $t(23) = 6.66$, $p < .001$.

A 2 (collectivist, individualist) x 2 (resting, stressor) mixed model ANOVA was performed with the SSSQ measure of task engagement as the dependent variable. There was a significant main effect found for stress ($F(1,23) = 28.64$, $p < .001$, $np^2 = .555$) but not for SCS group ($F(1,23) = 5.36$, $p = .030$, $np^2 = .189$) nor was there an interaction between stress and SCS group ($F(1,23) = .263$, $p = .613$, $np^2 = .011$). Post-hoc analyses showed that participants reported task engagement ($M = 27.9$, $SE = 1.31$) decreased after the stressor ($M = 20.4$, $SE = 1.56$), $t(23) = 5.35$, $p < .001$.

A 2 (collectivist, individualist) x 2 (resting, stressor) mixed model ANOVA was performed with the SSSQ measure of distress as the dependent variable. There was a significant main effect found for stress ($F(1,23) = 9.28$, $p = .006$, $np^2 = .288$) but not for SCS group ($F(1,23) = .253$, $p = .620$, $np^2 = .011$) nor was there an interaction between stress and SCS group ($F(1,23) = .0158$, $p = .901$, $np^2 = .001$). Post-hoc analyses showed participants reported that distress ($M = 12.2$, $SE = 1.01$) increased after the stressor ($M = 18.6$, $SE = 1.84$), $t(23) = -3.05$, $p = .006$.

A 2 (collectivist, individualist) x 2 (resting, stressor) mixed model ANOVA was performed with the SSSQ measure of worry as the dependent variable. There was no significant main effect found for stress ($F(1,23) = .112$, $p = .741$, $np^2 = .005$), nor for SCS

group ($F(1,23) = .193$, $p = .665$, $np^2 = .008$), nor was there an interaction between stress and SCS group ($F(1,23) = 1.212$, $p = .282$, $np^2 = .050$).

An independent sample t-test found that there were no significant differences between SCS groups for perception of stressor-stress ($t(23) = .880$, $p = .388$), perception of stressor-anxious ($t(23) = -1.453$, $p = .160$), nor perception of stressor-anger ($t(23) = -.160$, $p = .874$). The perception of stressor-sad violated the assumption of equal variances, therefore a Welch's t-test was used. There was no significant effect found for SCS on perception of stressor-sad ($t(10.4) = -1.970$, $p = .076$).

Given that SCS index can also be used as a continuous measure as opposed to dichotomized, repeated-measures ANCOVAs were also used to compare the resting and stressor HRV measurements while controlling for the SCS as a covariate. A 2 (collectivist, individualist) x 2 (resting, stressor) repeated-measures ANCOVA with heart rate as the dependent variable and SCS as a covariate was conducted. There was a significant effect for SCS on heart rate ($F(1, 25) = 11.3$, $p = .003$, $np^2 = .312$), a main effect for stress on heart rate ($F(1,25) = 44.15$, $p < .001$, $np^2 = .638$), however, no interaction between SCS and stress ($F(1,25) = 1.98$, $p = .171$, $np^2 = .074$). Post-hoc analyses showed that SCS is correlated with heart rate ($r = -.987$, $p < .001$), and that there was an increase in heart rate ($M = 79.7$, $SE = 1.97$) after the stressor ($M = 91.9$, $SE = 2.49$), $t(25) = -6.49$, $p < .001$, however, SCS does not modify this change.

A 2 (collectivist, individualist) x 2 (resting, stressor) repeated-measures ANCOVA with HRV R-R interval as the dependent variable and SCS as a covariate was also conducted. There was a significant effect for SCS on R-R interval ($F(1, 25) = 9.74$, $p = .0035$, $np^2 = .280$), a main effect for stress on R-R interval ($F(1,25) = 50.192$, $p < .001$), however, no interaction between SCS and stress ($F(1,25) = .120$, $p = .732$, $np^2 = .005$. Post-hoc analyses showed that SCS is correlated with R-R interval ($r = .476$, $p = .012$),

and that there was a decrease in R-R intervals (M = 768, SE = 18.9) after the stressor (M = 670, SE = 18.1), $t(25) = 7.17$, $p < .001$, however, SCS does not modify this change.

Table 3.

Aim 2 Perception of Stressors Group Descriptive Statistics

	Group	N	*M*	*SD*
POS: Stress	individualist	14	3.36	1.336
	collectivist	11	3.82	1.250
POS: Sad	individualist	14	1.07	.267
	collectivist	11	2.09	1.700
POS: Anxiety	individualist	14	3.36	1.447
	collectivist	11	4.09	.944
POS: Anger	individualist	14	1.64	1.216
	collectivist	11	1.73	1.421

Table 4.

Aim 2: Perception of Stressor Independent Sample t-test

		t-statistic	*df*	*p*
POS: Stress	Student's *t*	-.880	23.0	.388
POS: Sad	Welch's *t*	-1.970	10.4	.076
POS: Anxiety	Student's *t*	-1.453	23.0	.160
POS: Anger	Student's *t*	-.160	23.0	.874

CHAPTER IV:

DISCUSSION

The current study investigated whether differences due to individualist and collectivist culture traits (i.e., independence, interdependence) exist in psychophysiological processing (i.e., heart rate, heart rate variability) and during the stress response. Each participant was exposed to the stressor through the TSST, and average HR and RR-interval values were collected and analyzed. Overall, the study found that there was no significant difference of stress reactivity between individualists and collectivists, however, a significant relationship was found between the individualism/collectivism and the psychophysiological measures of resting HR and resting RR-interval, an index of HRV.

More specifically, the first aim of this study was to determine if there was a relationship between resting HRV and the cultural constructs of collectivism and individualism, as measured by the SCS index. The current study found that the SCS index predicted resting heart rate and resting R-R interval, a proxy of HRV. For resting heart rate, a lower score on the SCS index (i.e., more collectivistic values) was predictive of higher resting heart rate. Conversely, for R-R interval (HRV), a lower score on the SCS index (i.e., more collectivist values) was predictive of higher R-R intervals, that is, suggesting increased heart rate variability. Given the typical inverse relationship between cortisol and HRV, these findings are consistent with a study that reported resting cortisol differences between independent and interdependent groups (Souza-Talarico, 2014) Nonetheless, the current findings suggest that cultural values, measured through self-construal scale, affected resting heart rate and R-R interval measurements.

The second aim of the study was to determine if there was a difference between individualists and collectivists and stress reactivity, as measured by changes in HR, HRV,

and self-reported measures of stress. The present study's results did not support this hypothesis and found no differences between groups. These findings are inconsistent with a study that found these metrics showed consistent differences between no stress and stress phases for short-term analyses (Pereira, et al., 2017).

Study Limitations

A major limitation for the study was the small sample size of the participants. 28 participants were recruited for the study, but two were dropped because they scored a zero on the Self-Construal Scale and the third was dropped for lost heart rate data during data collection. Moreover, the sample was predominantly female and had an average age group of 28.4. The small sample size may not have provided enough power to yield significant results between the two groups compared throughout.

Suggestions for Future Research

The current study begins to contribute to the growing literature regarding the stress reactivity differences in individuals who align themselves with either individualist or collectivist values. Future research should include HRV metrics that fall into the frequency-domain (LF/HF Ratio, HF, LF) and time-domain measurements (SDNN, RMSSD, pNN50). Time-domain analyses measure HR variation over longer time measurements and typically indicate PNS input. Frequency-domain measurements are for short term time measurements that signify either PNS or SNS branches (Kim, et al., 2018). Future research should also the HRV recovery measurements should be recorded to see if there are any differences between groups. Regarding the sample distribution, female participants are more likely to display a lower mean R-R interval, SDNN, and LF/HF ratio HRV measurements than male counterparts (Kim, et al., 2017; Koenig & Thayer, 2016). To counteract this, more male participants should be recruited for future studies. Future research should also consider the effect of social ties and social support on

HRV in tandem with a stressor through the lens of culture. Gerteis & Schwerdtfeger (2016) found that during social interactions with low social support there was an attenuation with HRV. By contrast, when the individual perceived a strong sense of support, HRV increased significantly. Lastly, for future studies, a larger sample size is recommended to increase power levels for analyses.

This study calls attention to the importance of assessing individual differences and the impact of cultural values on psychophysiological measures in tandem with stress reactivity. The differences in psychophysiological underpinnings that can be based on self-construal allow for a deeper and more thorough understanding of positive and negative effects life experiences that may not have been previously investigated.

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