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# RSA in Young Adults: Identifying Naturally-Occurring Response Patterns and Correlates

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# RSA in Young Adults: Identifying Naturally-Occurring Response Patterns and Correlates

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# Dedication

To my husband, my tiny human, and my fur baby.

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**Abstract**

Few studies have focused on the joint contributions of baseline and stress-responsive RSA on mental health outcomes, and no research to date has examined naturally-occurring profiles of RSA, which may be more predictive of emotion regulation ability and mental health outcomes than looking at either component of RSA alone. Participants were 235 (87.1% female, 73.6% Caucasian) undergraduates ages 18-39 ($M$ = 19.62, $SD$ = 2.12). In Part 1, latent growth mixture modeling (LGMM) was used to identify naturally-occurring physiological profiles accounting for both resting and stress-reactive RSA among young adults. In Part 2, multivariate ANCOVAs were used to predict 18 variable outcomes, specifically state and trait negative affect, depressive symptoms, and multiple emotion regulation techniques. Part 1 analyses supported the identification of four RSA response profiles described by baseline/slope characteristics: moderate/moderate ($N$ = 183; $M$[intercept] = 6.72; $M$[slope] = -1.09), moderate/high ($N$ = 10; $M$[intercept] = 7.31; $M$[slope] = -1.71), moderate/augmenting ($N$ = 17; $M$[intercept] = 6.09; $M$[slope] = 0.77), and high/moderate ($N$ = 25; $M$[intercept] = 8.10; $M$[slope] = -0.99). Part 2 analyses yielded significant results, so effect sizes were utilized to identify trends on outcome variables. The moderate/moderate group appeared to be normative, with both capacity and sufficient response to environmental demands. The moderate/high and moderate/augmenting profiles differed most consistently from all other groups. The moderate/high profile demonstrated generally adaptive outcomes, with lower depression and NA; and higher brooding, social support, and thought suppression. In contrast, the moderate/augmenting profile demonstrated less adaptive emotion regulation overall, showing higher avoidance, acceptance, and thought suppression; and lower problem solving, social support, and expressive suppression.

Because the most variable component of the groups was the responsive RSA (e.g., moderate, high, or augmenting), it may be that this is an important defining factor in a profile when considering psychological outcomes. Results support clinicians considering biological strengths and vulnerabilities in case conceptualization, as well as coaching in effective engagement and appropriately modulated responses to life stressors.

**RSA in Young Adults: Identifying Naturally-Occurring Response Patterns and Correlates**

## Chapter I: Introduction and Literature Review

Respiratory sinus arrhythmia (RSA) is an index of parasympathetic activity and has been used as a biological marker of emotion regulatory capacity and response (Beauchaine 2001; Butler, Wilhelm, & Gross, 2006; Mezulis, Crystal, Ahles, & Crowell, 2015). High resting RSA (indicating high parasympathetic influence on heart rate in a resting state) is suggestive of high regulation capacity, and has been associated with lower negative affectivity, fewer depressive symptoms, and more adaptive emotion regulation strategies (Beauchaine, 2001; Mezulis et al., 2015). In contrast, low resting RSA (indicating low parasympathetic influence on heart rate in a resting state) is suggestive of lower regulatory capacity, and has been associated with higher negative affect, more depressive symptoms, and maladaptive emotion regulation strategies (Beauchaine, 2001; Mezulis et al., 2015). Furthermore, RSA can be used as an index of parasympathetic responsiveness; RSA withdrawal in response to stress would indicate withdrawal of parasympathetic influences as a person responds to environmental conditions. Although results are somewhat inconsistent, some studies have demonstrated greater RSA reactivity (greater withdrawal) to stress to be associated with lower internalizing symptoms and lower negative affect (Yaroslavsky, Rottenberg, & Kovacs, 2013).

There are individual differences in baseline RSA and in RSA reactivity that have been associated independently with psychological correlates and mental health outcomes. However, there are naturally-occurring patterns of physiological responding across both baseline and stress conditions that have associations with psychological outcomes. Few studies have examined the joint contributions of both baseline RSA and RSA reactivity. Certain patterns of RSA responding may be more predictive of an individual's ability to regulate state negative affect, depressive symptoms, and use of emotion regulation strategies than looking only at their resting RSA or RSA stress reactivity alone.

The purpose of the current study is to identify naturally-occurring patterns of resting and stress-reactive RSA among a young adult population, and to identify correlates of these RSA profiles, specifically negative affect, depressive symptoms, and use of emotion regulation strategies.

## Respiratory Sinus Arrhythmia as an Index of Emotion Regulatory Capacity

### Polyvagal theory: Cardiac indices of parasympathetic nervous system activity.

Being able to measure and interpret physiological data relies not only on the ability to detect and gather this data accurately, but also on an understanding of the underlying mechanisms connecting autonomic nervous system arousal and psychological responses. Porges' polyvagal theory (Porges, 1995, 2007) suggests that underlying neurophysiological processes regulate psychological and behavioral processes; these processes mediate individual responses to stress, and that the neurophysiological state prior to experiencing a stressor promotes or limits reactivity during stress. Furthermore, polyvagal theory states that the functioning of the autonomic nervous system is related to behavior bidirectionally through afferent and efferent communication between the heart and central nervous system. Afferent pathways convey information back to the autonomic nervous system, which enables the autonomic nervous system to not only respond to the environment but also restore homeostasis (Porges, 2007; Thayer & Lane, 2000). This theory also suggests that the functioning of the autonomic nervous system is closely linked to social behavior, emotional expression, and psychological experience (Diamond & Hicks, 2005; Porges, 1995, 2007).

The autonomic nervous system is divided into the sympathetic and parasympathetic nervous systems. The sympathetic nervous system allows the body to respond to challenges and stressors, while the parasympathetic nervous system promotes restoration and conservation of energy. Although there are times when both systems are activated (e.g., sexual arousal), the two systems often operate antagonistically or orthogonally; when one is activated, the other is depressed (withdraws) to meet external and internal demands on the body (Beauchaine, 2001; Porges, 1995, 2007). Thus, in a time of rest, the parasympathetic nervous system is activated, working to maintain homeostasis in the body, including growth and restoration processes. The parasympathetic nervous system has been conceptualized as a type of brake, providinng an inhibitory effect on heart rate during times of rest. Upon exposure to a stressor, the parasympathetic nervous system withdraws, letting go of the brake, allowing the sympathetic nervous system to respond to the stimulus and prepare the body for fight or flight responses. The parasympathetic nervous system then reasserts its influence, restoring homeostasis, upon removal of the stressor (Porges, 1995, 2007).

Parasympathetic influences on heart rate are regulated by the brainstem via the vagus nerve, the $10^{th}$ cranial nerve, which operates independently of the spinal cord (Beauchaine, 2001; Porges, 1995). High vagal tone indicates high parasympathetic influence on the heart via the myelinated vagal pathways originating in the nucleus ambiguus, and inhibits and regulates the sinoatrial node of the heart, the heart’s pacemaker. Low vagal tone, either at baseline or in response to the environment, indicates a release of the vagal brake and little to no inhibition of the sinoatrial node of the heart (Porges, 2007; Thayer & Lane, 2000). Theoretically, a disruption in homeostasis, or exposure to a stressor, would similarly disrupt the regulation of the vagus nerve, reducing vagal tone, and these changes would be indicative of a stress response. Similarly, a lack of vagal regulation at baseline may indicate a lack of regulatory capacity in response to, and management of, the effects of stress (Porges, 1995). The vagus nerve also regulates muscles in the face and neck, suggesting a link between regulation of the heart, emotional expression, and social interaction and bonding (Geisler, Kubiak, Siewert, & Weber, 2013).

A lack of parasympathetic influence at baseline may indicate a lack of response capacity; similarly, a lack of parasympathetic withdrawal during a stressor may indicate a lack of response to the environment. Both types of response may indicate difficulties with regulatory capacity and response. Polyvagal theory suggests, then, that higher baseline parasympathetic influence indicates a higher capacity for response to the environment (i.e., stressors) and would be adaptive. In contrast, lower baseline parasympathetic influence indicates a lower capacity for response to the environment and would be less adaptive. However, there are also variations in how much one responds to the environment, even independent of one's baseline regulatory capacity.

**RSA: Definition.**

Porges' polyvagal theory provides the foundation for the use of cardiac vagal tone as a physiological index of parasympathetic nervous system activity. Heart rate variability (HRV) is defined as the differences in the length of the cardiac cycle (the time between heart beats) over time (Beauchaine, 2001; Porges, 1995; Vasilev, Crowell, Beauchaine, Mead, & Gatzke-Kopp, 2009). Respiratory sinus arrhythmia (RSA) is a measure of naturally-occurring high-frequency HRV (HF-HRV) across the breathing cycle accounting for the influence of respiration on HRV, specifically heart rate increasing during inhalation and decreasing during exhalation (Beauchaine, 2001; Magagnin et al., 2010; Porges, 2007; Rottenberg, Gross, & Gotlib, 2005a; Vasilev et al., 2009). RSA is considered an index of parasympathetic nervous system activity;

RSA is an index of cardiac vagal tone, or the presumed influence of the vagus nerve on heartrate. RSA can reflect a baseline level of cardiac vagal tone, as well as changes in cardiac vagal tone during response to environmental demands (Beauchaine, 2001; Porges, 2007).

Although polyvagal theory indicates that RSA is a good index of cardiac vagal tone, and thus parasympathetic nervous system activity, one limitation is that it does not fully account for other influences on RSA, such as feedback provided by efferent vagal pathways or direct sympathetic nervous system influences on the heart (Beauchaine, 2001; Butler et al., 2006; Porges, 2007). It is thus important to remember that RSA is not a precise measure of total cardiac vagal tone, but rather an index.

**Biological marker of emotion regulation.**

An increasing body of literature suggests RSA is a biological measure of environmental engagement, emotion regulatory capacity, and emotional response across the life span (Butler et al., 2006; Demaree, Robinson, Everheart, & Schmeichel, 2004; Diamond & Hicks, 2005; Thayer & Lane, 2000). Responding to a situation that elicits high emotions is functional, as it requires the body to respond the same way as if there was danger/threat (Beauchaine, 2001). Although parasympathetic nervous system activity cannot be measured directly, RSA can be used as a proxy for measuring vagal tone, or the influence of the vagus nerve on the heart at rest and in response to stimuli. When RSA is high, parasympathetic influences are high. When RSA is low, parasympathetic influences are low (Beauchaine, 2001; Porges, 1995, 2007). Tonic (or baseline) levels of RSA are conceptualized as reflecting a temperamental level of emotion regulatory capacity. Changes in RSA when responding to stimuli are conceptualized as a reflection of emotion regulation and mood (Beauchaine, 2001; Butler et al., 2006; Porges, 1995; Vasilev et al., 2009). During a stress response, parasympathetic influences withdraw, leading to lower RSA, which allows a person to respond physiologically to the stressor. These physiological processes have been proposed to both reflect and contribute to emotion regulation capacity and emotional responses (Brosschot & Thayer, 1998; Diamond & Hicks, 2005).

**Measurement of RSA.**

RSA can be easily and noninvasively measured. Electrocardiogram (ECG) electrodes are attached to a participant’s skin to continuously detect a heartbeat and derive an electrocardiogram, measured at .15-.40 Hz. From the ECG, high-frequency heart rate variability (HF-HRV) is calculated by measuring the distance between consecutive R peaks in milliseconds. Time domain filters are then applied during data analysis, allowing for the extraction of RSA data (Beauchaine, 2001; Magagnin et al., 2010; Porges, 1995, 2007; Rottenberg, Salomon, Gross, & Gotlib, 2005b). RSA has been successfully measured in humans (infants, children, adolescents, and adults) and other species (including rodents and mammals; Beauchaine, 2001; Porges, 1995; Vasilev et al., 2009).

## RSA at Baseline, Response, and in Combination

**Correlates of baseline RSA.**

When conceptualized as an indicator of capacity for emotion regulation and response to the environment, higher baseline RSA indicates a higher response capacity, while lower baseline RSA indicates a lower response capacity (Beauchaine, 2001; Butler et al., 2006; Porges, 1995, 2007; Rottenberg, Wilhelm, Gross, & Gotlib, 2002). In general, the literature tends to demonstrate this pattern, with negative emotional traits being related to low RSA, or a deficiency in resting cardiac vagal tone, and positive emotional traits being related to high RSA.

Across the life span, RSA serves as an index of appropriate environmental engagement and emotion regulation, with higher RSA considered better for engagement and regulation.

Infant studies suggest that high RSA infants are more responsive to the environment – both to positive and negative stimuli. High RSA in infants has been shown to be correlated with emotional expressiveness, emotional and behavioral reactivity, and higher attentional capacity (Beauchaine 2001; Gazelle & Druhen, 2009). Studies indicate that children with higher baseline RSA tend to have fewer negative emotions, better behavior regulation, and have more developed social skills (for a review, see Beauchaine, 2001). Furthermore, RSA moderates the relationship between family stress (including marital hostility) and peer conflict; children with high baseline RSA tend to have less peer conflict than their lower RSA peers (Porges, 2007). Higher baseline RSA also correlated with higher emotional expression in children and adults (Demaree et al., 2004).

In adolescent studies, lower baseline RSA tends to be related to aggression (in boys), depression, anxiety, and disordered eating (Diamond & Hicks, 2005). Baseline RSA associated with emotional awareness in youth, and increases in RSA over time is associated with better emotion regulation over time (Vasilev et al., 2009). Interestingly, some studies suggest that it is the higher capacity for response that is adaptive; both children and adults with higher resting RSA demonstrate more emotion, both positive and negative (Butler et al., 2006; Porges, 2007).

In adults, higher baseline RSA is related to self-reported decrease in negative emotions in response to stress (Porges, 2007). Low RSA is related to marital conflict, while high RSA is related to relationship attachment security and perceived social support (Diamond & Hicks, 2005; Schwerdtfeger & Shlagert, 2011; Smith et al., 2011). Furthermore, young adults with higher RSA are more likely to use emotion regulation strategies that involve engagement and executive functioning (e.g., social-support seeking, reappraisal, and positive self-talk) and less likely to use disengagement strategies (e.g., avoidance; Geisler et al., 2013; Geisler, Vennewald, Kubiak, & Weber, 2010; Pu, Schmeichel, & Demaree, 2010; Vogele, Sorg, Studtmann, & Weber, 2010), particularly when dealing with stressors. In response to emotional stimuli, high RSA is related to facial response and expression in adults (Demaree et al., 2004).

Low baseline RSA is related to poorer coping and difficulty with self-regulation (Porges, 1995; Rottenberg et al., 2005a). It is related to a number of negative outcomes, including depressive and anxiety disorders (Beauchaine, 2001; Butler et al., 2006; Thayer, Friedman, & Borkovec, 1996), worry and rumination (Hofmann, Moscovitch, Litz, Kim, Davis, & Pizzagalli, 2005), emotional rigidity, hostility, alcoholism, and difficulty with impulse control (Beauchaine, 2001; Beauchaine, Katzke-Kopp, & Mead, 2007; Brosschot & Thayer, 1998; Butler et al., 2006; Demaree & Everhart, 2004; Geisler et al., 2013; Ingjaldsson, Laberg, & Thayer, 2003; Rechlin, Weis, Spitzer, & Kaschka, 1994; Rottenberg et al., 2005a; Sloan et al., 2001; Watkins, Grossman, Krishnan, & Sherwood, 1998). Furthermore, individuals with panic disorder have exhibited even lower baseline RSA than individuals with depression (Beauchaine, 2001; Thayer et al., 1996). Existing hypotheses state that low RSA is related to depression, or at least more severe depression, but results in the literature are mixed. Some have found low RSA predicting worse depression or sooner relapse after depression treatment (Balogh, Fitzpatrick, Hendricks, & Paige, 1993; Chambers & Allen, 2002; Karpyak, Rasmussen, Hammill, & Mrazek, 2004), while others have found low RSA predicting more mild depression (Rottenberg et al., 2002; Rottenberg et al., 2005b).

**Correlates of RSA withdrawal.**

RSA withdrawal is conceptualized as an index of changes in cardiac vagal tone in response to a stimulus, or the withdrawal of parasympathetic nervous system influence when responding to the environment. It is conceptualized as an indicator of physiological and emotional response to the environment, including self-regulatory efforts (Beauchaine, 2001; Butler et al., 2006; Porges, 1995, 2007). Theoretically, a lack of RSA withdrawal during stimulus response would indicate a lack of appropriate response to the environment, and having greater RSA withdrawal would indicate a more adaptive response. However, the literature on RSA withdrawal remains mixed.

More RSA reactivity is proposed to be more adaptive and protective against psychopathology; for instance, individuals with anxiety and trauma-related disorders have been shown to have low RSA reactivity (Cohen et al., 2000; Rottenberg et al., 2005a; Thayer et al., 1996). Cardiac vagal tone has also been shown to be related to several psychological outcomes and impairment, including depression. Depressed participants with high vagal withdrawal in response to watching a sad film (sad mood induction) were more likely to recover from depression 6 months later, compared to those who exhibited less withdrawal. (Rottenberg et al., 2005b). One study illustrated that, in adults, less physiological reactivity to acute psychological stress was associated with higher depression scores several years later, even when controlling for initial depressive symptoms, sociodemographic factors, and medication status (Phillips, Hunt, Der, & Carroll, 2011). Those with higher physiological reactivity, in other words, those who were responding to the environment, had lower depression scores several years later.

Moderate withdrawal likely indicates adequate/appropriate engagement to the environment and the sympathetic nervous system being ready to respond, to both positive and negative emotional stimuli (Butler et al., 2006); however, disproportionate withdrawal, especially in context of having a low RSA baseline, may be adaptive in situations of danger, but maladaptive because these individuals experience fight-or flight reactions during psychological and cognitive tasks/challenges. Excessive vagal reactivity is characteristic of emotional lability, particularly with regards to panic and anger (Beauchaine, 2001). A combination of lower baseline RSA and a lack of RSA withdrawal has also been shown in depressed individuals when compared with healthy controls (Rottenberg, Clift, Bolden, & Salomon, 2007).

**Naturally-occurring response profiles.**

Research focusing on baseline RSA or RSA withdrawal alone has had mixed results, but generally tends to suggest that high baseline RSA is adaptive, since it represents the capacity for environmental engagement and response, while either an excess or lack of RSA withdrawal is maladaptive, since it represents an inappropriate degree of reactivity. However, we know little about the frequency of specific response patterns or their unique associations with emotion regulation and mental health outcomes. For these purposes, focusing on a single index of physiological responding in relationship to outcomes is likely too narrow. It is important to consider both an individual's response capacity and their actual response style in more fully understanding psychophysiological vulnerabilities and outcomes; individuals who are similar on one physiological measure may differ on related measures, which may have specific and significant implications for mental health outcomes (Yaroslavsky et al., 2013).

Few studies have looked at baseline RSA and RSA withdrawal together. One study demonstrated that RSA baseline and reactivity, when looked at independently, were unassociated with depression; however, their interaction predicted levels of depressive symptoms. Specifically, for participants with high resting RSA, RSA withdrawal while watching a sad film predicted best outcomes (lowest depression), when controlling for past depression (Yaroslavsky et al., 2013a). Yaroslavsky and colleagues (2013) demonstrated that the combination of baseline and reactive RSA predicted maladaptive mood regulation, but not adaptive mood regulation. It may be that there isn't just an interaction between baseline and responsive RSA, but rather a set of response profiles, combining these constructs, that are more or less adaptive when responding to stressors in the environment (Yaroslavsky et al., 2013).

## Examining RSA Response Profiles in Relation to Negative Affect, Depressive Symptoms, and Emotion Regulation

### Negative affect.

Negative affect can broadly be conceptualized as the experience of psychological distress (Mroczek & Almeida, 2004). Examples of negative affect include feelings of sadness, hopelessness, agitation, anxiety, hostility, and anger (Heponiemi, Ravaja, Elovainio, & Keltikangas-Jarvinen, 2007). Heightened negative affect is characteristic of anxiety and depressive disorders, among other psychopathology and negative health outcomes (Leger, Charles, Turiano, & Almeida, 2016; Mroczek & Almeida, 2004; O'Neill, Cohen, Toplin, & Gunthert, 2004).

Negative affect can be measured at both a trait and state level. Trait negative affect is the temperamental tendency to experience negative emotional states, to become easily distressed, and to have a negative view of the self (Watson & Clark, 1984). High trait negative affect is significantly related to negative behavioral and psychological outcomes (Hussong & Chassin, 1994; Leger et al., 2016). Neuroticism, a personality trait characterized by more pronounced negative affect and the tendency to form negative appraisals of situations, has been shown to be negatively associated with cardiovascular health (Smith & MackKenzie, 2006; Suls & Bunde, 2005) and is associated even more specifically with cardiovascular reactivity to stress (Jonassaint et al., 2009). Individuals high in neuroticism have been shown to have muted initial cardiovascular stress responses compared to peers lower in neuroticism (Hughes, Howard, James, & Higgins, 2010). This may reflect lower motivation to engage with stressor task to begin with (Dobson, 2000; Hughes et al., 2010). Furthermore, individuals high in neuroticism tend to experience higher levels of negative affect in response to daily stressors than peers lower in neuroticism (Leger et al., 2016; Mroczek & Almeida, 2004).

At a state level, negative affect is experienced in response to environmental stressors, both actual and perceived (Mroczek & Almeida, 2004). High negative affect is strongly associated with a number of adjustment difficulties and psychopathologies, such as hostility, depression, and anxiety (Besser, Flett, & Hewitt, 2004; Flett, Blankstein, & Hewitt, 2009; Healy, Treadwell, & Reagan, 2011; Heponiemi et al., 2007; O'Neill et al., 2004). Negative affect is broadly associated with perfectionism, but more specifically associated with socially prescribed perfectionism, or the expectation that others expect perfection from an individual (Besser et al., 2004; Flett et al., 2009). This suggests that expectations about the demands of a situation may be associated with increased state negative affect. It is important to examine negative affect in context of stress responding, since overall, individuals report higher negative affect and lower positive affect when faced with stressors (Almeida, 2005; Bolger & Schilling, 1991; Leger et al., 2016; Mroczek et al., 2015; Mroczek & Almeida, 2004; Neupert, Almeida, & Charles, 2007; Scott, Ram, Smyth, Almeida, & Sliwinski, 2017). Changes in negative affect in response to even minor stressors are significantly related to increased health risks, including future mood disorders, developing chronic health conditions, and increased mortality; this relationship is particularly strong for those with heightened negative affect in response to stress (Cacioppo, 1998; Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013; Cohen, Gunthert, Butler, O'Neill, & Tolpin, 2005; O'Neill et al., 2004; Piazza, Charles, Sliwinski, Mogle, & Almeida, 2013; Scott et al., 2017).

High levels of negative affect may negatively impact the ability to utilize appropriate emotion regulation techniques, but being able to appropriately respond physiologically to a stressor may act as a buffer. Low vagal tone is associated with difficulty in emotion regulation, including increased aversive responses to environmental stimuli, particularly, threatening stimuli (Beauchaine, 2001; Bornas et al., 2004; Gorka et al., 2012). Lower resting RSA has been shown to be not only associated with heightened threat sensitivity (Melzig, Weike, Hamm, & Thayer, 2009), but even more strongly associated when threats were unpredictable as opposed to predictable (Gorka et al., 2012). Theoretically, a responsive autonomic nervous system, as indexed by RSA, would help an individual respond appropriately to environmental stimuli, particularly those that represent a threat. RSA withdrawal would be an appropriate response to dealing with increased negative affect from such stimuli, e.g., a stressor (Healy et al., 2011).

**Depressive symptoms.**

Depression is a significant global health concern characterized by depressed, dysphoric, or blunted mood, arousal and appetite and energy changes, distress, and impairment (American Psychiatric Association, 2013; Kim, Shin, & Song, 2015; Yaroslavsky et al., 2013). It affects almost 20% of the American population and is the leading cause of psychiatric hospitalizations (Rottenberg et al., 2005b; Rottenberg et al., 2007; Rubio et al., 2011; Yaroslavsky et al., 2013). Furthermore, it is the leading cause of disability, absenteeism, and reduced productivity in the workplace worldwide (Jonas, Brody, Roper, & Narrow, 2003; Rubio et al., 2011; U.S. Department of Health and Human Services, 1999). Lifetime prevalence of a major depressive episode in young adults (ages 17-39) in the United States is estimated to be at 8.6% to 16.6%, and lifetime prevalence of any mood disorder is estimated at 11.5% (Jonas et al., 2003; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). Prevalence of depression may be up to 75%

higher in women than men, and disproportionately affect individuals from low income families (Jonas et al., 2003; Kim et al., 2015). Depressive symptoms often onset in adolescent years, and confer risk for increased functional impairment prospectively (Pettit, Hartley, Lewinsohn, Seeley, & Klein, 2013; Yaroslavsky et al., 2016; Zisook et al., 2007). In college students ages 18-24 years, up to 35% of females and 25% of males reported elevated depressive symptoms (Whisman & Richardson, 2015).

Unfortunately, most individuals with depression, including college students, do not seek help, and most people reporting a history of a major depressive episode have had (and continue to have) recurrent episodes and an increased risk for comorbid nonaffective disorders (Jonas et al., 2003; Kessler et al., 2012; Whisman & Richardson, 2015; Yaroslavsky et al., 2016; Zisook et al., 2007). Furthermore, it is important to note that while a depression diagnosis indicates clinically significant distress and/or impairment, subsyndromal levels of depression also have similar comorbidities and negative health outcomes (Dimsdale, 1997; Jonas et al., 2003; Jonas, Franks, & Ingram, 1997; Judd, 2000). The current study will focus on depressive symptoms, rather than diagnosis, in a sample of college students.

Depression may be related to multiple kinds of parasympathetic nervous system activity deficits, including deficits in resting RSA (low) and stimuli-responsive RSA (lack of withdrawal or increase in RSA; Hughes et al., 2010; Rottenberg et al., 2007; Yaroslavsky et al., 2013; Yaroslavsky et al., 2016). In a study of adults without coronary disease, mildly depressed individuals exhibited more RSA withdrawal during a stressful task than non-depressed individuals, suggesting that individuals with higher depression scores may exhibit different parasympathetic responses to stressful environmental stimuli (Hughes & Stoney, 2000). An exaggerated withdrawal of parasympathetic influences when responding to a stressor may reflect an exaggerated response to perceived threatening situations in depression. This same study found that there were no differences in baseline RSA between mildly- and non-depressed adults (Hughes & Stoney, 2000). Other studies have also found blunted stress responding in participants with higher depression scores (Carroll, Phillips, Hunt, & Der, 2007; York et al., 2007).

**Emotion regulation strategies.**

Emotion regulation refers broadly to the ability to control and modify affect in response to emotionally arousing environmental stimuli (Gross & John, 2003; Healy et al., 2011). The type of emotion regulation strategies regularly employed by individuals can affect not only the experience and expression of emotions, but physical and mental health as well (Gresham & Gullone, 2012; Hu, Zhang, & Wang, 2014). Difficulties in emotion regulation has been identified as a vulnerability for both internalizing and externalizing psychopathology, social adjustment, and problematic behaviors (Beauchaine, 2001; Rueda, Posner, & Rothbart, 2005; Vasilev et al., 2009). Specifically, emotion regulation difficulties are related to depression and anxiety (Hu et al., 2014; Rottenberg et al., 2005a) and have been demonstrated in youth currently, previously, and at risk for being depressed (Bylsma et al., 2015; Thompson et al., 2010; Yaroslavsky et al., 2016).

Maladaptive emotion regulation is problematic in the sense that the attempt at attenuating negative emotions may actually prolong or worsen the negative affect. The use of maladaptive emotion regulation techniques is characteristic of depressed versus healthy individuals and can even predict relapse of depressive symptoms (Kovacs, Rottenberg, & George, 2009; Stone, Hankin, Gibb, & Abela, 2011; Yaroslavsky et al., 2016). Conversely, normative RSA patterns are linked with the use of more adaptive emotion regulatory processes, such as distraction, reappraisal, and seeking social support, and greater benefit from utilizing such techniques (Geisler et al., 2013; Volokhov & Demaree, 2010; Yaroslavsky et al., 2016). A significant link between stress and employment of maladaptive emotion regulation techniques has been demonstrated for both same-day technique use and weekly (prospective) technique use (Yacono, Freeman, & Gil, 2004), suggesting that in the face of stress, some individuals may be more vulnerable to using maladaptive emotion regulation techniques both immediately and cumulatively. Furthermore, the relationship between stress and maladaptive emotion regulation has been shown across multiple types of distress, including performance-related, relational, academic, and occupational stressors (Hilt, Cha, & Nolen-Hoeksema, 2008; Salafia & Lemer, 2012).

RSA is thought to reflect both an emotion regulation capacity (at baseline) and response (withdrawal). Higher RSA withdrawal is associated with higher emotional arousal, particularly in stressful conditions (Gracanin, Kardum, & Hudek-Knezevic, 2016; Healy et al., 2011; Thayer & Lane, 2000). Additionally, RSA may actually increase during a task when participants are instructed to use particular emotion regulation techniques (Gracanin et al., 2016). For example, the use of techniques such as suppression, reappraisal, and effortful self-control is associated with increases in RSA (Butler et al., 2006; Gracanin et al., 2016; Thayer & Lane, 2000). RSA is related to a tendency to engage in particular patterns of emotion regulation. Specifically, atypical RSA patterns are related to a trait level of maladaptive emotion regulation and reduced benefits from instructed mood repair in a laboratory setting; these maladaptive techniques mediate the relationship between RSA response patterns and depressive symptoms (Yaroslavsky et al., 2016).

## The Current Study

### Purpose.

My dissertation has two parts. My aim in part one was to use latent growth mixture modeling (LGMM) to identify naturally-occurring patterns of resting and stress-reactive RSA among young adults. I anticipated extracting six unique groups which vary on both resting RSA (low/high) and RSA reactivity to stress (low/moderate/high). My aim in part two was to examine predicted outcomes of the unique profiles of RSA responding, specifically negative affect, depressive symptoms, and emotion regulation strategies.

### Hypotheses.

I hypothesized that certain RSA response profiles would be associated with patterns of negative affect, depressive symptoms, and emotion regulation strategies. For example, I expected that profiles marked by a low regulatory capacity (i.e., low baseline RSA) and either a lack of response to the environment or an overresponse to the environment (i.e., low or high RSA withdrawal) would be the least adaptive, and would be characterized by high NA, high depressive symptoms, and poor emotion regulation strategies. In contrast, I expected that profiles marked by a high regulatory capacity (i.e., high baseline RSA) and appropriate response to the environment (i.e., moderate RSA withdrawal) would be the most adaptive, and would be characterized by low NA, low depression, and adaptive emotion regulation strategies. Outcomes characteristic of the remaining three profiles, if shown in the LCA, were to be further explored. Theoretically, profiles marked by low baseline RSA and moderate RSA withdrawal were thought to indicate a low regulatory capacity with moderate response to the environment, or an adaptive response. Furthermore, profiles marked by high baseline RSA were thought to indicate a high response capacity, with profiles characterized by either low or high RSA withdrawal in context of high baseline RSA thought to be maladaptive, with their withdrawal patterns indicating a lack of or excess response to the environmental stressor. A complete summary of my hypotheses can be found in the figure below.

| | Low Withdrawal | Moderate Withdrawal | High Withdrawal |
|---|---|---|---|
| Low Baseline RSA | Low regulatory capacity; not responding to stress/environment (maladaptive)<br><br>High depression<br><br>Low state NA<br><br>Poor emotion regulation strategies<br>• Higher in passive ER (avoidance/suppression)<br>• Lower in active ER (brooding/problem solving/acceptance) | Low regulatory capacity; responding somewhat to stress/environment | Low regulatory capacity; overresponding to stress/environment (maladaptive)<br><br>High depression<br><br>High state NA<br><br>Poor emotion regulation strategies<br>• Higher in active ER (brooding/problem solving)<br>• Lower in passive ER (avoidance/suppression/thought suppression) |
| High Baseline RSA | High regulatory capacity; not responding to stress/environment | High regulatory capacity; responding to stress/environment (adaptive)<br><br>Low depression<br><br>Moderate state NA<br><br>Adaptive emotion regulation strategies<br>• Higher in active ER (problem solving/acceptance/brooding)<br>• Lower in passive ER (avoidance/suppression) | High regulatory capacity; overresponding to stress/environment |

*Figure 1*. Hypothesized naturally-occurring RSA response profiles and predicted outcomes.

# Chapter II: Method

## Participants

Participants were 235 (87.1% female, 12.9% male) undergraduates ages 18-39 (*M* = 19.62, *SD* = 2.12) recruited from a university in the U.S. Pacific Northwest. Regarding race, 73.6% of participants were Caucasian, 11.5% were Asian American, 3.5% were African American, 1.8% were Pacific Islander, .9% were Native American, and 8.8% identified as Other. Seven percent of participants were Hispanic/Latino. Participants were eligible for the study if they were enrolled in the general psychology course and were at least 18 years old. Participants received course credit for completing the study. An a priori power analysis for ANCOVA was conducted using G*Power, and determined that the sample size required would be 211 participants for an effect size of .25 at the .05 significance level.

## Procedure

The current study is part of a larger ongoing study being conducted by the Adolescent Cognition and Emotion (ACE) Lab at Seattle Pacific University, titled Stress and Somatic Symptoms in Young Adults (SASSY). All study procedures and materials for SASSY were approved by the Seattle Pacific University institutional review board (IRB #141502023R). Below, I will detail only the procedures relevant to my dissertation.

Participants enrolled in the study online via the SONA platform used by Seattle Pacific University, after which students completed an online baseline questionnaire to provide basic demographic information. Upon completing the baseline questionnaire, participants were eligible to sign up for a laboratory visit conducted by a trained graduate researcher. After the laboratory visit, participants completed six additional online questionnaires that include measures of depressive symptoms. Participants then completed the battery of six questionnaires every two days for approximately two weeks, allowing collection of longitudinal depressive symptoms and emotion regulation data.

During the laboratory visit, informed consent was reviewed with and signed by the participant. Next, the researcher attached three electrodes to the participant's skin (one on each collarbone; one on the bottom left rib). Each sensor was connected via a lead to a Biopac MP 150 Data Acquisition System (Biopac Systems, Inc., Goleta, CA). ECG signals were recorded throughout the visit using AcqKnowledge 4.4 software. Participants then completed a paradigm including measures of state affect, baseline RSA (recorded while participants watch a series of nature scenes), and RSA withdrawal (recorded during a stress induction task). In the stress induction task, participants were told they had two minutes to prepare a speech that they may or may not have to present to the researcher. Following the allotted writing time, participants were informed that they did not have to give their speech (no participants were required to give their speech). At the end of the laboratory visit, participants were debriefed about the use of deception and told that no participants would have had to give their speech, as well as provided with several resources supporting the use of this task for stress induction. The total duration of the lab visit was approximately 90 minutes.

## Measures

### Respiratory sinus arrhythmia (RSA).

RSA data was collected via pre-gelled disposable Ag/AgCl electrodes placed on the chest and abdomen using a Lead II configuration. ECG was amplified and continuously sampled at a gain of 1000 Hz using the Biopac MP150 Data Acquisition System (Biopac Systems, Inc., Goleta, CA). ECG data was recorded using AcqKnowledge 4.4 software, then transformed and analyzed within the MindWare HRV 3.1.3 computer application. The MindWare HRV program identified interbeat (R-R) intervals and improbable intervals using an algorithm, after which all data files were visually scored and screened and manually corrected, as needed, by trained graduate students. RSA was scored in 30-second epochs. RSA was averaged across four minutes for the baseline task and averaged across two minutes for the stress induction task. RSA baseline was represented by the mean of RSA responses during the four-minute baseline task. RSA withdrawal was calculated by subtracting the mean of baseline RSA responses from the mean of stressor RSA responses. Negative change scores reflected vagal withdrawal, and positive change scores reflected vagal augmentation.

**Negative affect.**

*Trait Negative Affect.* Trait negative affect was measured at baseline via the Negative Affect super scale of the Adult Temperament Questionnaire-Short Form (ATQ-SF; Evans & Rothbart, 2007). The Negative Affect scale consists of 28 of the 58 items on the ATQ-SF. Scales of the Negative Affect factor include fear, sadness, frustration, and discomfort. Participants indicated the level each statement applied to them on a Likert scale ranging from 1 (*Extremely untrue of you*) to 7 (*Extremely true of you*) for items such as “I become easily frightened,” “Sometimes minor events cause me to feel intense sadness,” and “It doesn’t take very much to make me feel frustrated or irritated.” The Negative Affect super scale score is obtained by calculating the mean of the four scales; higher scores indicate greater trait negative affect. The scales on the ATQ each show reliability and convergent and divergent validity, and Cronbach’s alpha for the Negative Affect scales ranges from .72 to .80 (Evans & Rothbart, 2007). Cronbach’s alpha for the present study was .82.

*State Negative Affect.* State negative affect was measured before and during the stressor task, and in daily follow-up questionnaires (for a total of 8 times) via the negative affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The negative affect subscale consists of 10 of the 20 items on the PANAS. Participants indicated the level each emotion applied to them on a Likert scale ranging from 1 (*Very slightly or not at all*) to 5 (*Extremely*) for items such as “Distressed,” “Ashamed,” “Guilty,” and “Nervous.” The negative affect scale score is obtained by calculating the mean of the scale items, with higher scores indicating higher state negative affect. The negative affect scale shows good convergent and divergent validity and test-retest reliability. Cronbach’s alpha for the negative affect scale is .87 and is relatively stable across time periods assessed (i.e., affect in the moment, affect today, and affect in the past few days; Watson et al., 1988). The mean Cronbach’s alpha for the present study averaged .92, with a range of .90 to .94.

**Depressive symptoms.**

Depressive symptoms were measured at baseline via the Center for Epidemiological Studies Depression Scale (CESD; Radloff, 1977) and in daily follow-up questionnaires via the Center for Epidemiological Studies Depression Scale-Short Form (CESD-SF; Martens et al., 2006). The CESD consists of 20 items, and the CESD-SF consists of 9 items. Participants indicated the level each statement applied to them on a Likert scale ranging from 0 (*Rarely or none of the time; less than 1 day*) to 3 (*Most or all of the time; 5-7 days*). Scores are obtained by calculating the mean of all items, with higher scores indicating increased depressive symptoms. Scores of 16 or above on the CESD, and 5 or above on the CESD-SF, are generally used as a cutoff for classifying individuals with MDD, although these cutoffs often result in false positives, or classifying individuals as depressed when they do not meet full criteria (Martens et al., 2006). Cronbach’s alpha for the CESD ranges from .84 to .90, indicating good internal consistency. Test-retest reliability falls between .45 and .70, with larger correlations found for shorter time intervals between administrations (Radloff, 1977). Cronbach's alpha for the present study was .90 at baseline; for state measures, Cronbach's alpha ranged from .84 to .87 with a mean of .86.

**Emotion regulation**.

*Avoidance.* Trait avoidance was assessed at baseline via the Brief Experiential Avoidance Questionnaire (BEAQ; Gamez et al., 2014). The BEAQ consists of 15 items and assesses an individual's avoidance of distressing thoughts, emotions, and physical sensations. Participants responded to items on a Likert scale ranging from 1 (*Strongly disagree*) to 6 (*Strongly agree*) for items such as "I'm quick to leave any situation that makes me feel uneasy" and "I try to put off unpleasant tasks for as long as possible." Scores are obtained by calculating the mean for all items. Internal consistency is good, ranging from .80 in student populations to .89 in community populations. Cronbach's alpha for the present study was .84. State avoidance was assessed in daily follow-up questionnaires via an event-anchored BEAQ, consisting of 5 items and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .84, with a range of .79 to .89.

*Brooding.* Trait brooding was assessed at baseline via the brooding subscale of the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991). The brooding subscale consists of 5 of the 22 items on the RRS and assesses the tendency to ruminate on negative emotion. Participants responded to items on a Likert scale ranging from 1 (*Almost never*) to 4 (*Almost always*) for items such as "…think 'What am I doing to deserve this?'" and "…think 'Why do I always react this way?'" A score for brooding is obtained by calculating the mean of the items on the brooding subscale. Cronbach's alpha for the RRS was .90, and test-retest reliability was .67 (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Cronbach's alpha for the present study was .75. State brooding was assessed in daily follow-up questionnaires via an event-anchored RRS, consisting of 5 items and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .81, with a range of .74 to .85.

*Expressive Suppression.* Trait expressive suppression was assessed at baseline via the expressive suppression subscale of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). The suppression subscale consists of 4 of the 10 items on the ERQ and measures the degree to which individuals suppress the expression of emotions in the way they talk and behave. Participants responded to items on a Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*) for items such as "I control my emotions by not expressing them" and "I keep my emotions to myself." A score is obtained by calculating the mean of the items on the suppression subscale, with higher scores indicating increased suppression. Cronbach's alpha for the suppression subscale ranges from .68 to .76 (Gross & John, 2003). Cronbach's alpha for the present study was .76. State expressive suppression was assessed in daily follow-up questionnaires via an event-anchored ERQ, consisting of 4 items and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .83, with a range of .81 to .85.

*Acceptance.* Trait acceptance was assessed at baseline via the acceptance subscale of the Cognitive Emotion Regulation Questionnaire (CERQ; Garnevski, Kraaij, & Spinhoven, 2001). The acceptance subscale consists of 4 of the 36 items on the CERQ. Participants responded to items on a Likert scale from 1 (*Almost never*) to 5 (*Almost always*) for items such as "I think that I have to accept that this has happened" and "I think that I must learn to live with it." A score is obtained by calculating the mean of the items on the subscale, with higher scores indicating increased acceptance. Cronbach's alpha for the acceptance subscale is .76 and test-retest reliability is .51 (Garnefski & Kraiij, 2007). Cronbach's alpha for the present study was .80. State acceptance was assessed in daily follow-up questionnaires via an event-anchored CERQ, consisting of 4 the items in the acceptance subscale and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .89, with a range of .84 to .92.

*Problem Solving.* Trait problem solving was assessed at baseline via the problem solving/behavioral coping subscale of the Good Behavior Self-Control Measure (GBSCM; Wills et al., 2013). The problem solving subscale consists of 8 of the 44 items on the GBSCM. Participants responded to items on a Likert scale from 1 (*Never*) to 5 (*Usually*) for items such as "I think hard about what steps to take" and "I make a plan of action and follow it." A score is obtained by calculating the mean of the items on the subscale, with higher scores indicating increased problem solving. Cronbach's alpha for the present study was .91. State problem solving was assessed in daily follow-up questionnaires via an event-anchored GBSCM, consisting of 4 the items in the problem solving subscale and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .89, with a range of .86 to .92.

*Social Support.* Trait social support was assessed at baseline via the social support subscales (instrumental and emotional) of the COPE Inventory (COPE; Carver, Scheier, & Weintraub, 1989). The social support subscales consist of 8 of the 60 items on the COPE. Participants responded to items on a Likert scale from 1 (*I usually don't do this at all*) to 4 (*I usually do this a lot*) to items such as "I try to get advice from someone about what to do" and "I discuss my feelings with someone." A score is obtained by calculating the mean of the items on the subscale, with higher scores indicating increased social support seeking. Test-retest reliability for the social support subscales range from .64 to .77, and Cronbach's alpha ranges from .75 to .85 (Carver et al., 1989). Cronbach's alpha for the present study was .87. State social support was assessed in daily follow-up questionnaires via an event-anchored COPE consisting of 6 the items in the social support subscale and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .91, with a range of .87 to .93.

*Thought Suppression.* Trait thought suppression was assessed at baseline via the thought suppression subscale of the White Bear Suppression Inventory (WBSI; Altin & Gencoz, 2009; Wegner & Zanakos, 1994). The thought suppression subscale consists of 6 of the 15 items on the WBSI. Participants responded to items on a Likert scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*) to items such as "I do things to distract myself from my thoughts" and "I have thoughts that I cannot stop." A score is obtained by calculating the mean of the items on the subscale, with higher scores indicating increased thought suppression. Cronbach's alpha for the WBSI ranges from .87 to .89, and test-retest reliability ranges from .69 to .92 (Wegner & Zanakos, 1994). Cronbach's alpha for the present study was .89. State thought suppression was assessed in daily follow-up questionnaires via an event-anchored WBSI, consisting of the 6 items on the thought suppression subscale and referencing the participant's reported worst event for that day. The mean Cronbach's alpha for state measures in the present study was .95, with a range of .94 to .97.

# Chapter III: Results

## Part 1: Naturally-Occurring Profiles

For part 1 of my analyses, I used M*plus* 8.0 (Muthén & Muthén, 2015) to perform latent growth mixture modeling and determine naturally-occurring groups based on baseline RSA and RSA withdrawal. M*plus* uses expectation-maximization procedures to estimate individual membership in each group. Latent growth mixture modeling allows the post-hoc identification of latent classes using within-person repeated measures data, allowing both the intercept (baseline) and slope (withdrawal) to vary (Muthen & Muthen, 2016; Wickrama et al., 2016). Analyses were performed iteratively; I began with a null hypothesis of one latent class, then specified increasing numbers of classes, evaluating model fit statistics and group characteristics at each iteration (Muthen & Muthen, 2015; Wickrama, Lee, O'Neal, & Lorenz, 2016). Specifically, I utilized the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC), for which lower values generally indicate increasingly better model fit; the Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (Adj. LMR-LRT), which provides a *p* value reflecting if there is a significant difference between the current model and a model with one less class; and model entropy, which estimates classification accuracy on a scale of 0-1, with values closer to 1 reflecting a more precise classification (Clark & Muthen, 2009; Wickrama et al., 2016). Maximum likelihood estimation within *Mplus* was used to manage missing data. Finally, I examined the characteristics of the resulting profiles (i.e., intercept and slope) to see if the identified profiles made theoretical sense (Berlin, Williams, & Parra, 2014; Brown, 2003; Wickrama et al., 2016).

Evaluation of model statistics and characteristics indicated that a 5-class model provided the best fit for the data (see Table 1). Both AIC and BIC decreased from the 4-class model to the

5-class model, and entropy increased. Although AIC and BIC continued to decrease from the 5-class model to the 6-class model, with entropy increasing further, the 5-class model was ultimately chosen because (a) the Adjusted LMR-LRT was significant for the 5-class model (indicating a better fit than a 4-class model) but not the 6-class model (indicating no additional value in have 6 rather than 5 classes), and (b) in the 6-class model, a class showing an augmenting slope, which had been present in every other iteration of analyses, was no longer present; as this class had been shown to be otherwise consistently present, and because it was the only group to show this response pattern, it seemed a characteristically important group to identify. See Figure 2 for a visual representation of the five identified RSA response styles.

Table 1
*Latent Growth Mixture Model Statistics*

| Classes | AIC | ssBIC | Entropy | Adj. LMR-LRT |
|---|---|---|---|---|
| 1 | 1637.12 | 1639.44 | --- | --- |
| 2 | 1631.55 | 1635.32 | .99 | .2437 |
| 3 | 1625.63 | 1630.85 | .73 | .0077 |
| 4 | 1626.98 | 1633.65 | .61 | .8363 |
| ***5*** | ***1608.24*** | ***1616.36*** | ***.69*** | ***.0000*** |
| 6 | 1606.48 | 1616.05 | .74 | .2875 |
| 7 | 1613.26 | 1624.28 | .78 | --- |

*Note.* AIC = Akaike Information Criterion; ssBIC = Sample Size Adjusted Bayesian Information Criterion;
LMR = Lo-Mendell-Rubin; LRT = likelihood ratio test.
The best-fitting model is in bold italics.

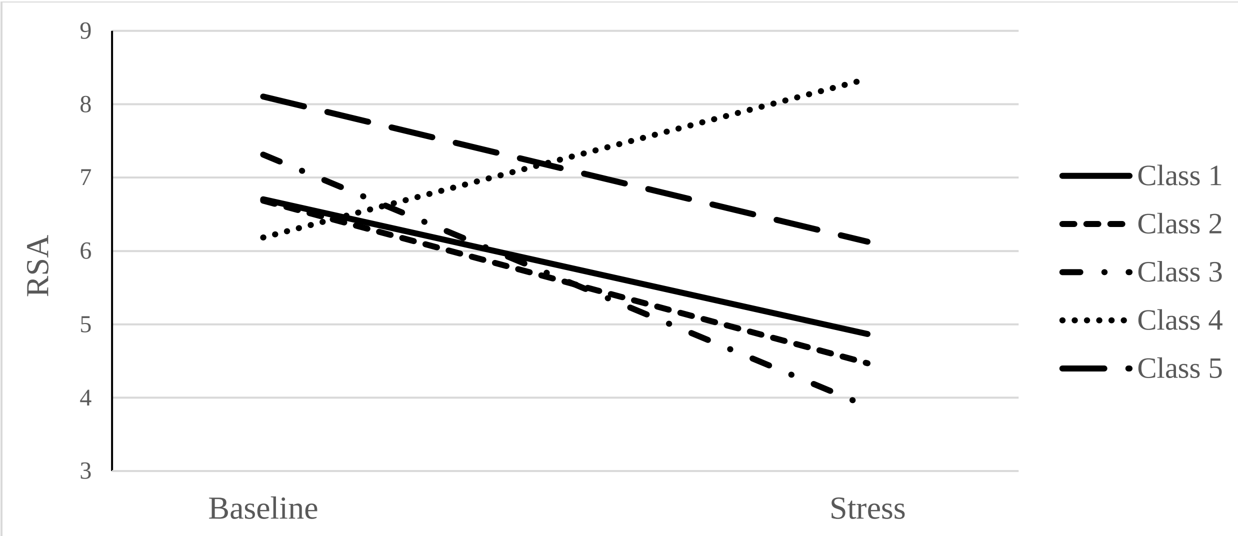


Figure 2. Response pattern of baseline and responsive RSA by identified profile.

Classes were labeled to describe the intercept and slope most descriptive of the class. I labeled Class 1 as moderate/moderate, comprising 41% of the sample and characterized by moderate baseline RSA and moderate withdrawal; Class 2 as moderate/moderate+, comprising 41% of the sample and characterized by moderate baseline RSA and slightly greater withdrawal; Class 3 as moderate/high, comprising 4% of the sample and characterized by moderate baseline RSA and high withdrawal; Class 4 as moderate/augmenting, comprising 3% of the sample and characterized by moderate baseline RSA and augmenting responsive RSA; and Class 5 as high/moderate, comprised of 11% of the sample and characterized by high baseline RSA and moderate withdrawal. Of note, no profiles were identified with low baseline RSA. See Table 2 for descriptive statistics of each response profile.

Table 2

*Descriptive Statistics of Identified Response Profiles*

| Class | *N* | % | Mean Intercept (*SD*) | Mean Slope (*SD*) |
|---|---|---|---|---|
| 1 (moderate/moderate) | 96 | 40.85 | 6.704 (0.486) | -0.918 (0.815) |
| 2 (moderate/moderate+) | 96 | 40.85 | 6.685 (1.233) | -1.108 (0.747) |
| 3 (moderate/high) | 10 | 4.26 | 7.313 (0.405) | -1.716 (1.195) |
| 4 (moderate/augmenting) | 8 | 3.40 | 6.183 (1.741) | 1.081 (0.420) |
| 5 (high/moderate) | 25 | 10.64 | 8.104 (0.415) | -0.989 (0.883) |

A multivariate ANCOVA was run within SPSS 25.0 to compare profile differences on intercept and slope. There was a significant difference in both intercept [$F(1,4) = 17.34$, $p = .000$] and slope [$F(1,4) = 14.74$, $p = .000$] between the profiles. Post hoc tests indicated that Classes 1 (moderate/moderate) and 2 (moderate/moderate+), which represent the expected typical pattern of RSA responding, were the most similar, with no significant difference between them in intercept, and a difference in slope that only trended towards significance. However, Classes 3, 4, and 5 represented significantly different patterns of responding from these normative groups. Class 3 (moderate/high) had a significantly higher intercept than Classes 1, 2, and 4, and a significantly lower intercept than Class 5; Class 3 also had a significantly greater slope of withdrawal than Classes 1, 2, and 4, and a marginally greater slope than Class 5. Class 4 (moderate/augmenting) had a significantly different slope than all other classes, trending upwards (augmenting) rather than withdrawing. Class 5 (high/moderate) had a significantly higher intercept than all other classes, but a significantly greater slope than only Class 4, which differed in the direction of response entirely. See Table 3 for a summary of all post hoc comparisons.

Table 3
*Post Hoc Analyses of RSA Response Profile Differences*

| Dependent Variable | Class (I) | Class (J) | Mean Difference (I-J) | Std. Error | *p* |
|---|---|---|---|---|---|
| Intercept (Baseline RSA) | 1.00 | 2.00 | 0.02 | 0.13 | .889 |
| | | 3.00 | -0.61 | 0.31 | .047 |
| | | 4.00 | 0.52 | 0.34 | .124 |
| | | 5.00 | -1.40 | 0.21 | .000 |
| | 2.00 | 1.00 | -0.02 | 0.13 | .889 |
| | | 3.00 | -0.63 | 0.31 | .041 |
| | | 4.00 | 0.50 | 0.34 | .138 |
| | | 5.00 | -1.42 | 0.21 | .000 |
| | 3.00 | 1.00 | 0.61 | 0.31 | .047 |
| | | 2.00 | 0.63 | 0.31 | .041 |
| | | 4.00 | 1.13 | 0.44 | .010 |
| | | 5.00 | -0.79 | 0.34 | .022 |
| | 4.00 | 1.00 | -0.52 | 0.34 | .124 |
| | | 2.00 | -0.50 | 0.34 | .138 |
| | | 3.00 | -1.13 | 0.44 | .010 |
| | | 5.00 | -1.92 | 0.37 | .000 |
| | 5.00 | 1.00 | 1.40 | 0.21 | .000 |
| | | 2.00 | 1.42 | 0.21 | .000 |
| | | 3.00 | 0.79 | 0.34 | .022 |
| | | 4.00 | 1.92 | 0.37 | .000 |
| Slope (Reactive RSA) | 1.00 | 2.00 | 0.19 | 0.11 | .093 |
| | | 3.00 | 0.79 | 0.26 | .002 |
| | | 4.00 | -1.99 | 0.29 | .000 |
| | | 5.00 | 0.26 | 0.18 | .143 |
| | 2.00 | 1.00 | -0.19 | 0.11 | .093 |
| | | 3.00 | 0.61 | 0.26 | .020 |
| | | 4.00 | -2.19 | 0.29 | .000 |
| | | 5.00 | 0.07 | 0.18 | .699 |
| | 3.00 | 1.00 | -0.79 | 0.26 | .002 |
| | | 2.00 | -0.61 | 0.26 | .020 |
| | | 4.00 | -2.79 | 0.37 | .000 |
| | | 5.00 | -0.54 | 0.29 | .066 |
| | 4.00 | 1.00 | 1.99 | 0.29 | .000 |
| | | 2.00 | 2.19 | 0.29 | .000 |
| | | 3.00 | 2.79 | 0.37 | .000 |
| | | 5.00 | 2.26 | 0.32 | .000 |
| | 5.00 | 1.00 | -0.26 | 0.18 | .143 |
| | | 2.00 | -0.07 | 0.18 | .699 |
| | | 3.00 | 0.54 | 0.29 | .066 |

| | | | | |
|---|---|---|---|---|
| | 4.00 | -2.26 | 0.32 | .000 |

## Part 2: Profiles and Outcomes

### Part 2A: Differences in RSA Classes on Mental Health Outcomes

For part 2 of my analyses, I used SPSS 25.0 to perform multivariate ANCOVAs by identified RSA class on each of 18 outcome variables (negative affect [baseline and daily], depressive symptoms [baseline and daily], and emotion regulation technique [7 each, baseline and daily]). A summary of correlations between variables is found in Table X.

Table 4

Correlation Matrix Showing Pearson's *r* for Demographic, Physiological, and Outcome Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sex | - | | | | | | | | | | | | | | | | | | | | | |
| 2. Age | -.08 | - | | | | | | | | | | | | | | | | | | | | |
| 3. Baseline RSA | -.11 | -.02 | - | | | | | | | | | | | | | | | | | | | |
| 4. RSA withdrawal | .01 | -.08 | -.47** | - | | | | | | | | | | | | | | | | | | |
| 5. Dep. symptoms (trait) | .14* | .01 | .01 | -.13 | - | | | | | | | | | | | | | | | | | |
| 6. NA (trait) | .31** | -.06 | .15* | -.22** | .50** | - | | | | | | | | | | | | | | | | |
| 7. Avoidance (trait) | .20** | .02 | -.02 | -.06 | .39** | .27** | - | | | | | | | | | | | | | | | |
| 8. Brooding (trait) | .00 | -.03 | .07 | -.03 | .19** | .20** | .15* | - | | | | | | | | | | | | | | |
| 9. Expressive sup. (trait) | -.03 | .09 | -.01 | -.09 | .25** | .04 | .37** | .06 | - | | | | | | | | | | | | | |
| 10. Acceptance (trait) | -.01 | -.01 | -.01 | .01 | .18** | .17** | .20** | .11 | .23** | - | | | | | | | | | | | | |
| 11. Problem solving (trait) | -.03 | .11 | .01 | -.04 | -.14* | -.01 | -.12 | -.03 | -.04 | .10 | - | | | | | | | | | | | |
| 12. Social support (trait) | .03 | .05 | .00 | -.07 | -.09 | .17** | -.24** | .00 | -.47** | -.07 | .31** | - | | | | | | | | | | |
| 13. Thought sup. (trait) | .04 | -.13 | -.02 | -.01 | .45** | .29** | .33** | .29** | .22** | .32** | -.10 | -.04 | - | | | | | | | | | |
| 14. Dep. symptoms (state) | .25** | -.07 | -.08 | -.08 | .55** | .35** | .19** | -.18* | .13 | .13 | -.09 | -.06 | .29** | - | | | | | | | | |
| 15. NA (state) | .14 | -.02 | .02 | .01 | .53** | .44** | .28** | .22** | .13 | .18** | -.10 | -.02 | .35** | .54** | - | | | | | | | |
| 16. Avoidance (state) | .21** | -.09 | -.19* | -.01 | .28** | .18* | .23** | .21* | .14 | .11 | .03 | -.16* | .21** | .50** | .30** | - | | | | | | |
| 17. Brooding (state) | .19** | .01 | -.11 | .04 | .47** | .30** | .26** | .02 | .10 | .18* | -.01 | -.06 | .24** | .53** | .49** | .39** | - | | | | | |
| 18. Expressive sup. (state) | .17* | .07 | -.11 | .02 | .28** | .21** | .16* | .10 | .24** | .14 | -.01 | -.06 | .26** | .36** | .38** | .38** | .42** | - | | | | |
| 19. Acceptance (state) | .02 | .13 | -.12 | .05 | .25** | .24** | .13 | .18* | .13 | .35** | .00 | .17* | .29** | .24** | .31** | .11 | .43** | .34** | - | | | |
| 20. Problem solving (state) | .13 | .10 | -.05 | -.02 | .13 | .19** | -.01 | -.04 | -.06 | .06 | .10 | .18* | .00 | .26** | .29** | .08 | .43** | .29** | .43** | - | | |
| 21. Social support (state) | .18* | .05 | -.16* | .02 | .24** | .15* | .10 | -.12 | -.08 | .07 | .04 | .26** | .09 | .43** | .32** | .13 | .48** | .15 | .44** | .57** | - | |
| 22. Thought sup. (state) | .26** | -.08 | -.15* | .02 | .42** | .31** | .30** | -.04 | .17* | .21** | .00 | -.11 | .35** | .62** | .50** | .71** | .60** | .57** | .33** | .34** | .42** | - |

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

No significant differences were found between classes on any of the outcome variables, for either baseline or daily measures (see Table 4). Post hoc analyses similarly yielded no statistically significant differences between groups for any of the outcome variables.

Table 5
*Test of Between-Subjects Effects for Part 2A*

| Source | DV (Trait) | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Class | Depression | 154.009 | 4 | 38.502 | .341 | .850 |
| | NA | .431 | 4 | .108 | .219 | .928 |
| | Avoidance | 340.756 | 4 | 85.189 | .686 | .602 |
| | Brooding | 146.762 | 4 | 36.691 | 1.396 | .236 |
| | Suppression | 3.316 | 4 | .829 | .522 | .720 |
| | Acceptance | 43.567 | 4 | 10.892 | 1.171 | .324 |
| | Problem Solving | 195.862 | 4 | 48.965 | 1.337 | .257 |
| | Social Support | 140.428 | 4 | 35.107 | 1.022 | .397 |
| | Thought Suppression | 81.300 | 4 | 20.325 | .665 | .617 |

| Source | DV (State) | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Class | Depression | 218.936 | 4 | 54.734 | 1.130 | .345 |
| | NA | 17.547 | 4 | 4.387 | .226 | .923 |
| | Avoidance | 28.444 | 4 | 7.111 | .674 | .611 |
| | Brooding | 1.651 | 4 | .413 | .067 | .992 |
| | Suppression | 5.161 | 4 | 1.290 | .372 | .828 |
| | Acceptance | 27.893 | 4 | 6.973 | 1.193 | .316 |
| | Problem Solving | 6.481 | 4 | 1.620 | .283 | .889 |
| | Social Support | 10.794 | 4 | 2.698 | .216 | .929 |
| | Thought Suppression | 75.472 | 4 | 18.868 | 1.104 | .357 |

**Part 2A: Effect Sizes**

It is possible that my relatively small sample size yielded less power to detect significant effects; this problem was likely exacerbated by uneven *N*s in each class with some classes having very small *N*s. Thus, to further understand possible profile differences on outcome variables, I decided to examine effect sizes of these comparisons. For brevity, I have reported below only those comparisons with effect sizes above .30 (see Table 5 for comparisons on trait measures, and Table 6 for comparisons on state measures).

On trait measures, the profiles that differed the most consistently from other profiles were Class 3 and Class 4. Specifically, Class 3 (moderate/high) demonstrated lower baseline depression and NA than all other groups; higher brooding than most other groups, and higher social support and higher thought suppression than some groups. Additionally, Class 4 (moderate/augmenting) demonstrated greater avoidance and higher acceptance than all other groups, lower problem solving and social support than all other groups, and greater thought suppression, but lower expressive suppression than most other groups.

On state measures, profile differences were fewer and slightly more variable. Again, Class 3 (moderate/high) had the most consistent differences, with lower depressive symptoms than all other groups; higher acceptance than all other groups; and lower avoidance, higher expressive suppression, and higher problem solving than some groups. Class 4 (moderate/augmenting) had fewer differences overall, but showed higher negative affect and higher thought suppression than most groups. Class 2 (moderate/moderate+) demonstrated higher thought suppression than Classes 1 and 5, while Class 5 (high/moderate) showed lower avoidance than most other groups. No differences were found between profiles on state brooding.

Table 6

*Effect Sizes of Class Comparisons 2A (Trait)*

| Dependent Variable | (I) Class | (J) Class | Effect Size |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Depression | 3 | 1 | -0.40 |
| | | 2 | -0.48 |
| | | 4 | -0.59 |
| | | 5 | -0.51 |
| Negative Affect | 3 | 1 | -0.35 |
| | | 2 | -0.31 |
| | | 4 | -0.43 |
| | | 5 | -0.39 |
| Avoidance | 4 | 1 | 0.54 |
| | | 2 | 0.46 |
| | | 3 | 0.66 |
| | | 5 | 0.52 |
| Brooding | 3 | 2 | 0.55 |
| | | 4 | 0.67 |
| | | 5 | 0.39 |
| | 4 | 1 | -0.41 |
| Expressive Suppression | 4 | 1 | -0.41 |
| | | 2 | -0.35 |
| | | 3 | -0.39 |
| Acceptance | 4 | 1 | 0.47 |
| | | 2 | 0.59 |
| | | 3 | 0.46 |
| | | 5 | 0.63 |
| Problem Solving | 4 | 1 | -0.52 |
| | | 2 | -0.80 |
| | | 3 | -0.65 |
| | | 5 | -0.85 |
| Social Support | 3 | 1 | 0.44 |
| | | 2 | 0.36 |
| | 4 | 1 | -0.41 |
| | | 2 | -0.49 |
| | | 3 | -0.84 |
| | | 5 | -0.61 |
| Thought Suppression | 3 | 2 | 0.32 |
| | | 5 | 0.45 |
| | 4 | 1 | 0.39 |
| | | 2 | 0.45 |
| | | 5 | 0.60 |

*Note.* Only effect sizes with an absolute value greater than .30 are shown.

Table 7

*Effect Sizes of Class Comparisons 2A (State)*

| Dependent Variable | (I) Class | (J) Class | Effect Size |
|---|---|---|---|
| Depression | 3 | 1 | -0.36 |
| | | 2 | -0.64 |
| | | 4 | -0.71 |
| | | 5 | -0.73 |
| | 5 | 1 | 0.32 |
| Negative Affect | 4 | 1 | 0.44 |
| | | 3 | 0.50 |
| | | 5 | 0.31 |
| Avoidance | 5 | 1 | -0.39 |
| | | 2 | -0.44 |
| | | 4 | -0.39 |
| | 3 | 2 | -0.31 |
| Expressive Suppression | 3 | 1 | 0.33 |
| | | 5 | 0.47 |
| Acceptance | 3 | 1 | 0.61 |
| | | 2 | 0.30 |
| | | 4 | 0.46 |
| | | 5 | 0.42 |
| Problem Solving | 3 | 1 | 0.43 |
| | | 4 | 0.53 |
| Social Support | 4 | 1 | 0.41 |
| Thought Suppression | 2 | 1 | 0.32 |
| | | 5 | 0.35 |
| | 4 | 1 | 0.60 |
| | | 3 | 0.34 |
| | | 5 | 0.62 |

*Note.* Only effect sizes with an absolute value greater than .30 are shown.

**Part 2B: Differences in RSA Classes on Mental Health Outcomes (Collapsed Normative Group)**

Overall, Class 1 (moderate/moderate) and Class 2 (moderate/moderate+) demonstrated relatively similar outcomes on the dependent variables, with only one comparison yielding an effect size of larger than .3. Although these two profiles were identified in Mplus to be different classes, results of the ANCOVA in Part 1 (see Table 3) also showed that these profiles did not differ significantly on either intercept or slope. I decided to see if collapsing these two profiles into one normative group would yield more meaningful differences in terms of my outcome variables of interest. New profiles were labeled as Class 1 (moderate/moderate), Class 3 (moderate/high), Class 4 (moderate/augmenting), and Class 5 (high/moderate).

A multivariate ANCOVA was run to compare profile differences on each of the 18 outcome variables (negative affect [baseline and daily], depressive symptoms [baseline and daily], and emotion regulation technique [7 each, baseline and daily]). Again, no significant differences were found between the 4 classes on any of the outcome variables, for either baseline or daily measures (see Table 7). Post hoc analyses similarly yielded no statistically significant differences between groups for any of the outcome variables.

Table 8
*Test of Between-Subjects Effects for Part 2B*

| Source | DV (Trait) | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Class | Depression | 131.910 | 3 | 43.970 | .391 | .760 |
| | NA | .419 | 3 | .140 | .285 | .836 |
| | Avoidance | 321.766 | 3 | 107.255 | .867 | .459 |
| | Brooding | 45.861 | 3 | 15.287 | .574 | .632 |
| | Suppression | 2.994 | 3 | .998 | .630 | .596 |
| | Acceptance | 28.396 | 3 | 9.465 | 1.015 | .387 |
| | Problem Solving | 100.575 | 3 | 33.525 | .909 | .437 |
| | Social Support | 128.507 | 3 | 42.836 | 1.251 | .292 |
| | Thought Suppression | 71.666 | 3 | 23.889 | .783 | .504 |

| Source | DV (State) | Sum of Squares | *df* | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|---|
| Class | Depression | 9.785 | 3 | 3.262 | .169 | .917 |
| | NA | 106.745 | 3 | 35.582 | .728 | .537 |
| | Avoidance | 27.260 | 3 | 9.087 | .866 | .460 |

| | | | | | |
|---|---|---|---|---|---|
| Brooding | 1.543 | 3 | .514 | .084 | .969 |
| Suppression | 3.527 | 3 | 1.176 | .341 | .796 |
| Acceptance | 12.031 | 3 | 4.010 | .678 | .567 |
| Problem Solving | 4.405 | 3 | 1.468 | .258 | .856 |
| Social Support | 9.727 | 3 | 3.242 | .261 | .853 |
| Thought Suppression | 25.986 | 3 | 8.662 | .500 | .683 |

**Part 2B: Effect Sizes (Collapsed Normative Group)**

Just as in Part 2A, to further understand possible profile differences on outcome variables, I decided to look at effect sizes of these comparisons. For brevity, I have reported below only those comparisons with effect sizes above .30 (see Tables 8 and 9).

On trait measures, the profiles that differed most consistently from other profiles were Class 3 and Class 4. Specifically, Class 3 (moderate/high) demonstrated lower depression and NA than all other groups, and higher brooding than all other groups. Class 4 (moderate/augmenting) demonstrated higher avoidance and acceptance than all other groups; lower problem solving and social support than all other groups; and lower expressive suppression and thought suppression than most other groups.

On state measures, as in Part 2A, profile differences were fewer and slightly more variable. Class 3 (moderate/high) still demonstrated lower depression and higher acceptance than all other groups, with more problem solving than most other groups. Class 4 (moderate/augmenting) showed higher negative affect and thought suppression than all other groups, and higher social support than only the normative Class 1 (moderate/moderate). Additionally, Class 5 (high/moderate) showed lower avoidance than most other groups, and lower expressive suppression than only Class 3 (moderate/high).

Because many of these differences on outcomes reflect the respective patterns seen in Part 2A, even with the merging of two large groups, it suggests that the two moderate/moderate groups identified in Part 1 and Part 2A, although identified as different groups by Mplus, do not differ significantly in character or in outcomes, and likely represent one large normative class.

Table 9

*Effect Sizes of Class Comparisons 2B (Trait)*

| Dependent Variable | (I) Class | (J) Class | Effect Size |
|---|---|---|---|
| Depression | 3 | 1 | -0.44 |
| | | 4 | -0.59 |
| | | 5 | -0.51 |
| Negative Affect | 3 | 1 | -0.33 |
| | | 4 | -0.43 |
| | | 5 | -0.39 |
| Avoidance | 4 | 1 | 0.50 |
| | | 3 | 0.66 |
| | | 5 | 0.52 |
| Brooding | 3 | 1 | 0.39 |
| | | 4 | 0.67 |
| | | 5 | 0.39 |
| Expressive Suppression | 4 | 1 | -0.38 |
| | | 3 | -0.39 |
| Acceptance | 4 | 1 | 0.53 |
| | | 3 | 0.46 |
| | | 5 | 0.63 |
| Problem Solving | 4 | 1 | -0.66 |
| | | 3 | -0.66 |
| | | 5 | -0.85 |
| Social Support | 3 | 1 | 0.40 |
| | 4 | 1 | -0.45 |
| | | 3 | -0.84 |
| | | 5 | -0.61 |
| Thought Suppression | 3 | 5 | 0.45 |
| | 4 | 1 | 0.42 |
| | | 5 | 0.60 |

*Note*. Only effect sizes with an absolute value greater than .30 are shown.

Table 10

*Effect Sizes of Class Comparisons 2B (State)*

| Dependent Variable | (I) Class | (J) Class | Effect Size |
|---|---|---|---|
| Depression | 3 | 1 | -0.49 |
| | | 4 | -0.71 |
| | | 5 | -0.73 |
| Negative Affect | 4 | 1 | 0.36 |
| | | 3 | 0.50 |
| | | 5 | 0.31 |
| Avoidance | 5 | 1 | -0.41 |
| | | 4 | -0.38 |
| Expressive Suppression | 5 | 3 | -0.47 |
| Acceptance | 3 | 1 | 0.46 |
| | | 4 | 0.46 |
| | | 5 | 0.42 |
| Problem Solving | 3 | 1 | 0.34 |
| | | 4 | 0.53 |
| Social Support | 4 | 1 | 0.35 |
| Thought Suppression | 4 | 1 | 0.41 |
| | | 3 | 0.34 |
| | | 5 | 0.62 |

*Note.* Only effect sizes with an absolute value greater than .30 are shown.

## Chapter IV: Discussion

RSA is an index of parasympathetic activity and responsiveness. It has been used as a biological marker of emotion regulatory capacity and response, building upon Porges' polyvagal theory which suggests that degree of parasympathetic influence (and withdrawal) reflects the degree of capacity to respond (and degree of response) to environmental stressors. Few studies have examined both baseline RSA and RSA reactivity together in relation to psychological correlates and mental health outcomes, and none to date have attempted to identify naturally-occurring patterns in responsiveness across baseline and stress-responsive RSA. The study was largely exploratory in nature, and the purposes of the study were twofold: first, to identify naturally-occurring patterns of resting and stress-reactive RSA among a young adult population, and second, to identify correlates of these physiological profiles, including state and trait measures of NA, depressive symptoms, and use of various emotion regulation strategies. I hypothesized that latent growth mixture modeling (LGMM) would identify up to six unique classes, varying on resting RSA (low/high) and RSA reactivity (low/moderate/high). Further, I hypothesized that profiles characterized by low baseline RSA and low or high RSA withdrawal would be characterized by high NA, high depressive symptoms, and poor emotion regulation strategies; and that profiles marked by high baseline RSA and moderate RSA withdrawal would be characterized by low NA, low depression, and adaptive emotion regulation strategies.

Results showed partial support for both sets of hypotheses. In Part 1, LGMM in Mplus yielded the identification of a 5-class model. Four of the five classes were characterized as having moderate baseline RSA, with one class identified as having high baseline RSA. The five classes showed more variability in RSA reactivity, ranging from high withdrawal to moderate withdrawal to augmenting (non-withdrawing) response patterns. Two of the 5 classes appeared to represent a normative group (moderate/moderate and moderate/moderate+ classes); these profiles did not differ significantly from each other on baseline or slope of reactivity. The other three classes (moderate/high, moderate/augmenting, and high/moderate) differed significantly from both the two large normative groups and each other.

Part 2 of the study was conducted in two waves, due to the presence of the two normative groups (moderate/moderate and moderate/moderate+) identified in Part 1. In the first wave, analyses were run using the 5 classes identified by Mplus, while in the second wave, analyses were run with 4 classes, with the two normative profiles (which had not differed from each other on slope or intercept) manually collapsed into a single class. The two groups, perhaps unsurprisingly, demonstrated similar outcomes on all dependent variables in the first wave of analyses. Although they were identified as independent classes in Mplus, it appears the differences between the two classes were neither statistically significant nor meaningful.

In both waves of analyses, Classes 3 and 4 (moderate/high and moderate/augmenting, respectively) stood out as differing most consistently from all other groups. The moderate/high profile, characterized by moderate baseline RSA (moderate response capacity) and high RSA withdrawal (exaggerated response to environment), showed lower NA and depressive symptoms at both trait and state level. Regarding emotion regulation, this profile demonstrated both adaptive and maladaptive patterns, showing higher brooding and thought suppression (which may be an attempt at interrupting brooding), but also higher social support. At the state level, this profile was associated with higher acceptance, lower avoidance, and higher problem solving. These patterns support that high RSA withdrawal reflects a high degree of response to the environment, particularly through the use of adaptive emotion regulation strategies, and seem to support adaptive outcomes in affectivity and depressive symptomology.

The moderate/augmenting class, characterized by moderate baseline RSA (moderate response capacity) and augmenting RSA was characterized by more differences from other groups in emotion regulation strategy, although the pattern to the differences appeared mixed in terms of adaptiveness, though likely maladaptive overall. Specifically, this profile was associated with high avoidance and thought suppression, lower problem solving and social support, but higher acceptance and lower expressive suppression. Individuals with this response pattern may avoid and control their thoughts about the stressor to the point where they don’t engage effectively with stressors, indicated by lower problem solving and social support. The moderate/augmenting class showed consistently higher NA at the state level. The high/moderate profile, characterized by high baseline RSA (high regulatory capacity) and high RSA withdrawal (exaggerated response to environment) demonstrated, most notably, lower avoidance than most other response profiles. This pattern tended to be reflected in both groups characterized by high RSA withdrawal.

There was a notable lack of identification of any response profiles with a low baseline RSA. This may be partially due to my sample not being clinical; participants may represent a subset of the population that is impaired less overall. Additionally, I had a relatively small sample and uneven *N* across classes, making it difficult to effectively identify what may have been a relatively small subset of participants. The smallest group (*N* = 8; moderate/augmenting) had the lowest mean baseline RSA with the largest SD of any of the groups, with the large moderate/moderate group having the second lowest mean baseline RSA, and second largest SD. It could be that although a distinct and cohesive augmenting group emerged through the iterative LGMM analyses, this group (and group differences in general) was driven more by the pattern of responsive RSA than by baseline RSA, and resulted in the lack of identification of a low baseline profile.

Overall, results suggest the existence of a normative pattern of psychophysiological response, in which individuals have both sufficient capacity for response to their environment and respond sufficiently to meet environmental demands. Other response profiles demonstrated mixed results in terms of adaptiveness. Because the most variable component of the profile was the responsive RSA (e.g., moderate, high, or augmenting), it may be that this is an important defining factor in a profile when considering psychological outcomes.

To my knowledge, no other studies to date have tried to identify naturally-occurring RSA response profiles, although studies commonly examine either baseline or stress responsive RSA independently in relation to psychological outcomes. One study (Yaroslavsky et al., 2013a) examined the interaction of baseline and reactive RSA and found that their interaction predicted maladaptive mood regulation. However, this study is unique in (a) using latent growth mixture modeling to identify RSA classes using both baseline RSA and RSA withdrawal, and (b) associating those profiles with outcomes related to affectivity, depressive symptoms, and emotion regulation. Although research on outcomes associated with baseline RSA or responsive RSA independently is mixed, results generally suggest that high baseline RSA is adaptive, while excessive or absence of responsive RSA tends to be maladaptive. The current study is congruent with, and builds upon, previous findings, while also highlighting the utility of examining the joint contributions of both baseline RSA and RSA reactivity.

The results of this study provide support for clinicians considering biological strengths and vulnerabilities in their conceptualizations of their clients. Although it would not be practical or possible to measure baseline and responsive RSA for everyone presenting for clinical services, knowing that there are naturally-occurring physiological response patterns within the population could be helpful information to keep in mind. Some clinical models take biological factors into consideration. For example, Linehan's biosocial theory suggests that some individuals have a biological propensity to experience emotions more intensely, and that the transaction between this sensitivity and an invalidating environment may give rise to borderline personality disorder (Linehan, 1993). The biopsychosocial approach to clinical care takes into account an individual's biological, psychological, and social influences, and considers the complex interactions between these factors in conceptualizing health, illness, and treatment (Borrell-Carrio, Suchman, &

Epstein, 2004; Engel, 1977). Furthermore, the results of this study suggest that although there is a normative pattern of psychophysiological response, individuals differing from the normative response pattern tend to engage in a mixture of adaptive and maladaptive emotion regulation techniques; clinicians may want to emphasize strategies that encourage their clients' effective engagement with life stressors and appropriately modulated responses (e.g., not under- or over-responding). For example, individuals prone to rumination may benefit from coaching on active problem solving. Due to the role of the parasympathetic nervous system in modulating an individual's stress response, psychoeducation about the sympathetic and parasympathetic nervous systems, the fight-or-flight response, and rationale behind relaxation techniques (e.g., diaphragmatic breathing) could be beneficial for clients; some may find incorporating biofeedback to also be useful in teaching adaptive emotion regulatory skills.

The current study is the first to identify naturally-occurring response profiles RSA responding, and to begin exploring possible important outcomes associated with identified profile. However, there are also several limitations to the current study. First, participants were overwhelmingly Caucasian females with a mean age of 19 years old, all of whom were enrolled in university classes; although sex and race were not found to be significant covariates in this study, sample characteristics may still limit the generalizability of the results. Second, the study was not conducted on a clinical sample. Questionnaires identified level of depressive symptomology but were not used to determine diagnostic status; further, I did not measure symptoms of anxiety, and did not examine other potentially important emotion regulatory strategies, such as substance abuse, self-injury, exercise, gratitude, or spirituality. Participants appeared to constitute a fairly high-functioning sample overall.

Finally, while my sample size suggested sufficient power for detecting effect sizes above .25 in Part 2 of my analyses, there are no well-established guidelines for determining power to detect subgroups using LGMM analyses. One review of the literature noted that most articles using LGMM make no mention at all of any power analysis and that when power analyses are discussed, it is in context as a study limitation (e.g., smaller sample yielded insufficient power; Frankfurt, Frazier, Syed, & Jung, 2016). The same review described simulation studies suggesting that sample sizes over 500 are more likely to supply sufficient power to detect meaningful groups, while smaller samples are likely underpowered (Frankfurt et al., 2016). It is also possible that, in addition to a small sample size overall, the small an uneven *N*s in some classes (e.g., classes as small as 8 participants, or 3.4% of the overall sample) contributed to difficulty identifying meaningful groups statistically, even though the small groups appeared to be meaningful from a theoretical perspective (Clark & Muthen, 2009; Berlin et al., 2014; Wickrama et al., 2016). Specifically, the smallest class (3.4% of the sample) was identified consistently through each iterative LGMM analysis, suggesting that it is a meaningful group to include despite its small size; however, a very large normative group was split into two classes in LGMM, despite those two classes not appearing meaningfully different in any way in post hoc analyses or when used to predict the identified outcome measures. This highlights the importance of being guided by statistics (e.g., fit indices), theory, and pragmatism when conducting and interpreting LGMM, since it is possible to both under-identify and over-identify classes (Berlin et al., 2014; Brown, 2003). Furthermore, my sample had a fairly high baseline RSA overall and no low baseline RSA group was identified; a broader sample with more heterogeneity may have facilitated the identification of other groups.

Future research may build upon the foundation this study lays, as well as its limitations. Future studies using LGMM in RSA response profiling would likely benefit from collecting significantly larger samples, which would increase power to identify meaningful classes. Additionally, this study structure could be extended to other age groups (e.g., children, adolescents) to examine not only outcomes, but to explore the stability of response pattern profile over time. Future studies could also examine clinical samples, and extend the current findings to other outcomes of interest such as anxiety or aggression.

While this study examined stress-responsive RSA profiles, it could be replicated under different mood inductions, such as shame, gratitude, or response to positive stimuli. Future studies may also incorporate RSA recovery. Recovery from a stressor may be an important element to consider in terms of RSA response patterns. As reactive RSA tends to reflect degree of response to an environmental demand, RSA recovery may reflect the effectiveness of chosen response to the environmental demands.

This study demonstrates the utility of LGMM in identifying classes of RSA responding, and may serve as a foundation for future research incorporating RSA recovery, response profiles under different mood inductions, and investigation in clinical samples. It also demonstrates that identified profiles are meaningful predictors of outcomes related to negative affect, depressive symptoms, and emotion regulation strategy. Results support the continued consideration of psychophysiological components in biopsychosocial models of psychological correlates and outcomes.

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