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AN INTERPERSONAL MODEL OF DEPRESSION: A PSYCHOPHYSIOLOGICAL
PERSPECTIVE

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Bachelor of Arts in Psychology

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May 2013

submitted in partial fulfillment of requirement for the degree

MASTER OF ARTS IN PSYCHOLOGY

at the

CLEVELAND STATE UNIVERSITY

May 2016

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ABSTRACT

This study examined whether parasympathetic nervous system (PNS) activity predicts depression risk through excessive reassurance seeking (ERS) which subsequently erodes social support and generates stress. Recent theories suggest that the PNS evolved to regulate social interaction and that the PNS is associated with depression and interpersonal deficits. Therefore, PNS deficits may be associated to ERS, given its interpersonal function. Participants ($N = 65$) completed measures of ERS, interpersonal stressors, social support quality, depression symptoms, and a protocol that measured indices of the PNS (i.e., respiratory sinus arrhythmia; RSA) at rest and during a paced breathing task. Multiple mediator models were used to examine the mediation of PNS activity on depression via ERS, interpersonal stress, and social support quality. Results suggest that PNS activity predicts ERS behavior that, in turn, predicts depression symptoms via interpersonal stress. High PNS activity, a purported marker of adaptive functioning, was related to greater use of a maladaptive interpersonal response (ERS), which subsequently predicted greater social support at a trend level. Findings provide new evidence of PNS activity in relation to interpersonal behavior and depression, and suggest the need to consider psychophysiology as a context for understanding depression risk and interpersonal processes.

Keywords: depression, excessive reassurance seeking, social support, stress, respiratory sinus arrhythmia

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CHAPTER I

INTRODUCTION

1.1 Background

Depression is a mood disorder that impairs social, vocational, and other significant areas of life. Interpersonal models of depression have garnered significant attention because social relationships support us during distress (Cohen & Wills, 1985). Conversely, depression impairs our social relationships by causing us to exhaust our social support systems in times of need and to withdrawal from social engagements and into isolation (Joiner, Alfano, & Metalsky, 1992; Rubin, Coplan, & Bowker, 2009).

Researchers have attempted to explain pathways to depression whereby social communication efforts predict the etiology and chronology of depression (i.e., interpersonal models). In particular, one interpersonal model of depression proposes two possible routes by which depressed individuals bring about and maintain their depression. First, depressed individuals can deplete their social support networks by seeking too much support (i.e., social support erosion). Those with depression seek reassurance of worthiness and acceptance by others to alleviate feelings of worthlessness and guilt (i.e., excessive reassurance seeking; ERS), yet are rejected by former sources of social support

who become frustrated by being asked to provide reassurance excessively (Coyne, 1976a, 1976b). Another route is through interpersonal behavior that exacerbates stress (i.e., interpersonal stress generation). For example, those who excessively seek reassurance unintentionally generate negative life events, some of which are interpersonal in nature, that increase their risk for depression (Joiner & Metalsky, 2001; Potthoff, Holahan, & Joiner, 1995).

A recent surge of literature suggests that the parasympathetic nervous system (PNS) evolved to regulate social communication and, more specifically, to express and interpret emotion accurately, and to respond appropriately during social interaction (Porges, 2007). Researchers aptly refer to this system as the "social engagement system." The vagus nerve, within the PNS, regulates organs such as the pharynx, larynx, esophagus, bronchi, and facial muscles, which are necessary for social communication efforts (e.g., vocalization and facial expression). The vagus further modulates the heart to promote calmness and communication. Thus, vocalization and facial expression reflect the internal state of the heart through communication of emotional expression to others. Children with decreased parasympathetic activity exhibit behavioral dysregulation, externalizing problems, and internalizing problems in the presence of unfamiliar peers, which suggest a failure of the social engagement system (Hastings et al., 2008). Adults with major depression also display similar decreases in parasympathetic activity (Rechlin, Weis, Spitzer, & Kaschka, 1994). Interpersonal models of depression are limited in that they are based on behavioral observations, whereas biological markers, such as the PNS, may be a potential predictor of depression. This study seeks to bridge

this gap by examining how the PNS may predict ERS, social support erosion, interpersonal stress generation, and outcome depressive symptoms.

1.2 Depression

Depression is one of the leading causes of morbidity and disease burden worldwide (World Health Organization [WHO], 2012). Approximately 16.6 percent of adults in the United States will experience depression at some point in their lifetime (Kessler et al., 2005). According to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association [APA], 2013), a diagnosis of major depressive disorder must meet several criteria. Five or more symptoms must be present most of the day nearly every day within a two-week period. Such symptoms are as follows: a depressed mood, significantly diminished interest in activities that were once pleasurable, significant weight loss or gain, changes in appetite, irregular sleep patterns, psychomotor changes, energy loss, feelings of worthlessness or excessive guilt, impaired ability to think or concentrate, and current thoughts of suicide or death. The symptoms of depression must be so severe that they impair one's occupational, academic, and most relevantly, social lives.

Researchers frequently debate over predictors of depression, though there are several prevailing theories. Biological theories argue that genetics may predispose one to an increased risk for depression (Haefel et al., 2008). Oppositely, environmental and social theories propose that stressful life events and early childhood experiences increase one's risk for depression in childhood and adulthood (Caspi et al., 2003). Childhood traumas, such as abuse and neglect, may also increase the risk for depression (Heim, Newport, Mletzko, Miller, & Nemeroff, 2008). In adulthood, being rejected and excluded

by peers (i.e., social rejection) is linked to depression (Slavich, Thornton, Torres, Monroe, & Gotlib, 2009). Repeated isolation from social supports (i.e., social withdrawal) is another predictor of depression (Bell-Dolan, Reaven, & Peterson, 1993; Katz, Conway, Hammen, Brennan, & Najman, 2011). No theory explains the development of depressive symptoms completely, yet social elements (e.g., abuse, rejection, exclusion, and isolation) are consistently implicated with an increased risk for depression.

1.3 Interpersonal Models of Depression

Those with depression can unintentionally reverse the positive effect of social support. Such occurrence is a major line of depression research that has given way to an interpersonal model of depression. Coyne's (1976a, 1976b) interactional theory of depression was among the earliest to propose the notion that interpersonal behaviors can influence our emotional well-being. For example, some individuals report feeling more depressed after a phone conversation with a depressed person (1976a). One reason for this finding may be that social supports develop negative affect toward depressed persons from having to excessively provide reassurance and, as a result, reject the depressed individual (Figure 1, Path B). In turn, rejection propagates depressive symptoms in the depressed individual and perpetuates the cycle of depression (1976b) (Figure 1, Path C). Similar findings are present among depressed college students and their roommates (Joiner et al., 1992; Joiner & Metalsky, 1995). ERS behavior also increases negative affect and negative spousal attitudes toward depressed partners in married couples (Benazon, 2000; Katz & Beach, 1997). Psychiatric youth patients with depressive symptoms, who excessively seek reassurance, report more interpersonal rejection than

others do (Joiner, 1999). Replication among a sample of air force cadets, along with the aforementioned samples, emphasizes the importance of ERS in interpersonal models of depression (Joiner & Schmidt, 1998).

1.4 Excessive Reassurance Seeking

To review, those who excessively seek reassurance unintentionally generate interpersonal negative life events and experience rejection by social supports who become frustrated from being asked to provide reassurance excessively (Coyne, 1976a, 1976b). A search for self-worth mediates the relationship between interpersonal stress and subsequent ERS behavior, which suggests that people may seek reassurance more often when they are unsure of how others feel about them (Joiner, Katz, & Lew, 1999). Moreover, ERS and interpersonal stress may contribute to increases in depressive symptoms (Potthoff et al., 1995). The reverse also holds true, in that interpersonal stress and pre-existing depression may predict and maintain future ERS behavior (Van Orden & Joiner, 2006). Several studies show that ERS behavior may be involved in the occurrence of depression, primarily through the erosion of social support, in child and adulthood (Coyne, 1976b; Joiner, Metalsky, Gencoz, & Gencoz, 2001; Oppenheimer, Technow, Hankin, Young, & Abela, 2012).

Garber and Hollon's (1991) three-criteria heuristic supports the role of reassurance-seeking behavior as a probable predictor of depression. First, ERS consistently exists alongside the presence of depression (i.e., covariance) and not consistently alongside other mental illnesses, lending support ERS as a possible vulnerability factor of depression (Joiner & Metalsky, 2001). Second, research often shows that ERS temporally precedes the onset of depression (Joiner & Metalsky, 2001;

Potthoff et al., 1995). Namely, initial ERS behavior significantly predicts levels of subsequent depressive symptoms, lending evidence for ERS as a vulnerability factor (Joiner & Schmidt, 1998). Finally, a third variable must not account for the relationship between the behavior and the disorder (i.e., nonspuriousness). Depressed college students display higher levels of ERS behavior than college students with other disorders and no disorders do. The same holds true for subjects with psychotic and anxious disorders (Joiner & Metalsky, 2001, Study 1). The same also holds true for youth with externalizing disorders (Joiner & Metalsky, 2001, Study 2). Finally, ERS is also specific to depression over subjects with anxiety (Joiner & Metalsky, 2001; Joiner & Schmidt, 1998).

Another line of research involves interpersonal rejection as a possible consequence of depression (Pettit & Joiner, 2006). ERS behavior may predict interpersonal rejection of depressed individuals in married and dating couples (Benazon, 2000; Katz & Beach, 1997). Interpersonal rejection may be prominent in only depressed individuals who also rate high in ERS behavior (Joiner & Metalsky, 1995). One possibility for this may be that depressed individuals convey symptoms that burden social supports more so than symptoms of other disorders (e.g., anxiety).

The hypothesis that ERS may predict depression is not without its weaknesses. Studies of ERS behavior and interpersonal rejection use similar methodologies (e.g., studying romantic relationships and the use of self-report measures) and samples (e.g., women and couples), which may explain the positive relationship between ERS and concurrent depressive symptoms (Starr & Davila, 2008). Aside from methodological criticisms, recent research suggests that the ERS model may not be exclusive to

depression. Prior evidence shows that depressed individuals may experience more rejection and negative reactions from others when excessively seeking reassurance, as compared to nondepressed individuals who also exhibit ERS behavior. Yet, newer evidence suggests ERS naturally accompanies negative affect, which is common to depressive symptoms and general anxiety (Oppenheimer et al., 2012). A modest correlation between ERS behavior and subsequent depression suggests that ERS may be present only alongside interpersonal stress generation and negative reactions from social supports (Joiner & Metalsky, 2001). Stressful life events lead one to seek reassurance, which perpetuates the negative cycle (Joiner et al., 1999). Thus, stress may play a larger role in the cyclical occurrence of ERS than depression symptoms. Aside from mood disorders, higher levels of ERS behavior are associated with anxious attachment styles (Davila, 2001; Shaver, Schachner, & Mikulincer, 2005). Attachment theory suggests that children learn to self-assure when they have a secure attachment with their parent (Bowlby, 1980). Inconsistent attachment figures may lead a child to learn to seek assurance externally, which may predict ERS behavior in adulthood (Evraire & Dozois, 2011).

1.5 Social Support

As mentioned, the presence of social support systems benefits those with depression and stress. Social support is broadly defined as the perception and experience of being valued and loved by others and the feeling of belonging to a larger social network (Wills, 1991). Social supports may be beneficial because they provide tangible goods (e.g., money), shared labor, intimacy, advice, feedback, and positive social interactions (Barrera & Ainlay, 1983). As expected, a lack of social support can harm

one's psychological well-being. Low levels of social support are correlated with higher levels of depression (Lakey & Cronin, 2008). Shy college students who lack social support display increases in depressive symptoms (Joiner, 1997). Single mothers who lack social support are more at risk for an episode of depression than married mothers are (Cairney, Boyle, Offord, & Racine, 2003). Indeed, social supports are a necessary component of well-being.

Two dominant models explain the relationship between social support and well-being: the direct effects hypothesis and the buffering hypothesis. The direct effects hypothesis predicts that social support is overall beneficial, even in the absence of stress. People with more social support are healthier than those with less social support, thus lending evidence to the direct effects hypothesis. Integration into a large social network may enhance well-being because social networks provide stability in one's life, safety from financial burden, recognition of self-worth, and positive affect (Cohen & Wills, 1985). Likewise, greater support from family and friends is related to increased well-being (Graham & Barnow, 2013). The buffering hypothesis predicts that social supports act as a protective "buffer" from the adverse effects of stressful life events. People are healthier and less stressed when they perceive an abundance of supports who are responsive to the individual's needs, which suggests that social support has a buffering effect against the effects of stress (Cohen & Wills, 1985). Taken together, social support directly and indirectly buffers against the effects of stress on depression.

Social support may explain the relationship between stress and depression. Involvement in many forms of social support such as intimate relationships, social networks, and community organizations, predicts that one is better buffered from

depression than others are with fewer forms (Lin, Ye, & Ensel, 1999). Depressed adults who socialize with their friends and family prevent an increase in negative affect they would experience if they were otherwise alone (Schwerdtfeger & Friedrich-Mai, 2009). Prior evidence suggests that social support reduces the effects of stress on depression (Peirce, Frone, Russell, Cooper, & Mudar, 2000). New evidence also suggests that social support moderates the effects of stress on depression among adolescents and college students (Raffaelli et al., 2013; Wang, Cai, Qian, & Peng, 2014; Zhang, Yan, Zhao, & Yuan, 2014). Future research will benefit by examining the moderation of social support on stress and depression, rather than examining social support and stress generation as separate pathways to depression.

1.6 Interpersonal Stress Generation

The modest correlation between ERS and depression suggests ERS is not a necessary or sufficient predictor of depression, but rather works in tandem with other potential predictors (Joiner et al., 1999). For example, ERS is associated with interpersonal stress generation in the course of depression (Potthoff et al., 1995) (Figure 1, Path D & E). Broadly speaking, stress predicts psychiatric features, such as depressive symptoms, and the occurrence of additional stressful life events (Hammen, Davila, Brown, Ellicott, & Gitlin, 1992). Prior evidence suggests that depressed individuals are partially responsible for the generation of stressful events and they experience more stressful life events than those without mental illness (Hammen, 1991). Depression in children also precipitates more stressful life events (Rudolph et al., 2000). Depressed persons may create additional life stress because they hold negative cognitions about themselves and events, thus decreasing their ability to cope with future events. These

stressors consequently contribute to the cycle of depression (Hammen, 1992). The stress generation model of depression extends prior findings by implicating interpersonal stress as a mediator of the positive relationship between reassurance-seeking behavior and the development of depressive symptoms (Potthoff et al., 1995) (Figure 1, Path D & E). For example, ERS behavior predicts interpersonal stressors, such as arguments with family, exclusion from social activities by friends, or being emotionally hurt by significant others. As such, individuals who excessively seek reassurance suffer interpersonal conflict as a consequence of their behavior, which predicts further depression. Support for interpersonal stress, as a mediator between reassurance-seeking behavior and depression, is also evident in college students (Potthoff et al., 1995). Researchers should examine stressful life events in interpersonal contexts, such as interpersonal behaviors and relationships, given the potential impact of social relationships in generating stress (Hammen, 1992).

1.7 Excessive Reassurance Seeking and the Parasympathetic Nervous System

Further examination of interpersonal models of depression is necessary in light of the field's growing interest in research on interpersonal relationships and depression. Interpersonal models identify maladaptive behaviors, such as ERS, and pathways to depression, yet they examine social support erosion and interpersonal stress generation independently of one-another. ERS behavior has several interpersonal components (e.g., social stressors, type of partner relationship, and interpersonal partner behaviors) and intrapersonal components (e.g., low self-esteem and increased self-doubt) that are necessary to potentiate interpersonal conflict and increase depressive symptoms (Joiner et al., 1999). Identifying when and how individuals use ERS as a coping mechanism and

intervening between its components may stop the increase of depressive symptoms. Furthermore, interpersonal models of depression have yet to consider advancements in physiological research as it pertains to interpersonal relationships. Revisiting interpersonal models of depression may be a worthwhile endeavor considering the model's weaknesses and advancements in research.

A growing body of research suggests that biological and neural systems are involved in social and emotional processes, which may also be implicated in ERS behavior (Porges, 2007). One such system, the autonomic nervous system (ANS), regulates automatic activity in the human body, including heart rate, digestion, respiration, urination, and sexual arousal. The ANS is divided into two branches: the parasympathetic nervous system (PNS) that controls the rest and digest and feed and breed functions of the human body, and the sympathetic nervous system that controls fight or flight responses. Inside the PNS lies the vagus nerve, which connects the brain and the heart to regulate heartbeat.

The ANS is phylogenetically organized to regulate shifts in emotion and social behavior. The ANS evolved in three stages that are each represented by a subsystem. The first, and the evolutionarily newest, subsystem is the social communication system of the myelinated vagus. The social communication system is comprised of cranial nerves and vagal fibers to regulate social behaviors such as speaking, listening, and facial expression. ERS behavior recruits the same neurophysiological pathways (e.g., facial muscles and vocal cords) for social communication. Second, the mobilization system regulates social fight or flight behaviors (Beauchaine, Gatzke-Kopp, & Mead, 2007). The third and the oldest subsystem is the immobilization system of the unmyelinated vagus

that regulates shutting down behaviors. If the evolutionary newer social communication system fails, then the older mobilization and immobilization systems will activate.

Evolutionarily, ERS may be considered a self-protective behavior when an individual seeks to bolster self-worth by easing uncertainty of being liked by others. Yet, when one questions the sincerity of feedback, they seek reassurance once more from their social supports. Thus, ERS may represent a failure of the social communication system with depression as a consequence.

PNS activity via the vagus nerve provides some utility to understand how the social communication system fails during reassurance-seeking behavior. The vagus nerve mediates stress responses and social communication via the newer ventral branch, which evolved to respond to social stressors in human life. The vagus is implicated in psychiatric disorders which are recognized for social maladjustment, such as autism and borderline personality disorder (Austin, Riniolo, & Porges, 2007; Porges, 2007). One evolutionarily newer stressor may be uncertainty, which may trigger our threat response by default (Thayer & Lane, 2009). ERS is a reaction to the threat of uncertainty about self-worth and love in the eyes of others (Joiner et al., 1999). The ventral branch of the myelinated vagus regulates social behaviors, such as social communication and self-calming, by inhibiting sympathetic circuits to the heart (i.e., vagal tone). Vagal tone heavily influences the sino-atrial node, which is the heart's pacemaker that lies within the heart. More specific, the myelinated vagus influences the heart, directly on the sino-atrial node, to induce calming behavior and social engagement. The myelinated vagus alternatively disinhibits low vagal tone to the heart to allow for mobilization in stressful

situations. Vagal dysregulation may be present among those who do not respond appropriately to social stressors and who seek reassurance excessively.

One way to quantify PNS activity on the heart is to measure natural changes in heart rate during breathing (i.e., respiratory sinus arrhythmia; RSA). RSA indexes how the vagus nerve moderates signals to the heart during states of rest. RSA indices are commonly used because they provide a noninvasive and accurate measure of intermittent changes in heart rate during periods of cardiovascular rest. Recent evidence reveals that social interaction moderates the relationship between depressed moods and RSA (Schwerdtfeger & Friedrich-Mai, 2009). RSA is also associated with the prefrontal cortex, amygdala, and other inhibitory pathways involved in dysfunction (i.e., a neurovisceral integration model), so RSA may be a risk factor for emotional disorders (Thayer & Lane, 2009).

1.8 Depression and the Parasympathetic Nervous System

The PNS may explain social communication impairment during the onset and occurrence of depression. Depressed individuals withdraw from social supports and engagements, and they exhibit maladaptive social behaviors in the company of others (Joiner & Metalsky, 2001; Rottenberg & Gotlib, 2004). Prior research has shown that RSA measures predict depression symptoms (Yaroslavsky, Bylsma, Rottenberg, & Kovacs, 2013; Yaroslavsky, Rottenberg, & Kovacs, 2013). High resting RSA levels predict positive emotional regulation (Porges, 2007). Conversely, low resting RSA levels predict difficulties in emotional regulation (Hastings et al., 2008). Low resting RSA is also implicated in emotional difficulties and depression (Beauchaine, 2001; Kemp et al., 2010; Rottenberg, 2007; Thayer & Lane, 2000). Overall, the literature supporting RSA

and its relationship to depression is not definitive (Rottenberg, 2007). Researchers know little about how the brain reflects ERS behavior through the vagal system, and resting RSA levels may predict ERS behavior in those with depression. Psychophysiology may be the framework by which researchers come to understand depression, interpersonal processes, and behaviors.

1.8.1 An Interpersonal Model of Depression and the Parasympathetic Nervous System

To help conceptualize the present interpersonal model of depression, ERS behavior is directly (Figure 1, Path A) and indirectly associated with increases in depressive symptoms through two mechanisms. First, ERS is associated with decreases in the quantity and quality of perceived social support (Figure 1, Path B). In turn, social support erosion is associated with increases in depressive symptoms (Figure 1, Path C). Second, ERS behavior is associated with the generation of interpersonal stressful life events (Figure 1, Path D). As a result of ERS behavior, the generation of interpersonal stress is further associated with increases in depressive symptoms (Figure 1, Path E).

New research sheds light on the physiological components of social behavior, yet interpersonal models of depression are based on behavioral observations. Measuring resting RSA in those who display reassurance-seeking behavior will expand upon the behavioral foundations of the present interpersonal model. In terms of interpersonal behaviors, low resting RSA predicts an individual's inability to control their facial responses to emotional stimuli (Demaree, Robinson, Everhart, & Schmeichel, 2004). High resting RSA levels predict positive social regulation and low resting RSA levels predict difficulties in social communication (Hastings et al., 2008; Porges, 2007). Resting RSA is correlated with subjective well-being (Geisler, Vennwald, Kubiak, & Weber,

2010). Furthermore, high resting RSA predicts healthy social engagement and social well-being (Geisler, Kubiak, Siewert, & Weber, 2013). High resting RSA also protects against depressive symptoms in those who engage with an abundance of quality social supports (Hopp et al., 2013). In this study, we expect that low resting RSA levels will predict poor social communication strategies, such as ERS, in participants who display depressive symptoms. ERS may be a viable target of depression prevention efforts if such research were to be successful. In addition, evidence of RSA activity with ERS behavior may guide future research to consider the utility of psychophysiological measurements in interpersonal models of depression. The present study may clarify and expand the interpersonal model of depression and reinforce the polyvagal theory by evidencing another poor social communication strategy (e.g., ERS) predicted by poorly modulated RSA activity. More important, this study will help researchers better understand the physiological underpinnings of depression.

1.9 The Present Study

The present study seeks to expand what is known about the relationship between ERS, social support erosion, interpersonal stress generation, and depression by considering the effects of the PNS. The first aim of this study is to test an original interpersonal model of depression, whereby, ERS predicts increased depression via the erosion of social support and presence of interpersonal stress (Hypothesis 1) (Figure 1). The second aim of this study is to examine whether social support moderates the effects of interpersonal stress on depression, whereby increased social support predicts a decreased effect of stress on depression (Hypothesis 2) (Figure 2). The third aim of this study is to build upon interpersonal models of depression by testing two competing

models that integrate measures of PNS activity. The first of which tests whether the PNS indirectly predicts depression, whereby low resting RSA predicts elevated symptoms of depression via ERS behavior, social support erosion, and interpersonal stress generation (Hypothesis 3) (Figure 3). The second of which examines whether the PNS directly predicts depression, whereby low resting RSA predicts depression over and above ERS, social support erosion, and interpersonal stress (Figure 4).

CHAPTER II

METHOD

2.1 Participants

A final sample of 65 participants took part in the study. Participants were recruited from the undergraduate student body of Cleveland State University and from the Cleveland Metropolitan Area through postings in online bulletins (e.g., Craigslist) and fliers posted around the Cleveland State University campus. Participants were offered the opportunity to complete a 13-minute prescreening survey to determine their eligibility. Eligible participants were paid \$45.00 for completing the study. Two hundred and forty participants took part in the online prescreening survey. An inconsistency scale, which consisted of three sets of three items, that required participants to respond in prescribed ways, screened would-be participants for the study. Participants who did not complete the survey, scored low on the inconsistency scale, or were younger than the required minimum age of 18 were excluded from the study, resulting in a final sample of 65 participants. Participants ranged from 18 to 63 years of age with a mean age of 28 ($SD = 11.89$). Among participants, 38.5% were men ($n = 25$) and 61.5% were women ($n = 40$).

Two participants' data were excluded from analyses due to health conditions that are known to influence RSA.

2.2 Procedure

Data used in this study was drawn from a larger study of mood, emotion regulation, and psychophysiology. As part of the larger study, participants provided informed consent, completed a battery of survey measures via computer, and completed psychosocial interviews administered by masters' level clinicians. Participants also completed a psychophysiology protocol in which RSA was collected through ECG during a three-minute free breathing rest period and a three-minute paced breathing task, during which participants were instructed to breath 12 times per minute (the average respiration rate for adults).

2.3 Instruments

Depression Symptoms. The Center for Epidemiologic Studies Depression Scale (CES-D) is a 20-item scale measuring depressive symptoms in the general population (Radloff, 1977). Participants make responses on a 4-point Likert scale to such prompts as "I was bothered by things that usually don't bother me." Prior research has shown the CES-D to be a reliable and valid measure of depression ($\alpha > .85$) (Hann, Winter, & Jacobsen, 1999; Radloff, 1977). The CES-D had excellent internal consistency in this study ($\alpha = .93$).

Reassurance Seeking. The Depressive Interpersonal Relationships Inventory-Reassurance Seeking subscale (DIRI-RS) is a 4-item self-report scale measuring emotion regulation efforts via excessive reassurance-seeking behavior (Coyne, 1976b). Participants make responses via a 7-point Likert scale to such prompts as "In general, do

you find yourself often asking the people you feel close to how they truly feel about you?” The DIRI-RS is considered to be a reliable and valid measure ($\alpha > .85$) (Joiner et al., 1992; Joiner & Metalsky, 1995, 2001), and had excellent internal consistency in this study ($\alpha = .92$).

Interpersonal Stressful Life Events. The Negative Life Events Questionnaire (NLEQ) is a 66-item questionnaire that measures the frequency of negative life events that occur within the last four weeks. Participants make responses via a 5-point Likert scale to prompts such as “Did poorly on, or failed, an exam or major project in an important course (i.e., grade less than or equal to C).” The NLEQ is a reliable and valid measure and will be an index of stressful life experiences (Metalsky & Joiner, 1992; Saxe & Abramson, 1987). The NLEQ also contains items that assess for interpersonal stress such as “Close friend has been withdrawing affection from you.” Forty-five stressful life events related to interpersonal relationships were utilized for the purposes of this study. The interpersonal NLEQ items had excellent internal consistency in this study ($\alpha = .95$).

Social Support. The Multidimensional Scale of Perceived Social Support (MSSS) is a 12-item scale measuring an individual’s perceived quality of social supports (Zimet, Dahlem, Zimet, & Farley, 1988). Participants respond via a 7-point Likert scale to prompts such as “There is a special person who is around when I am in need.” The MSSS has been found to be reliable and valid (Canty-Mitchell & Zimet, 2000; Zimet, Powell, Farley, Werkman, & Berkoff, 1990), and had excellent internal consistency in this study ($\alpha = .92$).

Respiratory Sinus Arrhythmia. An electrocardiogram (ECG) measured resting RSA levels following standard guidelines (Berntson et al., 1997; Task Force, 1996) using

the MP150 Data Acquisition System and software from BIOPAC Systems, Inc. (Santa Barbara, CA). Ag/AgCl ECG electrodes were placed in a modified Lead – II configuration on the chest. The biosignals were acquired at a 2000 Hz frequency and submitted through a 0.01 high-pass filter. The interbeat intervals of the ECG were interpolated into 250 millisecond segments and subjected to Fast Fourier transformation as per best practices (Berntson et al., 1997; Task Force, 1996). Frequencies between 0.15 and 0.40 Hz reflect RSA activity and were calculated for the three-minute resting baseline, into two epochs: one during free breathing and one during paced breathing at a rate of 12 breaths per minute. Both epochs were used because variable respiration rates are known to confound the measure of PNS activity (Grossman & Kollai, 1993).

2.4 General Analysis

All statistical analyses were completed using IBM SPSS Statistics 21 (IBM Inc., 2012) software. Preliminary analyses revealed that approximately 2% of the data were missing from the DIRI-RS, MSSS, and CES-D measures due to one participant who did not complete the laboratory surveys. Approximately 11% of the data were missing from the NLEQ measure due to change in protocol early in the study. Little's MCAR test supported the assumption that data were missing completely at random, and thus did not bias the statistical results, Little's $\chi^2(14) = 12.7, p = .55$. Statistical analyses were carried out on data with list-wise deletion given this pattern of missing data. An evaluation of the assumptions of regression revealed violations of homoscedasticity and, consequently, heteroscedasticity-robust standard errors were used to correct this violation. Mediation analyses and path models were fit using the PROCESS Macro (Hayes, 2013) for SPSS 21 (Fig. 1, 2, 3, and 4 were tested with PROCESS models 4, 14, 6, and 6, respectively).

Bias-corrected 95% confidence intervals and bootstrap estimates were calculated with 50,000 samples.

CHAPTER III

RESULTS

3.1 Descriptive Analyses

Means, standard deviations, and bivariate correlations are presented in Table I. Pearson correlations were conducted to examine bivariate correlations between all variables. Higher use of ERS behavior was significantly related to greater levels of interpersonal stress, $r = .51$, and greater levels of depressive symptoms, $r = .54$ (all $ps < .01$). Furthermore, greater levels of interpersonal stress were related to greater levels of depression, $r = .60$, $p < .05$. Social support was significantly correlated with lower levels of interpersonal stress, $r = -.28$, $p < .01$. Social support was also correlated with lower levels of depression, $r = -.43$, $p < .05$. Surprisingly, PNS activity was unrelated to the study variables with the exception that paced breathing RSA was related to free breathing RSA, $r = .67$, $p < .05$. No other variables were correlated with free breathing RSA. Because free breathing was not related to any other variables in the model, it was not considered as a predictor. In regards to demographic variables, sex was significantly related to age but not related to variables of interest, $r = -.25$, $p < .05$. Age was significantly related to ERS in that older participants reported engaging in fewer ERS

behaviors, $r = -.27$, and age was also associated with paced breathing RSA in that older participants displayed lower levels of resting RSA, $r = -.31$ (all $ps < .05$). Age was examined as a potential covariate by including and excluding it in the models due to its relation to the variables of interest. The overall effects among the models were reduced and several effects dropped below the level of significance when controlling for age.

3.2 Hypothesis Testing

The first aim of this study was to examine whether ERS predicted increased depression via the erosion of social support and the presence of interpersonal stress (Figure 5). Two PROCESS analyses were conducted to determine the predictive effects of ERS behavior on levels of depressive symptoms via social support quality (Figure 5, Path B & C), and via interpersonal stress generation (Figure 5, Path D & E). As expected, the direct effect of ERS behavior on depression was significant (Figure 5, Path A), $\beta = .54$, $t(58) = 2.57$, $R^2 = .30$, $p < .05$. As also expected, greater ERS behavior significantly predicted higher levels of interpersonal stress generation (Figure 5, Path D), $\beta = .51$, $t(58) = 3.34$, $R^2 = .26$, $p < .05$. In turn, mediation analyses revealed that greater ERS behavior predicted higher levels of depression through interpersonal stress generation (Figure 5, Path E), $\beta = .42$, $t(58) = 2.94$, $R^2 = .48$, $p < .05$. Contrary to expectation, ERS did not predict social support (Figure 5, Path B), and social support did not predict depression (Figure 5, Path C).

The second aim of this study was to extend prior interpersonal models of depression by testing the hypothesis that social support moderates the effects of interpersonal stress on depression (Figure 2, Path F). PROCESS analyses were conducted to test the moderating effect of social support on interpersonal stress generation's

influence on depression symptoms. Contrary to this hypothesis, social support did not moderate the effects of interpersonal stress on depression.

The third aim of this study was to test two competing interpersonal models of depression that incorporate PNS activity. First, a restricted model tested whether low resting RSA would indirectly predict elevated symptoms of depression via ERS behavior (Figure 3, Paths A), social support erosion (Paths B), and interpersonal stress generation (Paths C). Second, a full model tested whether PNS activity would directly predict depression (Figure 4, Path A₄), whereby low resting RSA would predict depression over and above ERS (Path A₁), social support erosion (Path A₂), and interpersonal stress (Path A₃). Models examined both free breathing and paced breathing epochs. PROCESS analyses were conducted to test direct and indirect effects and the relationship between RSA and ERS.

The effects of paced breathing RSA partially supported the full model (Figure 6). Two path analyses were conducted to determine the predictive effects of RSA on levels of depressive symptoms via ERS and social support quality (Figure 6, Path A, C, & D), and via ERS and interpersonal stress generation (Figure 6, Path A, E, & F). Contrary to expectation, high RSA activity predicted elevated ERS behavior (Figure 6, Path A), $\beta = .20$, $t(57) = 2.19$, $R^2 = .05$, $p < .05$. Increased ERS behavior, in turn, mediated the effects of RSA on depression directly when controlling for social support (Figure 6, Path B) ($\beta = .34$, $t(57) = 3.66$, $R^2 = .30$, $p < .05$), and via increased interpersonal stress (Figure 6, Path F), $\beta = .43$, $t(57) = 2.98$, $R^2 = .48$, $p < .05$. In partial support of PNS activity in interpersonal depression risk, high RSA activity predicted greater social support at a trend level (Figure 6, Paths A & C), $\beta = .18$, $t(57) = 1.72$, $p = .09$.

Surprisingly, when free breathing RSA was the predictor, the above associations between RSA, ERS, social support, and interpersonal stress were reduced below the level of significance.

Age as a Covariate. Several effects were reduced below the level of significance when controlling for age, which suggests that age may be a confounding variable. In the paced breathing RSA condition, paced breathing RSA failed to predict ERS behavior when controlling for age. Further, ERS did not predict social support, interpersonal stress, or depression when controlling for age. In the free breathing RSA condition, the model was unaffected, as free breathing RSA did not predict ERS behavior when controlling for age.

CHAPTER IV

DISCUSSION

4.1 Discussion of Findings

This study examined the role of tonic PNS activity, indexed via resting RSA, in an interpersonal model of depression. Recent literature suggests that the PNS is involved in the regulation of social and emotional processes (Porges, 2007). However, current interpersonal models of depression are limited in that they do not consider biological aspects of social behavior. Therefore, the overall goal of this study was to examine whether the PNS predicted maladaptive social communication behaviors, such as ERS, in the onset and maintenance of depression symptoms. The first aim of this study was to test and reproduce a current conceptualization of an interpersonal model of depression, whereby ERS predicts depression via two separate mediational pathways: social support erosion and the generation of interpersonal stress. The first hypothesis, that depression is predicted by ERS behavior via social support erosion and interpersonal stress generation, was partially supported. As expected and consistent with prior findings, greater ERS behavior predicted higher levels of depression symptoms (Coyne, 1976a, 1976b; Joiner & Metalsky, 2001; Joiner & Schmidt, 1998). The results also support that ERS behavior

generates additional stress in one's interpersonal relationships, which subsequently increases depressive symptoms. Stress from interpersonal conflict and feelings of worthlessness and rejection may propagate a depressed mood (Potthoff et al., 1995). Contrary to this study's hypothesis, ERS did not significantly predict social support erosion, even in the wake of interpersonal stress. Furthermore, levels of social support did not predict depressive symptoms. These findings and those of prior studies support that ERS invokes, at a minimum, negative reactions from interpersonal relationships in the form of stressful interpersonal conflict rather than outright rejection (Joiner & Metalsky, 2001). This could be due to the burdening nature of reassurance-seeking behavior on social supports that become frustrated with the individual seeking reassurance. Moreover, the predictive relationship between ERS, stress, and depression indicates that interpersonal stressors are at least partially correlated with one's behavior, rather than by chance (Potthoff et al., 1995). However, it should be noted that the direction of the relationship between stress and depression has been questioned in other literature, as those with depression are prone to generating stress in their lives (Hammen, 1991; Hammen et al., 1992). Future research should continue to examine the directionality between stress and depression with the consideration of ERS as a probable agonist.

The lack of support for ERS as a predictor of social support erosion was partially unexpected in the initial model (Figure 1). Though ERS is significantly associated with rejection, its effect is often weak (Starr & Davila, 2008). Mixed findings could suggest that ERS predicts rejection under specific conditions, such as seeking reassurance over time. Joiner, Alfano, and Metalsky (1992) and Joiner and Metalsky (1995) found that ERS predicted rejection in depressed men, but not women, over a several week period. In

partial support of the deleterious nature of ERS on social support, trend effects were found when considering PNS activity. Thus, the inclusion of PNS activity as predictor of ERS behavior and subsequent rejection from social supports may be another specific condition. Regardless of the trend-level effects of ERS on social support erosion, the findings of this study and prior studies support that ERS generates turmoil in one's social life under certain conditions.

The second aim of this study was to examine whether social support erosion moderates the effects of interpersonal stress on depression. The results did not support the hypothesis that social support would act as a buffer against the effects of stress on depression. This finding is contrary to a long line of research that has shown social support to be a valuable resource against the effect of stress in a variety of populations (Cohen & Wills, 1985; Peirce et al., 2000; Raffaelli et al., 2013; Zhang et al., 2014). Social support was unrelated to reassurance-seeking behavior and depression, so the absence of a buffering effect of stress on depression is plausible. One reason for this is that the experience of stress in interpersonal relationships could prevent social supports from aiding reassurance-seeking individuals in an already tumultuous relationship climate, thus, it is possible that ERS erodes social support indirectly by increasing interpersonal stress. The perceptions of participants into the quality of their social supports may explain this finding. That is, those who engage in ERS behavior may misperceive the quality and abundance of support that is available to them. Further research is necessary to elucidate the impact ERS has on social supports, as a participant's perceived social support quality may not represent the actual quality of one's social support system.

The third aim of this study was to examine the PNS and its possible relationship to an interpersonal model of depression. We specifically hypothesized that low resting RSA would indirectly predict elevated symptoms of depression via ERS behavior, social support erosion, and interpersonal stress generation. High PNS activity, a purported marker of adaptive functioning, was surprisingly related to greater use of a maladaptive interpersonal response (ERS). This finding contradicts the hypothesis that decreased PNS activity will predict ERS behavior. Furthermore, subsequent ERS behavior predicted the erosion of social support, albeit at trend levels. High PNS activity also predicted greater social support at trend levels, which partially supports prior research that found high PNS activity fosters social well-being (Geisler et al., 2013). Prior research has linked high PNS activity to less externalizing and internalizing problems in children who successfully navigate social challenges (Hastings et al., 2008). In addition, high PNS activity is associated with greater levels of social engagement or, more specifically, the amount in which individuals use available social resources (Hopp et al., 2013). Nevertheless, that PNS activity significantly promoted ERS behavior and somewhat predicted elevated social support quality is counterintuitive. Thus, one can reason that the PNS may be related to social behavior in general. Given that ERS is an interpersonal strategy to elicit support, the results suggest the PNS may support such help seeking efforts irrespective of their adaptive or maladaptive nature. Another possible explanation for these contradictory findings may lie in the method of examining RSA. Recent research suggests that RSA patterns, specifically resting RSA combined with RSA reactivity (i.e., changes in RSA in response to stimuli), may moderate the effects of mood repair on depression (Yaroslavsky et al., 2013). RSA patterns, as opposed to examining resting RSA levels

and RSA reactivity separately, may moderate the effects of ERS behavior and social support on depression. When considering the PNS, social support failed to predict depressive symptoms. In light of the PNS partially predicting greater social support, it is possible that this relationship detracted from the overall effect of social support on depression. Prior studies suggest that high PNS activity protects against depressive symptoms if an individual has high levels of social support available to them (Hopp et al., 2013). Likewise, if social support is reduced, then high PNS activity may not buffer against depressive symptoms (Coifman & Bonnano, 2010; Hawkley & Cacioppo, 2010; Porges, 2007). Taken together, PNS activity predicted one's use of a maladaptive communication strategy, which subsequently predicted depression. The nonsignificant relationship between the PNS and depression is unsurprising as well, given the mixed literature on the ability of RSA to predict depression (Rottenberg, 2007). However, when in context with its link to social support, this finding may suggest that the PNS is related to interpersonal behaviors in general irrespective of their adaptive functioning. These findings suggest the need to consider psychophysiology as a context for understanding depression risk and interpersonal processes.

The findings also revealed that free breathing RSA did not predict ERS or have an effect on the model, which may be due to confounding factors. One factor may be respiration, which is known to confound free breathing RSA (Grossman & Taylor, 2007). For example, when participants are allowed to breathe freely, they may breathe in a state-like way other than how they typically breathe, which may confound estimates of their true RSA. Thus, it is possible individual differences in respiration influenced the findings. However, there has been an ongoing debate regarding the necessity of

controlling for respiration while interpreting RSA (Denver, Reed, & Porges, 2007; Grossman, Karemaker, & Wieling, 1991; Grossman & Taylor, 2007). Future studies may benefit from utilizing other ways to quantify RSA, such as through respiration, in addition to using ECG. The relationship between the PNS and reassurance seeking is complex given that PNS activity influences and is influenced by circuits, or regions, of the central nervous system (Thayer & Lane, 2000, 2009). More studies are needed to elucidate the interplay between central and peripheral nervous system responses in interpersonal models of depression.

Finally, controlling for age reduced the variables' associations below the level of significance. The effect of age on the results may be due to several reasons. First, the sample size of participants likely provided relatively low power given the complexity of the model. Second, the effect of age on the variables may be due to developmental differences as depression rates vary across age groups (Kessler, Avenevoli, & Merikangas, 2001). In addition, the types of social support one seeks may vary by age group. Starr and Davila (2008) suggest that individuals may seek social support and reassurance from different sources. For example, children often turn to parents, college students turn to their significant others, and married couples turn to their spouses for support. Third, little research has been done in ERS models to distinguish age and behavior differences. In fact, much of the work on ERS has been conducted on college-aged populations that range between 18 to 22 years of age (Starr & Davila, 2008). One potential hypothesis then, and consistent with what is to be expected, is that ERS behavior declines as individuals age. In our sample, approximately 57% of participants were older than 22 years of age, with these participants being an approximate mean age

of 29 years. Therefore, the present model may not hold among older adult populations. In sum, examining whether the relationship between the present variables can hold across age may be an important avenue for future research.

4.2 Limitations

The findings of this study should be considered with several limitations. First, causal inferences cannot be drawn because of the correlational design of this study. Second, this study may be limited by low sample size, which may reduce the ability to detect small effects that are related to RSA and depression (Rottenberg, 2007). Third, it is difficult to ascertain in which direction interpersonal stress operates, as stress generation may have a dynamic relationship between depression and interpersonal stress. Fourth, social supports were measured via the perception of the participant, which may not provide an accurate depiction of their actual social support quality. Prinstein, Borelli, Cheah, Simon, and Aikins (2005) found that greater levels of ERS behavior in participants predicted decreases in friendship quality as reported by participants' friends, and not by participants, which suggests that participants who excessively sought reassurance did not accurately perceive the quality of their friendships.

4.3 Future Research

The design of this study reveals several limitations that should be addressed in future research. First, longitudinal studies of ERS behavior may provide promising results of how social support erosion promotes depressive symptoms. Future study designs should incorporate ecological momentary assessment (EMA) so researchers can observe whether PNS activity predicts ERS behavior and depression in daily life. Second, higher sample sizes than that of this study may reveal effects not otherwise found

between interpersonal models of depression and the PNS. Third, future studies should distinguish the directionality of interpersonal stress as it relates to ERS and depression before drawing causal inferences. Fourth, including self-reports from participants' social supports themselves may provide a more accurate depiction of participants' social support quality.

4.4 Strengths and Clinical Implications

This study has several strengths despite its limitations. First, it is the foremost study to integrate the PNS, a purported physiological system that supports interpersonal relationships, into an interpersonal model of depression. Prior studies have examined the PNS as it relates to social support, social engagement, and depressive symptoms. Yet, no known research has examined specific interpersonal behaviors, such as ERS, in PNS activity and the onset of depression. Second, the community sample of this study may increase the generalizability of the findings. Third, the wide age range of participants may also increase the generalizability of these findings. Taken together, the results of this study reinforce the polyvagal theory and partially reinforce an interpersonal model of depression, in that the PNS is involved in social behaviors that contribute to stress and depression risk (Hopp et al., 2013; Porges, 2007; Potthoff et al., 1995).

This study is clinically significant because interpersonal models inform current treatments for depression but do not consider the role of physiological processes, such as the PNS, that may serve as novel targets of treatment. Given that PNS activity is inexpensive to measure, and is modifiable, findings from this study may be portable into clinical practice. Furthermore, this study will help researchers to better understand the physiological underpinnings of depression, which may inform prevention efforts. Finally,

this study is clinically and scientifically important because it combines behavioral and biological observations as advocated by the National Institute of Mental Health (NIMH, 2013).

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APPENDIX

Appendix A

Table I. Descriptive statistics and bivariate correlations among demographics, ERS, social support, interpersonal stress, RSA measures, and depression ($N = 65$).

Measures		M (SD)	2.	3.	4.	5.	6.	7.	8.
1.	Sex	.61 (.49)	-.25*	.23	-.05	.05	.06	.02	.21
2.	Age	28.72 (11.89)		-.27*	-.13	-.19	-.31*	-.17	-.06
3.	DIRI-RS	2.87 (1.76)			-.18	.51**	.20	.00	.54**
4.	MSSS	60.11 (15.59)				-.28*	.18	.13	-.43**
5.	NLEQ	77.55 (26.96)					-.11	-.17	.60**
6.	RSAPB	6.91 (1.26)						.67**	-.01
7.	RSAFB	6.35 (1.27)							-.02
8.	CES-D	22.47 (13.20)							---

Note. Sex = high value represents males; Age = high value represents higher age; DIRI-RS = Depressive Interpersonal Relationships Inventory – Reassurance Seeking subscale; MSSS = Multidimensional Scale of Perceived Social Support; NLEQ = Negative Life Events Questionnaire; RSAPB = RSA during paced breathing; RSAFB = RSA during free breathing; CES-D = Center for Epidemiologic Studies Depression Scale.

* $p < .05$. ** $p < .01$.

Appendix B

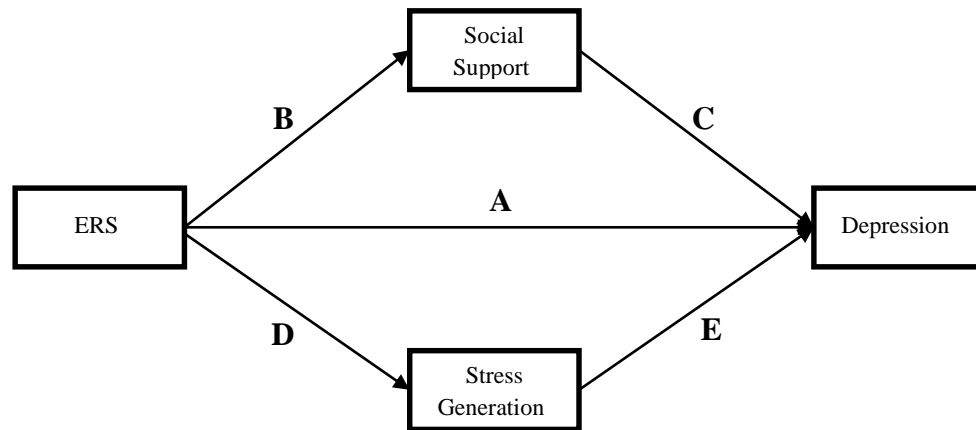


Figure 1. The present interpersonal model of depression. This figure illustrates the hypothesized mediational effects of ERS (A), social support (B & C), and interpersonal stress generation (D & E) on depressive symptoms.

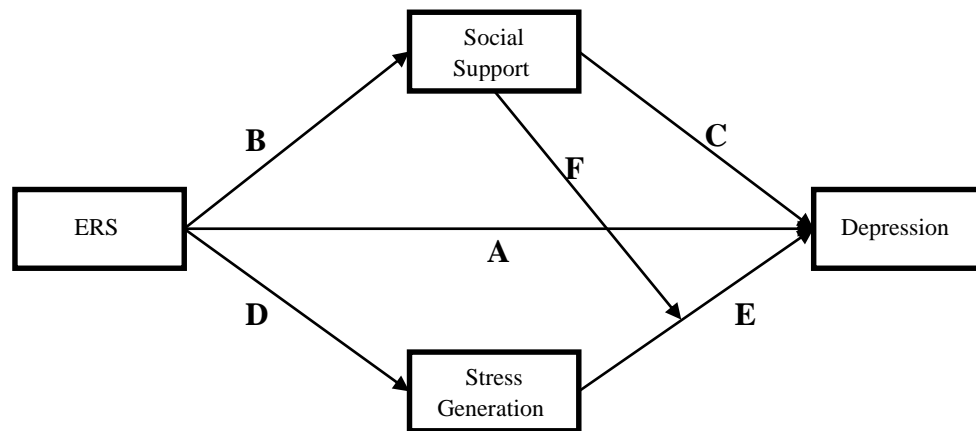


Figure 2. Interpersonal model of depression with social support as a buffer. This figure illustrates the hypothesized moderation of social support (F) as a buffer from the effects of interpersonal stress on depression (E). A = direct effect of ERS on depression symptoms; B = direct effect of ERS on social support; C = direct effect of social support on depression symptoms; D = direct effect of ERS on interpersonal stress generation.

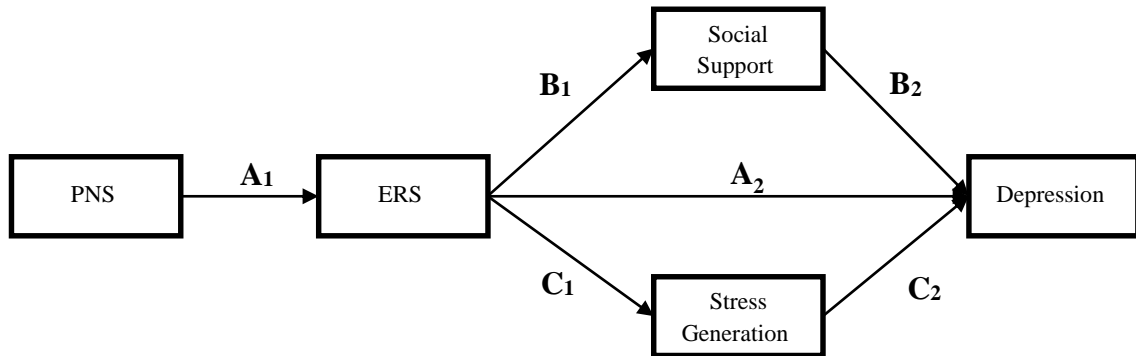


Figure 3. Conceptualization of the indirect relationship between the PNS, ERS, and depression. This figure illustrates the hypothesized mediation effects of the PNS and ERS (A_1 & A_2), social support (B_1 & B_2), and interpersonal stress generation (C_1 & C_2) on depressive symptoms.

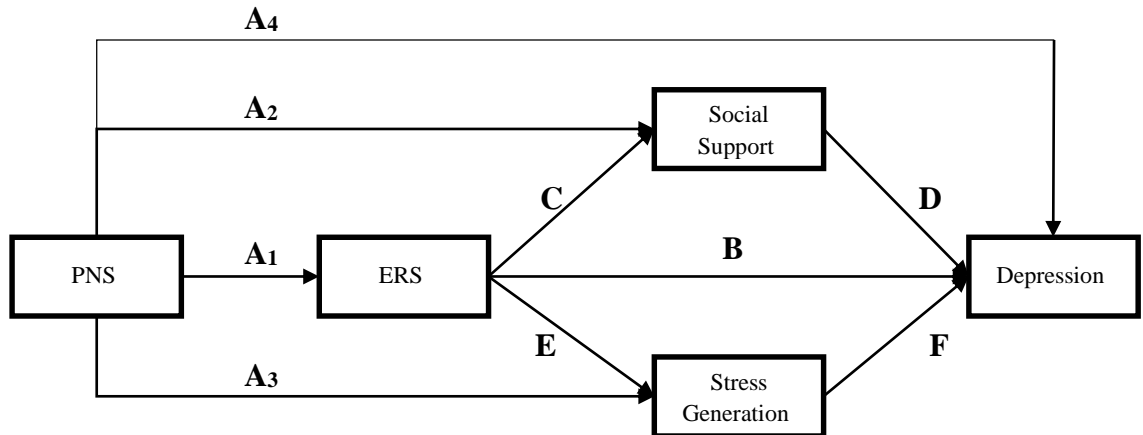


Figure 4. Model of the direct relationship between the PNS and depression. This figure illustrates a competing model to Figure 3, whereby the PNS directly predicts ERS (A_1), social support (A_2), interpersonal stress generation (A_3), and depressive symptoms (A_4).

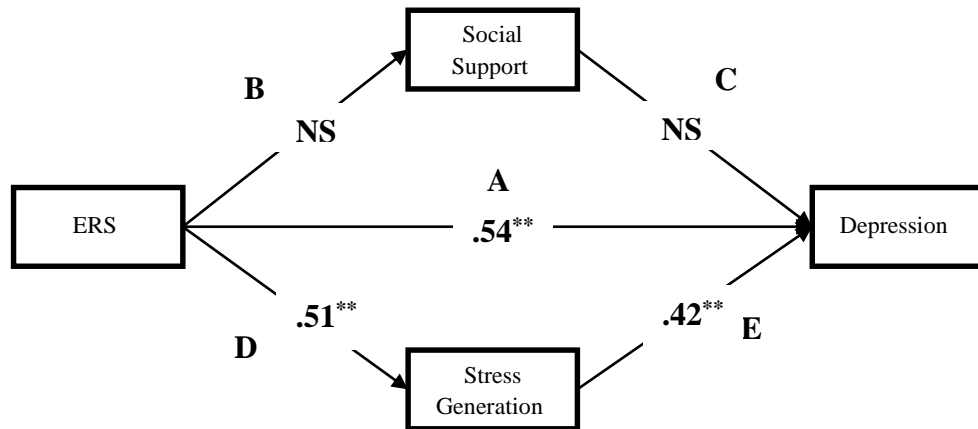


Figure 5. Standardized effects of ERS on depression via social support and interpersonal stress. A = direct effect of ERS on depression symptoms; B = direct effect of ERS on social support; C = direct effect of social support on depression symptoms; D = direct effect of ERS on interpersonal stress generation; E = direct effect of interpersonal stress generation on depression symptoms.

$**p < .01$. NS = Not Significant.

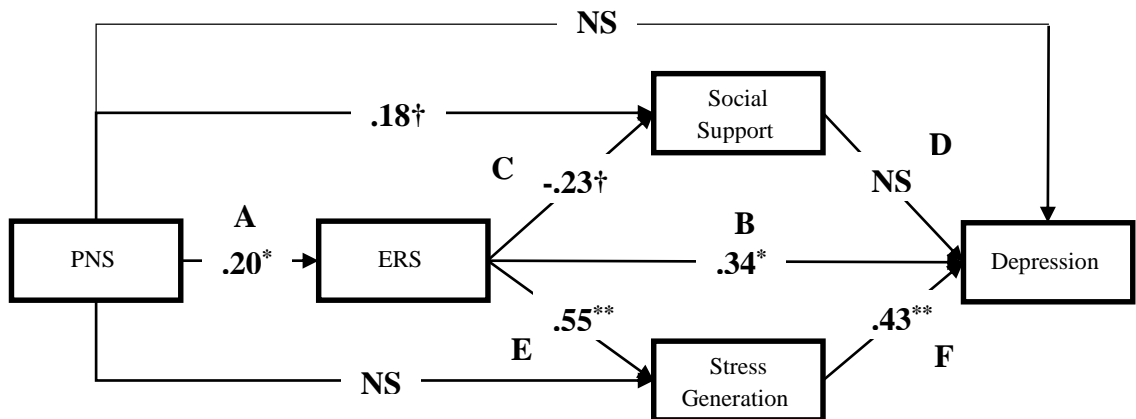


Figure 6. Standardized effects of the PNS and its relationship on ERS, social support, stress generation, and depression. A = direct effect of the PNS on ERS; B = direct effect of ERS on depression symptoms; C = direct effect of ERS on social support; D = direct effect of social support on depression symptoms; E = direct effect of ERS on interpersonal stress generation; F = direct effect of interpersonal stress generation on depression symptoms.

$*p < .05$. $**p < .01$. $^\dagger p < .10$. NS = Not Significant.