Daily Unmet Interpersonal Needs Among Adolescents At Lower and Higher Risk for Suicidal Ideation & The Moderating Role of Respiratory Sinus Arrhythmia

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ABSTRACT

Daily Unmet Interpersonal Needs Among Adolescents At Lower and Higher Risk for Suicidal Ideation & The Moderating Role of Respiratory Sinus Arrhythmia

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The Interpersonal Theory of Suicide posits that unmet interpersonal needs of thwarted belongingness and perceived burdensomeness are associated with the onset and severity of suicidal ideation. Research to date has largely examined the between-person associations of unmet interpersonal needs with suicide risk. Still, unmet interpersonal needs have been shown to vary significantly over time among adult clinical populations, yet little is known about the daily predictors and emotional impacts of this variability among adolescents at lower and higher risk for suicidal ideation. This dissertation sought to examine the day-to-day variability in unmet interpersonal needs and explore the risk factors for, and emotional consequences of, within-person fluctuations in unmet interpersonal needs among a sample of fifty-five adolescents with and without major depressive disorder (MDD), considered at higher- and lower-risk for suicidal ideation, respectively. The first study examined the day-to-day variability in unmet interpersonal needs and between- and within-person associations with emotional pain. The results of this study demonstrated that adolescents at higher risk for suicidal ideation had greater frequency, severity, and variability in unmet interpersonal needs. Nonetheless, adolescents at lower and higher risk for suicidal ideation both reported greater emotional pain on days when they reported greater perceptions of unmet interpersonal needs than usual for them. The second study sought to examine whether respiratory sinus arrhythmia (RSA), a physiological index of emotion regulation in social situations, moderated the within-person fluctuations in unmet interpersonal needs in response to negative social interactions. Results from this study demonstrated that participants reported more unmet interpersonal needs on days when they reported more negative social interactions. Among higher-risk adolescents, higher RSA was associated with less daily burdensomeness compared to their counterparts with lower RSA, especially on days with fewer negative social interactions. Taken together, these studies demonstrated that adolescents at lower and higher risk for suicidal ideation exhibit similar risk factors for and emotional outcomes of within-person fluctuations in unmet interpersonal needs. Thus, the longitudinal processes via which risk for unmet interpersonal needs and suicidal ideation is accrued across these two groups may be a matter of degree rather than kind.

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Contribution of Authors

This thesis consists of two manuscripts. The relative contribution of my colleagues to each manuscript is outlined below.

Study 1: MacNeil, S., Renaud, J., & Gouin, J.-P. (Under Review**).** Fluctuations in unmet interpersonal needs and emotional pain among adolescents at lower and higher risk for suicidal ideation: a daily diary study. *Journal of Clinical & Social Psychology.*

SM and JPG designed the study. SM collected the data under the clinical supervision of JR and JPG. SM prepared and analyzed the data, and wrote the first draft of the manuscript. All authors edited subsequent versions of the manuscript and approved the final manuscript.

Study 2: MacNeil, S., Renaud, J., & Gouin, J.-P. (2023**).** Fluctuations in unmet interpersonal needs and emotional pain among adolescents at lower and higher risk for suicidal ideation: a daily diary study. *Suicide and Life-Threatening Behaviors, 53*, 597-612. https://doi-org.lib-ezproxy.concordia.ca/10.1111/sltb.12967

SM and JPG designed the study. SM collected the data under the clinical supervision of JR and JPG. SM prepared, and analyzed the data, and wrote the first draft of the manuscript. All authors edited subsequent versions of the manuscript and approved the final manuscript.

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Chapter 1: General Introduction

Suicidal ideation ranges in intensity from passive thoughts about death to thoughts of desire for and planning of one's own death. Suicidal ideation also ranges in frequency, such that these thoughts may occasionally occur fleetingly, or may be experienced daily and persistently for many hours (Silverman et al., 2007). Suicidal ideation typically emerges in adolescence and quickly increases in prevalence from 12 to 18 years old (Glowinski et al., 2001; Nock et al., 2013). Among adolescent population-based samples, the prevalence of suicidal ideation has been estimated between 12% and 33% (Brezo et al., 2007; Evans et al., 2005; Nock et al., 2013; Orri et al., 2020), compared to approximately 9% in older age groups (Nock et al., 2008). Certain sub-populations of adolescents also carry a higher burden of suicidal ideation, with prevalence estimates as high as 85% in clinically-referred samples of adolescents with a mood disorder such as major depressive disorder (MDD; Cash & Bridge, 2009). Moreover, approximately one third of adolescents with suicidal ideation transition towards making a suicide attempt (Nock et al., 2013), and the vast majority experience this transition within the first year of onset of suicidal ideation (Nock et al., 2013; Silverman & Berman, 2014). Greater frequency of suicidal ideation is also associated with sooner transition to a first suicide attempt in adolescence and young adulthood (Miranda et al., 2014). Thus, insight into the risk factors associated with the onset, intensity, and frequency of suicidal ideation is important to identify high-risk adolescents and mitigate the transition to suicide attempts.

Decades of suicide research have identified risk factors spanning individual differences in identity, psychological, biological, environmental, and social characteristics to better recognize those at greater risk for suicidal ideation and attempts (see Franklin et al., 2017; Nock et al., 2016 for reviews and discussion). More recently, four contemporary theories of suicide converge

in differentiating suicidal ideation from suicide attempts as distinct clinical phenomena with distinct risk factors and mechanisms (Klonsky et al., 2018). Among these theories, two of them distinguish broad categories of risk factors that contribute to the onset of suicidal ideation and those that contribute to the transition towards suicide attempts. The Integrated Motivational-Volitional Theory of Suicide distinguishes motivational risk factors, which are associated with thoughts of and intent for suicide, from volitional risk factors, which prompt the transition from suicidal ideation to suicidal behaviours (O'Connor, 2011; O'Connor & Kirtley, 2018). The Fluid Vulnerability Theory differentiates the baseline suicidal state, which is thought to vary between individuals based on personal history and accumulated risk factors over time, from acute suicidal ideation and behaviours that are triggered by prompting environmental events (Rudd, 2006). These two contemporary theories therefore emphasize the categorical differences between risk factors associated with suicidal ideation from those associated with suicide attempts.

In contrast to these theories that organize suicide risk factors, two other contemporary theories of suicide focus on the role of specific interpersonal and psychological factors that are associated with the onset of suicidal ideation and the transition towards suicidal ideation. The Three-Step Theory of Suicide outlines that pain, sometimes physical but most often emotional, and hopelessness are necessary precursors to the onset of suicidal ideation (step 1). Suicidal ideation becomes more severe as individuals increasingly lack connectedness to others (step 2), and eventually progresses to suicide attempts based on individual dispositional and acquired capability for suicide over time (step 3; Klonsky & May, 2015). In turn, the Interpersonal Theory of Suicide (IPTS; Joiner, 2005; Van Orden et al., 2010) postulates that individuals develop suicidal ideation in response to perceptions that they do not belong and are a burden to others. As individuals become more hopeless over time about their poor belongingness and

burdensomeness improving in the future, suicidal ideation progresses to increasingly lethal suicide attempts as individuals acquire the capability for suicide over time. Thus, these theories outline specific risk factors associated with between-person risk in suicidal ideation and attempts, and emphasize the longitudinal, within-person mechanisms that contribute to increasing suicide risk over time. These theories build upon decades of suicide research by acknowledging that, in addition to predicting *who* is at greater risk for suicidal ideation and attempts, research examining *when* individuals are at increased risk for suicidal ideation and attempts is necessary to improve timely interventions with high-risk adolescents.

The current dissertation is anchored within the tenets of the IPTS given that this theory outlines the role of specific psychological risk factors in the onset and progression of suicide risk. More specifically, the IPTS argues that suicidal ideation emerges when fundamental interpersonal needs of thwarted belongingness and perceived burdensomeness are not met. *Thwarted belongingness* refers to feelings of loneliness, social isolation, or social disconnection that disrupt the basic human need to feel connected to others. *Perceived burdensomeness* refers to feelings that one is not needed by and makes things worse for others. These unmet interpersonal needs of thwarted belongingness and perceived burdensomeness are posited to individually contribute to passive suicidal ideation and synergistically contribute to more persistent and active suicidal ideation. As unmet interpersonal needs and suicidal ideation persist, individuals may develop hopelessness about their interpersonal needs being met in the future. Such hopelessness may prompt repeated exposure and habituation to increasingly physically damaging forms of self-harm, thereby acquiring the capability for suicide, which is required for increasingly lethal suicide attempts (Van Orden et al., 2010). In support of this theory, meta-analytic evidence from cross-sectional and longitudinal studies supports stronger associations of

thwarted belongingness (r = .37) or perceived burdensomeness (r = .48) with suicidal ideation compared to suicidal attempts (rs = .11 and .25, respectively). Moreover, the interaction of unmet interpersonal needs was associated with suicidal ideation above and beyond their main effects (r = .12-.14; Chu et al., 2017). Taken together, individuals with more intense perceptions of both thwarted belongingness and perceived burdensomeness are expected to report the greatest concurrent and longitudinal severity of suicidal ideation.

Research examining the validity of the IPTS has been more prominent among adult samples compared to adolescent samples (Chu et al., 2017). Yet, adolescents may be particularly susceptible to the effects of unmet interpersonal needs on risk for suicidal ideation given that this developmental period is marked by important social transitions including the increasing importance of peer influence and the decreasing importance of family influence on adolescent self-evaluations (Blakemore & Mills, 2014; Larson et al., 1996; Larson & Richards, 1991). Moreover, adolescence is considered a critical period for the effects of interpersonal stress on mental health outcomes (Blakemore & Mills, 2014; Sisk & Gee, 2022). Research among adolescent samples can help shed light on the developmental trajectory from unmet interpersonal needs to suicide given that suicidal ideation often develops in adolescence and persists into adulthood (Chu et al., 2017). Early research relying on proxy measures of thwarted belongingness (e.g. social support, attachment, or quality of peer and family relationships) and perceived burdensomeness (e.g. low self-esteem, involvement in youth programs, out-of-home placement) does support the associations between these unmet interpersonal needs and suicidal ideation (see Stewart et al., 2017 for review). Evidence is also accumulating in support of the association of direct measures of thwarted belongingness and perceived burdensomeness with the onset and severity of suicidal ideation in adolescence (Calear et al., 2021; Eaddy et al., 2019;

Horton et al., 2016; Hunt et al., 2022; Kang et al., 2019; Opperman et al., 2015; Stewart et al., 2017; Wolford-Clevenger et al., 2020; Zullo et al., 2021). However, much more research has focused on thwarted belongingness than perceived burdensomeness (Buchman-Schmitt et al., 2014), likely due to comparatively delayed understanding of the operationalization, causes, and consequences of burden-related cognitions, particularly among adolescents (Hill, Hunt, et al., 2019). Thus, research aiming to understand the experience of unmet interpersonal needs in adolescence, including their antecedents and associations with emotional and suicidal distress among adolescents at lower and higher risk for suicide, is important to better understand the processes via which suicidal ideation emerges.

Studies examining the prevalence of perceptions of thwarted belongingness and perceived burdensomeness suggest that they occur at varying rates and severity within the general population (Van Orden et al., 2010). In a cross-sectional, representative population-based study, 84% of the population aged 14 and up reported perceptions of thwarted belongingness to some extent (Hallensleben et al., 2016). Research estimating rates of thwarted belongingness among adolescents specifically is scarce. However, loneliness, an important facet of thwarted belongingness (Van Orden et al., 2010), peaks in prevalence during adolescence and subsequently stays relatively stable throughout adulthood (Mund et al., 2020). It has been estimated that approximately 80% of adolescents experience loneliness to some extent (Hawkley & Cacioppo, 2010), with estimates of moderate loneliness as high as 71% in late adolescence (Beutel et al., 2017; Qualter et al., 2015). Moreover, rates of "severe" loneliness are reported by approximately 4% of the general population, but by approximately 64% of adolescents with depression (Garnefski & Diekstra, 1997; Qualter et al., 2015). Similarly, meta-analytic evidence demonstrates moderate correlations between loneliness and depression in adolescence (r = .48;

Dunn & Sicouri, 2022). In contrast to the near ubiquity of perceptions of thwarted belongingness, only about 25% of individuals aged 14 and up reported perceptions of burdensomeness (Hallensleben et al., 2016). Instead, burdensomeness seems more prevalent among specific subgroups of the population, such as among individuals with medical needs reporting prevalence as high as 70% (Wilson et al., 2017), or older adults reporting prevalence at around 30% (Hallensleben et al., 2016). Empirical studies also report moderate to large correlations of burdensomeness with depressive symptoms in both clinical and community samples of adults (Bell et al., 2018; Nalipay & Ku, 2019; Silva et al., 2015; Smith et al., 2018) and adolescents (Buitron et al., 2016; Hill, Hunt, et al., 2019). Thus, unmet interpersonal needs of thwarted belongingness and perceived burdensomeness occur to varying extents among adolescents, and seem to be experienced more frequently and intensely by adolescents with depression.

In addition to understanding the prevalence of unmet interpersonal needs, research has sought to identify emotional, cognitive, and social risk factors for thwarted belongingness and perceived burdensomeness. Individual differences in negative affectivity such as depression (Hallensleben et al., 2020; Kang et al., 2019; Venta et al., 2014), anxiety (Hill et al., 2017), neuroticism (Cramer et al., 2016; Hartley et al., 2019), and emotion regulation difficulties (Eaddy et al., 2019; Swee et al., 2020) have been associated with between-person differences in the severity of unmet interpersonal needs in adolescence and young adulthood. Among adolescents with and without depression, negative interpersonal experiences, such as peer victimization (Brailovskaia et al., 2020), low parental warmth (Buitron et al., 2020), negative and social schemas such as attachment insecurity and interpersonal mistrust (Hill, Penner, et al., 2019; Hunt et al., 2022; Venta et al., 2014), deficits in social problem-solving (Chu et al., 2018),

negative in-person and online interactions (Donker et al., 2014; Moberg & Anestis, 2015), as well as chronic interpersonal stress (Buitron et al., 2016) have also been associated with increased thwarted belongingness and perceived burdensomeness in adolescence and young adulthood. Thus, the severity of emotional and interpersonal challenges are important predictors of unmet interpersonal needs in adolescence. Yet, some adolescents may by more vulnerable than others to interpersonal stress, differentially impacting the severity of perceptions of unmet interpersonal needs in response to interpersonal stress.

Respiratory sinus arrhythmia (RSA) is a measure of cardiac vagal tone considered to be a trans-diagnostic marker of emotional and social self-regulation (Beauchaine, 2015; Porges, 2003; Sgoifo et al., 2009; Thayer & Brosschot, 2005; Thayer & Lane, 2000). Cardiac activity is regulated by the dual innervation of the heart by both parasympathetic and sympathetic branches of the autonomic nervous system, which contribute to the variability in time intervals between consecutive heart beats (Saul, 1990). At rest, the parasympathetic nervous system sends dominant inhibitory inputs to the sinoatrial node of the heart via the vagus nerve, reducing the intrinsic speed at which the heart beats. This "vagal brake" on heart rate is temporary lifted during the inspiration phase of the respiration cycle (Berntson et al., 1997; Kemp et al., 2017), leading to changes in heart beat intervals manifested rapidly within 0.5 seconds (Shaffer & Venner, 2013). In addition to parasympathetic influences, the sympathetic nervous system sends slower-acting excitatory inputs to the sinoatrial node of the heart via the stellate ganglion nerves, manifesting over the course of 1 to 4 seconds (Berntson et al., 1997; Shaffer et al., 2014). Consequently, RSA represents the variability in beat-to-beat time intervals resulting primarily from the faster-acting, vagally-mediated parasympathetic output at the sinoatrial node of the heart (Berntson et al., 1997).

Two major theoretical frameworks outline the utility of RSA as an index of social and emotional regulation. The Neurovisceral Integration Model (Thayer & Lane, 2000) posits that RSA indexes the efficiency of a neural circuit promoting flexible and adaptive responses to the environment. At rest, the prefrontal cortex exerts an inhibitory influence upon the amygdala, inhibiting hypervigilance and energy mobilization in the absence of threat (Thayer & Brosschot, 2005; Thayer & Lane, 2000). The top-down inhibition of the amygdala and of associated sympathetic projections to the heart allows the organism to maintain a state of energy conservation modulated by the increased parasympathetic influence on the heart via the vagal nerve. The output of this neural system is indexed by RSA, whereby higher RSA at rest represents greater top-down inhibitory strength of the prefrontal cortex via the vagal nerve on the heart, required for controlling affective, cognitive, and behavioural resources to maintain better psychological and physiological flexibility (Appelhans & Luecken, 2006; Kemp et al., 2017).

In addition, the Polyvagal Theory (Porges, 2001) posits that RSA indexes a neural system that supports social engagement behaviours. Specifically, the autonomic nervous system has evolved to integrate the regulation of cardiac output, facial muscles, and the vocal apparatus via efferent and afferent projections of the vagal nerve, thereby coordinating cardiac functioning with emotional expression and social communication (Porges, 2003). According to this theory, higher RSA supports greater flexibility in rapidly and adaptively engaging and disengaging attention, facial expressions, and behaviour from social situations. Higher RSA is also associated with greater social awareness and emotional and physiological regulation from positive social interactions. Taken together, in both of these models resting RSA is a biomarker of the strength of a top-down neurophysiological system that supports emotion regulation during social

interactions, and may confer risk for perceptions of unmet interpersonal needs and, consequently, suicidal ideation, in response to interpersonal stress.

One way RSA may moderate perceptions of unmet interpersonal needs (and subsequent suicidal ideation) is through the differential modulation of social functioning and emotional responses to interpersonal stress. Evidence suggests that greater resting RSA is associated with better interpersonal functioning, including greater accuracy in identifying others' emotions (Quintana et al., 2012), and greater capitalization on positive emotions and events (Kok & Fredrickson, 2010) among adults. In contrast, among children and adolescents, lower resting RSA has been associated with less prosocial behaviours (Beauchaine et al., 2013; Cui et al., 2015), social phobia (Schmitz et al., 2011), and less behavioural warmth over time (Diamond & Cribbet, 2013). In addition, resting RSA has been found to moderate the association between negative social experiences and affective responses. For example, studies have demonstrated that, among adolescents with lower resting RSA, interpersonal stressors were associated with externalizing behaviours (Van der Graaff et al., 2016) and internalizing symptoms (Khurshid et al., 2019; McLaughlin et al., 2015), but these association were attenuated among participants with higher RSA. Conversely, higher resting RSA was associated with better adjustment to loss of social relationships among adolescents with more attachment avoidance (Fagundes et al., 2012). Thus, individuals with higher resting RSA may be better able to modulate the impact of interpersonal stress on their mood, on their perceptions of belongingness and burdensomeness, and on subsequent suicidal ideation.

Most research examining risk factors and outcomes associated with unmet interpersonal needs have relied upon between-person research designs. Yet, thwarted belongingness and perceived burdensomeness are considered dynamic phenomena, such that individual perceptions

of burdensomeness and thwarted belongingness are expected to vary in severity over time (Van Orden et al., 2010). Antecedents of such within-person variability and associations with subsequent changes in suicidal distress cannot be examined using traditional between-person designs. Instead, within-person research designs relying upon repeated measurements of risk factors, unmet interpersonal needs, and emotional distress over time seek to determine *when* individuals report greater suicidal risk. Within-person associations are considered independent from between-person associations, from which they may differ in magnitude or direction (Wang & Maxwell, 2015). Compared to traditional longitudinal designs, daily diary designs include repeated measurements over hours or days to observe reliable within-person change over time, and examine predictors of and individual differences in such within-person changes (Bolger et al., 2003). Moreover, these short-term within-person changes are thought to contribute to patterns of longitudinal change over the longer-term (Nesselroade, 1991). As such, daily diary studies are useful to understand *when* adolescents experience unmet interpersonal needs over the short-term, which can provide insight into how longer-term suicide risk is accrued.

Few studies to date have examined the within-person variability in unmet interpersonal needs, all of them among adults and adolescents with psychopathology. These studies demonstrate significant within-person changes in severity of perceptions of burdensomeness and thwarted belongingness over hours and days (Hallensleben et al., 2019; Kleiman et al., 2017). However, little is known about the daily fluctuations in perceptions of burdensomeness and thwarted belongingness among adolescents without psychopathology. Moreover, within-person changes in unmet interpersonal needs were associated with subsequent changes in suicidal ideation (Czyz et al., 2021; Forkmann et al., 2018; Glenn et al., 2021; Kleiman et al., 2017; Kyron et al., 2018; Parrish et al., 2021; Rath et al., 2019). Yet, despite the high prevalence of

suicidal ideation in adolescence, those without psychopathology may experience lower frequency and intensity of suicidal ideation that may not be captured during intensive longitudinal studies. This comparatively decreased rate of suicidal ideation may limit the study of within-person unmet interpersonal needs and suicidal distress among non-clinical samples. One solution is to examine associated fluctuations in pre-suicidal distress. The Three-Step Theory of suicide (Klonsky & May, 2015) proposes that emotional pain, defined as intense, frequent, and intolerable negative affective states (Orbach et al., 2003), when combined with feelings of hopelessness about a future without such emotional pain, is posited to contribute to a decreased desire to live and, eventually, to the onset of suicidal ideation. Empirical research also indicates that unmet interpersonal needs are associated with worse psychological well-being and greater emotional pain (Lear et al., 2018; Leary et al., 2013; Y. Liu et al., 2022; McCallum et al., 2021; Verhagen et al., 2018). Thus, within-person fluctuations in unmet interpersonal needs may be associated with changes in emotional pain among adolescents with and without psychopathology, considered at higher and lower risk for suicidal ideation, respectively.

Taken together, unmet interpersonal needs of thwarted belongingness and perceived burdensomeness are important theoretical and empirical predictors of suicidal ideation. Prior work suggests that negative interpersonal experiences and depression are associated with more severe perceptions of burdensomeness and thwarted belongingness. Subsequently, these more severe perceptions of unmet interpersonal needs are synergistically associated with severity of suicidal ideation. Yet, research has primarily examined these associations using between-person research designs and clinical samples, and little is known about the risk factors and emotional consequences of daily fluctuations in perceived burdensomeness and thwarted belongingness among adolescents without psychopathology. In two manuscripts, the current dissertation

examines within-person risk factors for and emotional consequences of unmet interpersonal needs among adolescents with and without MDD, who may be respectively considered at the higher and lower end of the spectrum of clinical risk for suicidal ideation. Specifically, the first manuscript examined the occurrence, severity, and chronicity of unmet interpersonal needs as well as average and daily associations with emotional pain across these two risk groups. The second manuscript examined fluctuations in unmet interpersonal needs in response to daily negative social interactions across higher and lower risk groups, and whether this association was moderated by between-person differences in social emotion regulation, as indexed by RSA.

Chapter 2: Fluctuations in unmet interpersonal needs and emotional pain among adolescents at lower and higher risk for suicidal ideation: a daily diary study

MacNeil, S., Renaud, J., & Gouin, J.-P. (Under Review**).** Fluctuations in unmet interpersonal needs and emotional pain among adolescents at lower and higher risk for suicidal ideation: a daily diary study. *Journal of Clinical and Social Psychology.*

Abstract

Introduction: Emotional pain and unmet interpersonal needs, i.e. thwarted belongingness and perceived burdensomeness, are associated with increased risk for suicidality. This study examined their daily occurrence and variability among adolescents at both lower and higher risk for suicidality, and whether unmet interpersonal needs predicted daily emotional pain.

Method: Fifty-five adolescents with major depressive disorder (MDD; i.e. higher risk group) and without MDD (i.e. lower risk group) completed 10 consecutive daily diaries assessing perceptions of burdensomeness, loneliness (as a proxy for thwarted belongingness) and emotional pain. Descriptive analyses explored the occurrence, severity, and variability in these daily experiences. Mediation analyses explored whether unmet interpersonal needs severity accounted for group differences in emotional pain. Within-person associations of daily unmet interpersonal needs with emotional pain were examined using multilevel modeling.

Results: The higher-risk group reported greater occurrence, severity, and variability in day-to-day loneliness, burdensomeness, and emotional pain, compared to the lower-risk group. Unmet interpersonal needs mediated group differences in emotional pain. Daily unmet interpersonal needs independently and interactively predicted daily emotional pain across both groups, such that greater emotional pain was experienced on days when participants reported greater loneliness and burdensomeness than average for them.

Conclusion: Although adolescents at higher risk for suicidality presented with more unmet interpersonal needs and emotional pain, the within-person associations between daily unmet interpersonal needs and emotional pain were similar between adolescents with and without MDD. Daily fluctuations in unmet interpersonal needs and emotional pain over time may represent a potential mechanism via which increasing risk for suicidal ideation is accrued longitudinally.

Keywords*: emotional pain, loneliness, perceived burdensomeness, daily diary, adolescence*

From a life course perspective, adolescence is a developmental period often marked by the emergence of suicidal ideation. Prevalence rates of suicidal ideation increase from 12 to 18 years old, ranging between 12% and 33% in population-based samples (Brezo et al., 2007; Nock et al., 2013; Orri et al., 2020), to as high as 85% in clinically-referred samples of adolescents with mood disorders such as major depressive disorder (MDD) or dysthymia (Cash & Bridge, 2009). Many theoretical models and empirical studies have outlined factors associated with greater risk for suicidal ideation spanning psychological, biological, social, environmental, and identity characteristics (see Nock et al., 2016 for review and discussion). However, most people in the general population present at least one risk factor for suicidal ideation at any given time (Franklin et al., 2017). This non-specificity of suicide risk factors suggests that, in addition to predicting *who* is at greater risk for suicidal ideation, research examining *when* specific factors are associated with increased suicidality is necessary to improve timely interventions with high-risk adolescents.

The Interpersonal Theory of Suicide (IPTS; Van Orden et al., 2010) proposes that unmet interpersonal needs of thwarted belongingness and perceived burdensomeness are important risk factors for the development of suicidal ideation. Thwarted belongingness refers to feelings of loneliness, social isolation, or social disconnection that disrupt the basic human need to feel connected to others, whereas perceived burdensomeness refers to feelings that one is not needed by and makes things worse for others. It is posited that these unmet interpersonal needs occur on a spectrum of severity within the population (Van Orden et al., 2010). A cross-sectional, representative population-based study demonstrated the relatively high frequency of unmet interpersonal needs, with 84% of the sample aged 14 and up reporting feelings of thwarted belongingness, and approximately 25% reporting feelings of perceived burdensomeness

(Hallensleben et al., 2016). Greater severity of unmet interpersonal needs are also moderately correlated with the severity of depressive symptoms (Bell et al., 2018; Nalipay & Ku, 2019; Silva et al., 2015; Smith et al., 2018). Thwarted belongingness and perceived burdensomeness are also independently and interactively associated with the onset and severity of suicidal ideation, such that suicidal ideation severity was highest among those reporting greater thwarted belongingness *and* perceived burdensomeness (Chu et al., 2017; Stewart et al., 2017). Research has also shown that unmet interpersonal needs mediated the association between depression and suicidal ideation among adults (Campos & Holden, 2016; Jahn et al., 2011; Mitchell et al., 2018; Rainbow et al., 2021). Thus, unmet interpersonal needs occur to varying extents within the general population, but seem more severe among individuals with major depressive disorder (MDD), partially accounting for the greater severity of suicidal ideation within this population.

In addition, the Three-Step Theory of suicide (Klonsky et al., 2021; Klonsky & May, 2015) suggests that feelings of emotional pain precede the development of suicidal ideation. Despite differing definitions and conceptualizations, many theorists outline that essential to the experience of emotional pain are the intensity and frequency of negative emotions, as well as feelings of intolerability and loss of control over the negative emotional state (Mee et al., 2011; Orbach et al., 2003; Pachkowski et al., 2019; Schneidman, 1998). This theory proposes that intense, frequent, and intolerable negative affective states (Orbach et al., 2003), when combined with feelings of hopelessness about a future without such emotional pain, are posited to contribute to a decreased desire to live and, eventually, to the onset of suicidal ideation (Klonsky & May, 2015).

Empirical research indicates that unmet interpersonal needs are associated with greater emotional pain. Some cross-sectional studies among young adult and adult community samples

have reported small to large correlations between thwarted belongingness and perceived burdensomeness with indices of worse psychological well-being (Leary et al., 2013; Y. Liu et al., 2022; McCallum et al., 2021; Verhagen et al., 2018) and greater emotional pain (Lear et al., 2018). Furthermore, increased unmet interpersonal needs were associated with greater severity of depressive symptoms in both clinical and community samples of adults (Bell et al., 2018; Nalipay & Ku, 2019; Silva et al., 2015; Smith et al., 2018) and adolescents (Buitron et al., 2016; Hill, Hunt, et al., 2019). Thus, individuals with MDD experience increased levels of both unmet interpersonal needs and emotional pain, and these enhanced unmet interpersonal needs may also account for their increased emotional pain compared to individuals without MDD.

Most research examining unmet interpersonal needs have relied upon between-person research designs. Yet, thwarted belongingness and perceived burdensomeness are considered dynamic phenomena, such that individual feelings of burdensomeness and thwarted belongingness are expected to vary in severity over time (Van Orden et al., 2010). Such within-person variability and associations with subsequent changes in emotional pain or suicidal ideation cannot be examined using traditional between-person designs. Instead, within-person research designs relying upon repeated measurements over short time intervals (e.g., days or hours) seek to determine *when* individuals report greater suicidal ideation. Within-person associations are considered independent from between-person associations, from which they may differ in magnitude or direction (Wang & Maxwell, 2015). As such, intensive longitudinal study designs are useful to understand the variability in unmet interpersonal needs and emotional pain over the short-term, which are thought to contribute to patterns of longitudinal change in suicidal risk over the longer-term (Nesselroade, 1991).

Only a few studies to date have examined the within-person variability in unmet interpersonal needs, all of them among individuals with psychopathology. Among adults, both burdensomeness and thwarted belongingness varied significantly over hours and days (Hallensleben et al., 2019; Kleiman et al., 2017), although feelings of burdensomeness were more stable day-to-day than feelings of thwarted belongingness (Forkmann et al., 2018; Parrish et al., 2021). However, little is known about the daily fluctuations in feelings of burdensomeness and thwarted belongingness among adolescents, a developmental period during which individuals are more sensitive to interpersonal stress (Blakemore & Mills, 2014). Furthermore, studies examining the tenets of the IPTS among clinical populations using intensive repeated measurement designs have shown that greater burdensomeness or thwarted belongingness at a given time or day independently (Czyz et al., 2021; Forkmann et al., 2018; Glenn et al., 2021; Kleiman et al., 2017; Kyron et al., 2018; Parrish et al., 2021; Rath et al., 2019) and interactively (Al-Dajani & Czyz, 2022; Czyz et al., 2019; Hallensleben et al., 2019) predicted greater concurrent suicidal ideation. Whether daily elevation in both burdensomeness *and* thwarted belongingness are associated with increased daily emotional pain in adolescents with and without MDD is unknown.

Taken together, unmet interpersonal needs and emotional pain are well-established predictors of suicidal ideation. Prior work suggests that individuals with depression experience more severe feelings of perceived burdensomeness, thwarted belongingness, suicidal ideation, and emotional pain than individuals without psychopathology. Although some studies with adults suggest that both perceived burdensomeness and thwarted belongingness fluctuate on a daily basis, little is known about daily fluctuations in perceived burdensomeness and thwarted belongingness and their associations with daily emotional pain among adolescents with and

without MDD. Accordingly, the first aim of this study was to explore the daily fluctuations in thwarted belongingness, perceived burdensomeness, and emotional pain among adolescents with and without major depressive disorder (MDD) considered at higher- and lower-risk for experiencing daily fluctuations in suicidal ideation, respectively. The second aim of this study was to examine whether between-person differences in emotional pain across adolescents at lower- and higher-risk for suicidal ideation were explained by differences in the severity of unmet interpersonal needs (i.e. mediation). The third aim of this study was to investigate the within-person associations between unmet interpersonal needs and emotional pain. Adolescents with MDD (i.e. higher-risk group) and without MDD (i.e. lower-risk group) completed a 10-day daily diary reporting on their loneliness (as a proxy for thwarted belongingness), burdensomeness, and emotional pain in the last 24 hours. It was expected that the higher-risk group would report greater occurrence, severity, and variability of daily unmet interpersonal needs and emotional pain. It was also hypothesized that burdensomeness and belongingness would be parallel mediators of the association between group (i.e predictor) and average emotional pain (i.e., outcome). Finally, it was expected that unmet interpersonal needs would interact to predict greater emotional pain at the within-person level (i.e. daily), such that participants would report greatest emotional pain on days when they experienced both elevated burdensomeness and loneliness.

Method

Participants

Two groups of adolescent participants aged 12-18 with access to an internet connection and having reached puberty based on self-reported beginning of menses for females and maturation of voice and development of body pilosity for males, were recruited. Participants

were recruited based on their risk for experiencing suicidal ideation on any given day. The Higher-Risk group (n=24) were recruited from a psychiatric outpatient clinic. Participants in this group had received a priori diagnosis of MDD during their routine intake assessment with a psychologist or psychiatrist in the clinic. The Lower-Risk group (n=32) included adolescents without psychopathology recruited via flyers shared in the community and local social media pages. Interested adolescents in the community were screened for eligibility during a phone interview. Participants were required to respond "no" to the following questions: have you felt sad or depressed almost every day, for most of the day, in the last two weeks; have you felt less pleasure or less interest in your activities most days, for most of the day, in the last two weeks; are you currently in psychotherapy or counseling; have you or anyone around you thought you needed professional help currently or in the past to deal with your emotions or how you were behaving. Overall, 56 participants were recruited into the study. One participant in the higher-risk group did not complete any daily diary entries and was excluded from current analyses, for a total of 55 participants retained in the present study.

On average, participants were 15.55 years old (SD = 1.55, range = 12-18). Participants in the higher-risk group were significantly older (M = 16.13, SD = 1.22) than lower-risk group participants (M = 15.13, SD = 1.641); $t(53) = -2.485$, $p = .016$). The lower-risk group was comprised of 65.6% female participants, and the higher-risk group was comprised of 86.96% female participants ($\chi^2 = 3.209$, $p = .07$). Both groups were predominantly White (lower-risk group: 78.12%; higher-risk group: 69.57%, $\chi^2 = 0.517$, $p = .472$). Participants in the higher-risk group were less likely than participants in the lower-risk group to live with their fathers ($\chi^2 = 10.166$, $p = .001$), but were similarly likely to live with their mothers, step-parents, siblings, and other family members. Participants from both groups had parents with similar levels of education

(Bachelor's degree or higher; lower-risk group: 37.5%; higher-risk group: 43.48%, $\chi^2 = 3.196$, $p = .670$). Compared to lower-risk group participants, adolescents in the higher-risk group reported greater suicidal ideation in the past month ($M = 31.65$, $SD = 19.12$ vs. $M = 3.09$, $SD = 3.35$, t(df) = -7.08(53), $p<.001$, Cohen's $d = 2.08$).

Procedure

Participants completed a two-hour laboratory visit during which they provided demographic information, completed self-reported questionnaires on past and present psychiatric symptoms, and completed various laboratory tasks as part of a larger study. Starting that same evening, participants completed 10 daily diary questionnaires in which they reported on their feelings of burdensomeness, loneliness, negative affect, hopelessness, and emotional pain in the last 24-hours. Participants were asked to complete these entries every night, as close to their bedtime as possible. To encourage adherence to the study protocol, participants were sent a reminder email in the morning following missed evening entries prompting them to complete their next daily diary that evening. A total of 492 daily diary entries were completed across all participants, with on average 8.94 entries per person, ($SD = 2.31$; range = 1 to 14 entries). Participants were compensated $15CAD for the laboratory visit and $15CAD for the daily diary portion of the study. This study was approved by the institutional ethics review boards of Concordia University (#30006535) and of the Douglas Mental Health University Institute (IUSMD#16-10).

Measures

Suicidal Ideation. As part of the background questionnaires completed during the laboratory visit, participants completed the Suicidal Ideation Questionnaire-Junior, Short Form

(SIQ-JR; Reynolds, 1987), a measure of the severity of suicidal ideation in the last 30 days. This measure was used to validate the group differences in past suicidal ideation and indicate future risk for suicidal ideation. This measure contains 15 items measuring the spectrum of suicidal ideation ranging from passive thoughts of death (e.g. I thought about death) to active suicidal planning (e.g. I thought about how I would kill myself). Participants rated the extent to which each thought "was on their mind in the last 30 days" on a Likert-type scale ranging from 0 (I never had this thought) to 6 (Almost every day). Individual items are summed to obtain an overall score of past-month suicidal ideation, with higher scores representing greater suicidal ideation. Internal reliability of this measure within this sample was high (Cronbach's $\alpha = .964$). On this measure, the lower-risk group reported significantly lower past suicidal ideation (M = 3.13, SD = 0.61, range: 0 – 14) compared to the higher-risk group (M = 29.64, SD = 3.60, range: 6 – 57, $F(df)$ = 69.882(51), $p < .001$). In the lower-risk group, 25% of participants reported no suicidal ideation (score of 0), whereas all participants in the higher-risk group reported some extent of suicidal ideation in the past month. Given that past suicidal ideation is associated with three-fold increased risk for future suicidal ideation (Ribeiro et al., 2016), the higher-risk group presented with greater risk for experiencing suicidal ideation during the daily diary period compared to the lower-risk group, based on the higher prevalence of suicidal ideation in the last month.

Daily Perceived Burdensomeness. Daily feelings of perceived burdensomeness were measured using one item from the Interpersonal Needs Questionnaire (INQ; Van Orden et al., 2012). Participants selected the statement that applied best to their feelings today from the following options: 0 – I think that people in my life are happier when I'm around; 1 – I do not think that people in my life would be happier if I were gone; 2 – I wonder that people in my life

would be happier if I were gone; 3 – I am sure that people in my life would be happier if I were gone. This item had the highest item-total correlation on the INQ, suggesting it is most closely related to the construct of perceived burdensomeness (Van Orden et al., 2006).

Daily Loneliness. A single-item measure of loneliness devised for this study was used as a proxy for daily thwarted belongingness. Loneliness refers to the feeling of distress when one perceives discrepancies between their actual and desired social interactions (Hawkley & Cacioppo, 2010). Loneliness loaded strongly with the thwarted belongingness subscale of the INQ (r=.914), but not the perceived burdensomeness subscale (r=-.078) in a sample of young adults, supporting its discriminant validity as a proxy construct for thwarted belongingness (Van Orden et al., 2012). Moreover, evidence suggests that single-item measures of loneliness are valid and reliable in adolescence (Asher & Paquette, 2003; Mund et al., 2022). Thus, participants rated the extent to which they felt lonely today on a 5-point Likert-type scale ranging from 0 (Not at all) to 4 (Extremely).

Daily Emotional Pain. Daily emotional pain was computed as a composite of daily negative affect, daily difficulty tolerating negative emotions, and daily hopelessness to represent the negative affective state outlined by the Three-Step Theory as leading to the onset of suicidal ideation (Klonsky & May, 2015). Specifically, participants rated their daily affect on the short form of the Positive and Negative Affect Scale for Children (PANAS-C; Ebesutani et al., 2012). They responded to 5 items measuring the extent to which they experienced various negative affective states (miserable, angry, afraid, guilty, sad) in the last 24 hours, rated on a 5-point Likert scale ranging from 0 (Very Slightly/Not at all) to 4 (Extremely). Next, participants rated the extent to which they felt they could tolerate their emotional pain in the last 24 hours on a 5-point Likert-type scale ranging from 0 (Not at all a problem) to 4 (An important problem). This

item was adapted from the psychache subscale of the Inventory of Motivations for Suicide Attempts (May & Klonsky, 2013), with higher scores representing greater difficulty tolerating emotional pain. Finally, daily hopelessness was measured using one item by Van Orden and colleagues (2006). Participants selected which statement applied best to their feelings today from the following three options: 0 – There is something I can do to make things better for myself; 1 – I am unsure that there is something I can do to make things better for myself; 2 – I might as well give up now because there is nothing I can do about making things better for myself. In prior work, this item was moderately correlated with symptoms of depression and was an important predictor of suicidality (Van Orden et al., 2006). All seven items of negative affect, daily hopelessness, and emotional pain intolerance were averaged to create a composite score, with higher scores representing greater daily emotional pain. Within-person reliability of this measure was excellent (α_{wp} =.93) (Bonito et al., 2012).

Statistical Analyses

Descriptive analyses (central tendency, percent of responses endorsed as 0 or % zero) were used to characterize the occurrence and intensity of daily unmet interpersonal needs and emotional pain across lower-risk and higher-risk groups. As measures of variability, intra-class correlations (ICC) were computed using the following equation:

$$ICC = \frac{\sigma_B^2}{\sigma_B^2 + \sigma_W^2}$$

Where σ_B^2 represents the variability of the between-cluster component, individual participants, and where σ_W^2 represents the variability of the within-cluster component, days. The ICC is interpreted as the proportion of variance in the observed variable that is found at the between-person level, whereas 1 – ICC is interpreted as the proportion of variance at the within-

person, day level (Stapleton et al., 2016). This estimate was calculated for the entire sample and separately per group to estimate the proportion of the sample- and group-level variance in each variable that is attributed to between- and within-person differences. To estimate within-person variability at the individual level, the mean square of successive differences (MSSD; calculated as the mean of squared differences between participants' consecutive daily scores, divided by two) were also calculated for each variable. An independent samples *t*-test was used to compare group differences in MSSD, or within-person variability, in daily loneliness, burdensomeness, and emotional pain (Parrish et al., 2021).

Hypothesis testing analyses examined whether interpersonal needs were associated with emotional pain 1) at the between-person level and 2) at the within-person level. Specifically, the first set of analyses examined the main and interaction effects of between-person, average feelings of burdensomeness and loneliness during the daily diary period on average emotional pain using linear regression. Participants' daily perceived burdensomeness, loneliness, and emotional pain were averaged across all daily diary entries per individual to obtain individual person-means on these variables. For the independent variables, person-means were centered around the entire sample mean, with higher scores representing greater burdensomeness or loneliness on average, relative to the entire sample. Age, sex (coded 0 for male, 1 for female), ethnicity (coded 0 for White, 1 for non-White), and group (coded 0 for lower-risk, 1 for higher-risk) were specified as covariates. Two parallel multiple mediation analyses were conducted to examine the partially standardized indirect effects of higher-risk group membership or severity of suicidal ideation in the past month on average emotional pain via burdensomeness and loneliness. These two paths were contrasted to determine whether mediators were statistically significantly different from each other. These moderation and mediation analyses were

conducted using the PROCESS SPSS Macro (Hayes, 2022). Emotional pain was square-root transformed to correct for assumptions of linear regression. All continuous covariates and predictors were mean centered.

Within-person analyses were conducted using hierarchical linear modeling to account for the hierarchical structure and the non-independence of days (level 1) nested within individuals (level 2; Bolger & Laurenceau, 2013). To capture within-person fluctuations in daily interpersonal needs, daily burdensomeness and loneliness scores were person-mean centered, such that higher scores represent greater perceived burdensomeness or loneliness on a given day compared to the participant's own personal average. These within-person effects of burdensomeness and loneliness are considered independent from between-person effects (Curran & Bauer, 2011). Participants were required to have at least 3 entries to compute personal averages and obtain within-person fluctuations for each variable. Two participants (one higher-risk and one lower-risk participant) were removed for these within-person analyses as they had less than 3 daily diary entries[1]. Model 1 included participant age, sex, ethnicity, and group (lower-risk or higher-risk) as covariates[2]. Models 2 and 3 examined the main and interaction effects of within-person interpersonal needs on daily emotional pain, respectively. Model 4 tested the two-way and three-way interactions with higher-risk group. Significant interaction terms were decomposed by computing the simple slopes at different levels of the interpersonal needs (±1SD of the mean value). Models were also tested including number of days into the daily diary period as a covariate to examine potential time trends. This time variable was not a

[1] Results were identical when participants with <3 daily diary entries were included in within-persona analyses.
[2] Sensitivity analyses were conducted using depressive symptoms severity (BDI-II scores) as covariate in this model instead of group, with the same pattern of results.

significant predictor of emotional pain, did not improve model fit, and was thus omitted from the presented results for parsimony. An unstructured covariance structure was specified for all models, and degrees of freedom were estimated using the between-within method for fixed effects. Statistical analyses were conducted using SAS PROC MIXED, version 9.4 (Cary, North Carolina, USA).

Results

Daily occurrence (% zero values), descriptive, and variability (ICC, MSSD) statistics for loneliness, burdensomeness, and emotional pain for the entire sample and across groups are presented in Table 1. The higher-risk group reported greater average unmet interpersonal needs and emotional pain than the lower-risk group. Daily emotional pain and unmet interpersonal needs occurred more frequently in the higher-risk group (fewer zero values), but both groups reported daily fluctuations in loneliness, burdensomeness, and emotional pain, as depicted in Figure 1. These variables were all strongly correlated (all *r*s < .80).

Results from the mediation analysis examining indirect effects of higher-risk group on average emotional pain via between-person differences in unmet interpersonal needs are presented in Figure 2. Age, sex, and ethnicity were not significantly associated with burdensomeness, loneliness, nor emotional pain. There was a significant overall total effect of higher-risk group on emotional pain (*c* path: $b = 0.638$, $SE = 0.09$, $p < .001$), but no direct effect of group on emotional pain after addition of mediators (*c'* path: $b = 0.07$, $SE = 0.108$, $p = .548$). There were significant indirect effects via both burdensomeness (*a* path: $\beta = 0.472$, $SE = 0.220$, $p = .047$) and loneliness (*b* path: $\beta = 0.832$, $SE = 0.246$, $p = .001$). Indirect effect contrasts showed that mediating pathways via loneliness and burdensomeness were not significantly different from each other (difference = -0.360, bootstrap $SE = 0.422$; 95% confidence interval [-1.165, 0.476]).

Thus, those in the higher-risk group reported higher emotional pain than those in the lower-risk group via their higher overall burdensomeness and loneliness during the daily diary period. The pattern of results was identical in the parallel multiple mediation model examining the indirect effect of past-month suicidal ideation (SIQ-JR) on average emotional pain via unmet interpersonal needs, such that individuals with greater suicidality in the past month reported more emotional pain via greater unmet interpersonal needs.

In line with the interpersonal theory of suicide, the main and interaction effects of burdensomeness and loneliness on emotional pain at the between- and within-person levels were examined. At the between-person level, covariates age, sex, and ethnicity were not associated with average emotional pain. Higher-risk group predicted greater emotional pain, accounting for 52.4% of the variance ($b = 0.638$, $SE = 0.093$, $p < 0.001$). The model including average burdensomeness, loneliness, and their interaction accounted for 79.9% of the variance in emotional pain ($\Delta R^2 = 0.265$, $F(df1,df2) = 20.711(3,47)$, $p < .001$). Between-person burdensomeness ($b = 0.323$, $SE = 0.098$, $p = 0.001$) and loneliness ($b = 0.397$, $SE = 0.084$, $p < 0.001$) were independent predictors and interactive predictors ($b = -0.113$, $SE = 0.040$, $p = 0.006$) of emotional pain, such that participants reporting both greater thwarted belongingness and perceived burdensomeness also reported greater emotional pain (Figure 3, Panel A).

Results from the moderation model examining the within-person associations between daily burdensomeness and loneliness on daily emotional pain are presented in Table 2. Higher-risk group, but not covariates, was associated with greater daily emotional pain. Within-person deviations in loneliness and burdensomeness were positively associated with daily emotional pain. Model 3 showed a significant interaction of within-person loneliness and burdensomeness. As depicted in Figure 3, Panel B, participants reported greater emotional pain on days when they

experienced greater loneliness than their personal average, and this association was stronger on days when they also experienced greater burdensomeness than usual for them. In Model 4 examining the moderating effect of group, a trending two-way interaction between higher-risk group and within-person burdensomeness predicting emotional pain was found, such that increases in within-person burdensomeness tended to be more strongly associated with emotional pain in the higher-risk group compared to the lower-risk group. No other two-way nor three-way interactions emerged between group and within-person interpersonal needs (Model 4). Thus, the interactions of within- and between-person loneliness and burdensomeness on daily emotional pain were similar across groups.

Discussion

Study results indicated that adolescents with MDD at higher-risk for suicidal ideation reported more frequent occurrence, greater severity, and greater variability of daily unmet interpersonal needs and emotional pain, compared to adolescents without psychopathology at lower-risk for suicidal ideation. Greater unmet interpersonal needs mediated the associations between higher-risk group and suicidality in the past month with current emotional pain. Furthermore, at the within-person level, daily fluctuations in unmet interpersonal needs independently and interactively predicted daily emotional pain, with greatest emotional pain observed on days when participants reported greater loneliness *and* burdensomeness than usual for them, regardless of psychopathology. Taken together, these findings highlight that although adolescents with MDD report more unmet interpersonal needs than adolescents without MDD, the daily process through which loneliness and burdensomeness lead to daily emotional pain was similar across groups.

This study provides novel information about the daily occurrence and variability in unmet interpersonal needs and emotional pain among adolescents at both lower and higher risk for suicidal ideation. Although more is known about the average prevalence of loneliness in adolescence (Qualter et al., 2015), this study is the first to describe the daily occurrence and variability in feelings of burdensomeness in adolescence, including among adolescents without psychopathology. The lower-risk group exhibited less frequent daily occurrence (higher % zero), lower average scores, and lower variability in loneliness, burdensomeness, and emotional pain compared to the higher-risk group. The lower-risk group reported feeling lonely at approximately twice the rate that they reported feeling like a burden (28.5% vs. 16.5%, respectively), whereas feelings of loneliness and burdensomeness occurred at relatively similar rates in the higher-risk group (approximately 75-78% of entries). Thus, loneliness may be a relatively more normative experience whereas feelings of burdensomeness may be indicative of increased psychological distress, which aligns with past research showing that burdensomeness is a more consistent predictor of suicidal ideation than thwarted belongingness (Hill & Pettit, 2014). Adolescents in the higher-risk group also demonstrated greater within-person fluctuations in unmet interpersonal needs, including across a greater range of daily severity, compared to adolescents in the lower-risk group. Although past research has shown that burdensomeness is less variable day-to-day than thwarted belongingness (Forkmann et al., 2018; Parrish et al., 2021), this could not be tested explicitly in this study due to differing item scales for loneliness and burdensomeness. Nonetheless, data visualization (Figure 1) could suggest a similar trend across both groups in this study. The lower-risk group was specifically recruited based on the absence of psychological distress, suggesting that feelings of loneliness and burdensomeness also

occur among adolescents at lower risk for suicidal ideation, albeit to a lesser frequency and at a more chronically lower level relative to adolescents with MDD.

Moreover, average loneliness and burdensomeness mediated the association between higher-risk group (or severity of suicidal ideation in the past month) and average emotional pain. These results converge with past research showing that thwarted belongingness and perceived burdensomeness mediated the association between clinical depressive symptoms and suicidal ideation among adolescents and adults (Bryan et al., 2013; Campos & Holden, 2016; Hill et al., 2017; Mitchell et al., 2018; Nsamenang et al., 2013; Poindexter et al., 2022). In addition to these between-person effects, study results indicated that unmet interpersonal needs were a within-person risk factor for enhanced emotional pain. Within-person effects are statistically distinct from between-person effects, and are independent in magnitude and direction (Wang & Maxwell, 2015). Results showed that the within-person fluctuations in loneliness and burdensomeness interacted to predict average and daily emotional pain in adolescents with and without MDD alike, such that participants in both groups reported more emotional pain on days when they had higher loneliness and burdensomeness than usual for them. The similar within-person process observed in both groups (no three-way interaction) suggests that the mechanisms outlined by the IPTS, wherein unmet interpersonal needs are associated with enhanced risk for suicidal ideation, is not a mechanism specific to individuals at higher risk for suicidal ideation such as adolescents with MDD, but is also observed among adolescents at lower-risk with low psychological distress.

To our knowledge, this is the first intensive longitudinal study to examine the tenets of the IPTS among a sample of adolescents at both higher and lower-risk for suicidal ideation. Although community and general population adolescent samples present with a lower base rate

of suicidal ideation than patient samples, they may still experience emotional pain. By focusing on emotional pain, an outcome closely associated with the emergence of suicidal ideation (Klonsky & May, 2015), yet also experienced by non-patient populations to a frequent yet lesser, more tolerable extent (Orbach et al., 2003), this study was the first to examine the within-person mechanisms outlined by the IPTS in association to a distal indicator of suicide risk in both high-risk patient and low-risk control adolescent groups. Moreover, this study further supports the importance of identifying *when* specific risk factors are associated with enhanced suicide ideation, given that these mechanisms leading to enhanced suicidal risk over time are also observed among adolescents who are otherwise deemed at lower risk.

The interaction between daily loneliness and burdensomeness on emotional pain could represent a potential mechanism via which increasing risk for suicidal ideation is accrued longitudinally (Nesselroade, 1991; Wrzus & Roberts, 2017). Different theories may explain how this within-person mechanism may lead to increased longitudinal risk for suicidal ideation. Behavioural sensitisation models of depression suggest that, compared to prior episodes of suicidality, subsequent episodes of suicidal ideation and behaviour require less external stimuli to be triggered (Lau et al., 2004). According to this model, it is possible that the experience of emotional pain in response to feelings of loneliness and burdensomeness may prime both the experience of subsequent feelings of unmet interpersonal needs and increasing severity of emotional pain in response to such feelings, progressing the individual along the continuum of severity towards the onset of suicidal ideation (Klonsky & May, 2015; Nesselroade, 1991; Van Orden et al., 2010). Alternatively, the stress generation hypothesis of depression (Hammen, 2005) argues that individuals with depression contribute to stressful interpersonal experiences that repeat, maintain, and enhance their depressive states. Thus, it is also possible that, when they

are feeling more lonely or burdensome than usual, adolescents may contribute to interpersonal situations that deteriorate relationships and maintain or enhance feelings of unmet interpersonal needs, impacting longitudinal change in emotional pain and suicide risk. Research examining the between-person factors and within-person mechanisms associated with increasing chronicity and magnitude of unmet interpersonal needs over time could inform intervention strategies to prevent the transition from normative to intolerable emotional pain and the emergence of suicidal ideation among youth at both lower- and higher-risk for these outcomes.

The inclusion of two groups of adolescents with and without MDD is a strength of this study to capture a wider range of unmet interpersonal needs and emotional pain and to examine the within-person processes associated with subsequent suicidal ideation across the spectrum of clinical risk. Nonetheless, the statistical modeling techniques including mediation and three-way interactions in this study require large sample sizes to achieve adequate statistical power. Mediation analyses in this study were also tested with cross-sectional data, which cannot exclude reverse causality as a plausible alternative interpretation of the data. Moreover, the higher-risk group was older and had a greater proportion of female participants than the lower-risk group. Although this age and sex distribution accurately reflect the greater propensity of older female adolescents to both suffer from depressed mood and suicidal ideation and to seek help compared to younger and male adolescents (Sen, 2004), further research is needed among larger and more generalizable samples. Relatedly, longitudinal, population-based studies are needed to understand the developmentally normative prevalence, intensity, and variability of unmet interpersonal needs and emotional pain. In addition, daily emotional pain was measured as a composite score of negative affect, hopelessness, and intolerability of emotional pain to capture various theoretical aspects of this construct. However, this measure does not capture the other

facets of this cognitive-affective experience (Mee et al., 2011; Orbach et al., 2003; Pachkowski et al., 2019; Schneidman, 1998). Similarly, unmet interpersonal needs were measured using single items capturing only one facet of thwarted belongingness and perceived burdensomeness (Van Orden et al., 2010). Future research should use validated, multidimensional measures of these constructs.

Taken together, this study indicated that unmet interpersonal needs occur in adolescents across the spectrum of risk for suicidal ideation, albeit to different magnitude and chronicity. Furthermore, the greater average unmet interpersonal needs reported by higher-risk adolescents with MDD account for their enhanced emotional pain compared to adolescents without MDD. Nonetheless, daily within-person associations of loneliness and burdensomeness with emotional pain were similar among adolescents with and without MDD alike. Highest levels of emotional pain were reported when individuals reported both greater thwarted belongingness and higher burdensomeness than usual. Future research investigating the predictors of the co-occurrence of daily thwarted belongingness and burdensomeness among adolescents with and without MDD could be helpful to understand risk factors associated with the transition from normative emotional pain to increasingly chronic and severe suicidal distress that could be targeted in prevention and intervention programs.

Table 1. Descriptive and variability statistics of unmet interpersonal needs and emotional pain.

Daily Variable	**Entire Sample** (N=55, 492 daily entries)						**Higher-Risk Group** (n=23, 208 daily entries)						**Lower-Risk Group** (n=32, 284 daily entries)					
	M	SD	Range	% Zero	ICC	MSSD	M	SD	Range	% Zero	ICC	MSSD	M	SD	Range	% Zero	ICC	MSSD
Loneliness	0.932	0.956	0-4	50.8	.525	0.461	1.77*	0.88	0-4	22.6	.265	0.889*	0.33	0.39	0-3	71.5	.328	0.167
Burdensomeness	0.654	0.769	0-3	59.1	.673	0.189	1.33*	0.72	0-3	24.5	.456	0.339*	0.17	0.27	0-2	84.5	.369	0.086
Emotional Pain	0.678	0.698	0-3.71	29.7	.667	0.170	1.24*	0.71	0-3.71	6.7	.515	0.324*	0.27	0.29	0-2.29	46.5	.444	0.064

* indicates a statistically significant difference with the control group, $p < .001$

Note: % Zero refers to the percentage of daily entries in which participants endorsed a zero value on each variable; ICC = Intraclass Correlation; MSSD = Mean Square Successive Differences

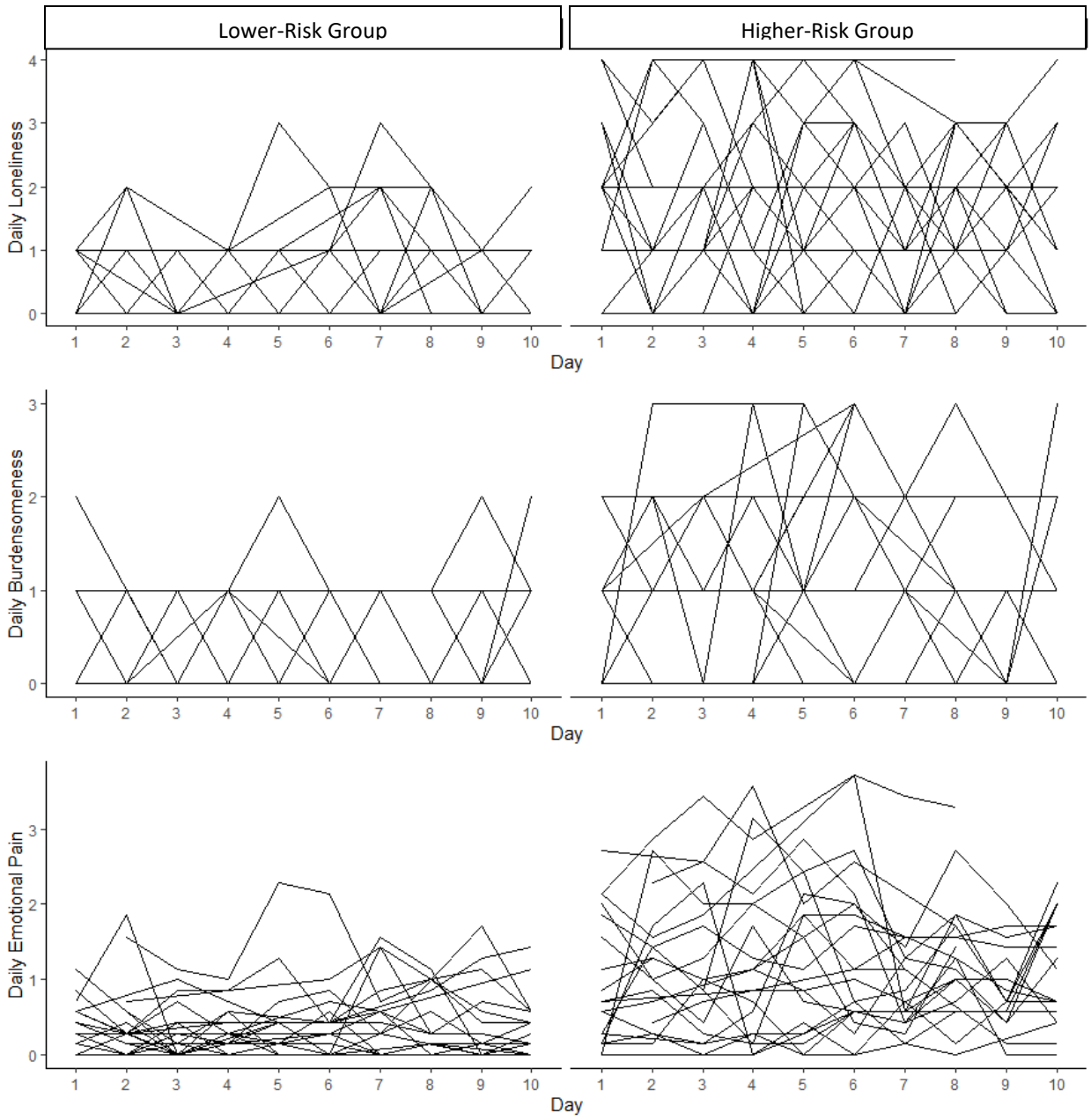


Figure 1. Daily fluctuations in unmet interpersonal needs and emotional pain per group.

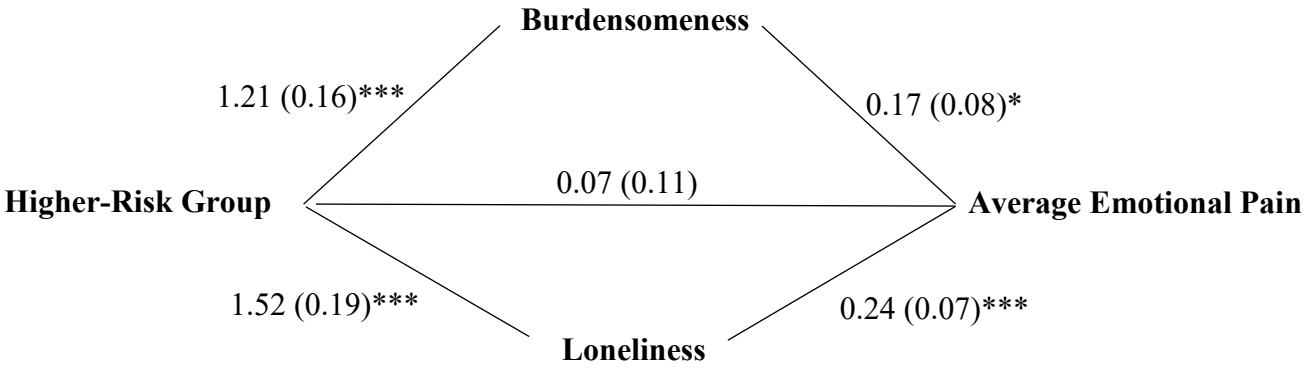


Figure 2. Mediation by between-person interpersonal needs on the association between higher-risk group and average emotional pain.

Note: Coefficients are unstandardized.

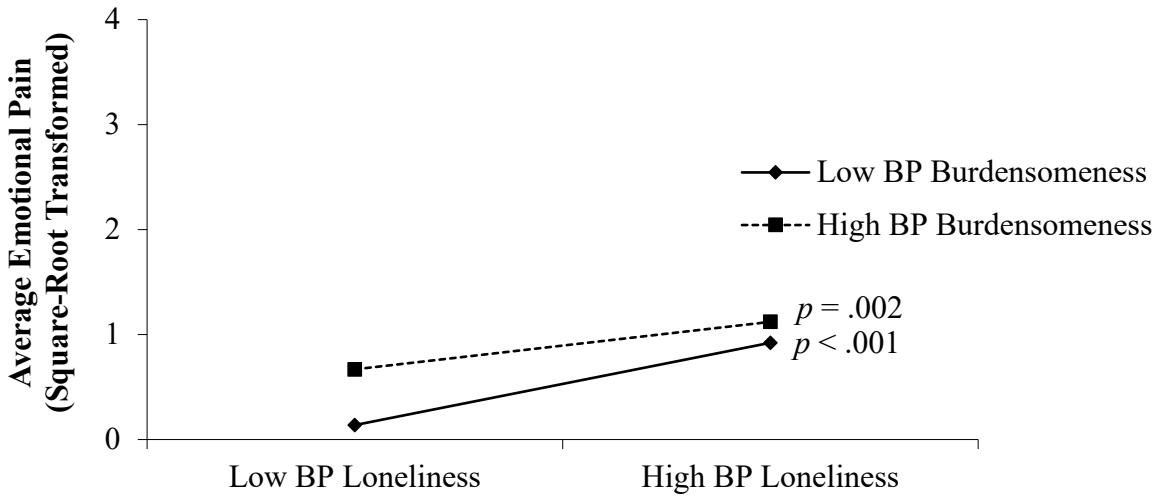
Table 2. Hierarchical linear regression models predicting daily emotional pain.

	Model 1	**Model 2**	**Model 3**	**Model 4**
Fixed Effects				
Intercept	0.254 (0.141)^{t}	0.256 (0.141)^{t}	0.242 (0.139)^{t}	0.242 (0.139)^{t}
Age	-0.022 (0.046)	-0.022 (0.046)	-0.022 (0.046)	-0.023 (0.046)
Sex	0.048 (0.155)	0.046 (0.155)	0.051 (0.153)	0.049 (0.153)
Ethnicity	-0.073 (0.151)	-0.075 (0.151)	-0.040 (0.150)	-0.041 (0.150)
H-R Group	0.921 (0.147)***	0.924 (0.148)***	0.878 (0.146)***	0.885 (0.146)***
WP Burden		0.287 (0.038)***	0.269 (0.037)***	0.153 (0.073)*
WP Lonely		0.245 (0.024)***	0.241 (0.023)***	0.275 (0.045)***
WP Burden X WP Lonely			0.155 (0.036)***	0.299 (0.120)*
H-R Group X WP Burden				0.160 (0.085)^{t}
H-R Group X WP Lonely				-0.055 (0.053)
H-R Group X WP Burden X WP Lonely				-0.156 (0.125)
Random Effects				
Intercept	0.201 (0.044)***	0.210 (0.044)***	0.205 (0.043)***	0.205 (0.043)***
Fit Indices				
AIC	762.0	560.4	544.4	545.6
BIC	775.8	578.1	564.1	571.2

^{t}p <.10; *p<.05; **p<.01; ***p<.001

Note: WP= within-person; H-R Group = Higher-risk Group; N=53.

Panel A)



Panel B)

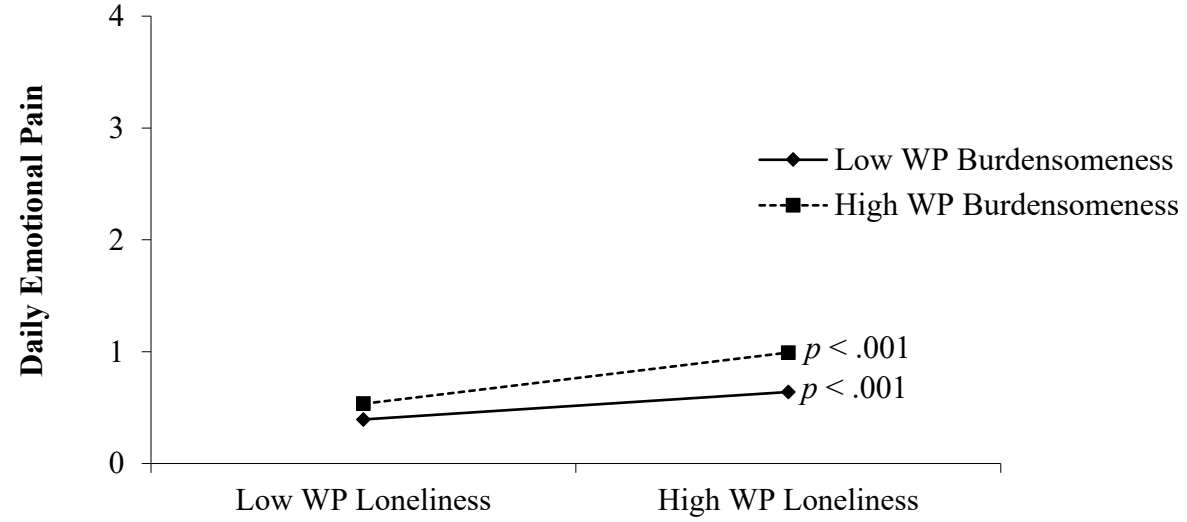


Figure 3. Interaction of between-person (BP) and within-person (WP) unmet interpersonal needs predicting emotional pain during the daily diary period.

Conclusion of Study 1

The first study in this dissertation demonstrated that unmet interpersonal needs occur in adolescence across the spectrum of risk for suicidal ideation, albeit to different magnitude and chronicity. Specifically, adolescents at higher risk for suicidal ideation reported greater frequency, severity, and variability in loneliness and perceived burdensomeness compared to their counterparts at lower risk for suicidal ideation. Despite these differences in magnitude and chronicity, daily within-person associations of loneliness and burdensomeness with emotional pain were similar among adolescents with and without MDD alike. Highest levels of emotional pain were reported when individuals reported both greater thwarted belongingness and higher burdensomeness than usual for them. Thus, these results suggest that adolescents across the spectrum of clinical risk for suicidal ideation experience the same daily mechanism outlined by the IPTS, in which fluctuations in unmet interpersonal needs are associated with emotional pain, an indicator of emotional distress that precedes suicidal ideation.

In the discussion of this study, it is suggested that research examining the between- and within-person risk factors for fluctuations in unmet interpersonal needs is an important next step to better understand the development of increasing chronicity and magnitude of unmet interpersonal needs over time. Study 2 sought to answer this question and examine negative social interactions as a within-person risk factor for perceptions of loneliness and burdensomeness among adolescents at lower and higher risk for suicidal ideation. Moreover, study 2 examined the role of RSA as a between-person moderator of the daily association between negative social interactions and unmet interpersonal needs. It was hypothesized that daily negative social interactions would be associated with increases in perceptions of loneliness and burdensomeness, and that this association would be stronger among those with lower RSA and those at higher risk for suicidal ideation.

Chapter 3: Respiratory sinus arrhythmia, negative social interactions, and fluctuations in unmet interpersonal needs: A daily diary study

Study 2: MacNeil, S., Renaud, J., & Gouin, J.-P. (2023**).** Fluctuations in unmet interpersonal needs and emotional pain among adolescents at lower and higher risk for suicidal ideation: a daily diary study. *Suicide and Life-Threatening Behaviors, 53*, 597-612. https://doi-org.lib-ezproxy.concordia.ca/10.1111/sltb.12967

Abstract

Introduction: This study examined daily fluctuations in the unmet interpersonal needs of thwarted belongingness and perceived burdensomeness in response to daily negative social interactions, as well as the moderating role of respiratory sinus arrhythmia (RSA) across adolescents at lower and higher risk for suicidal ideation. RSA was also examined as a predictor of between-person differences in unmet interpersonal needs.

Methods: 55 adolescents with major depressive disorder (MDD, i.e., higher-risk group) and without MDD (i.e., lower-risk group) completed measures of resting RSA, and daily measures of negative social interactions, perceived burdensomeness, and loneliness, as a proxy for thwarted belongingness, for 10 consecutive days. Within-person analyses examined the association between daily negative social interactions and unmet interpersonal needs, and the moderating roles of RSA and higher-risk group. Between-person analyses also examined the association between RSA and unmet interpersonal needs across groups.

Results: At the within-person level, participants reported more unmet interpersonal needs on days when they reported more negative social interactions. Higher RSA was associated with a trend towards decreased daily burdensomeness among the higher-risk group, especially on days with fewer negative social interactions. At the between-person level, lower RSA was associated with greater average loneliness in both groups, and greater burdensomeness in the high-risk group.

Conclusions: Negative social interactions are associated with daily unmet interpersonal needs. Higher RSA may serve as a protective factor mitigating risk for unmet interpersonal needs, particularly burdensomeness, among adolescents at higher risk for suicidal ideation.

Keywords: Respiratory Sinus Arrhythmia; Loneliness; Perceived Burdensomeness; Negative Social Interactions; Daily diary; Adolescents

Abbreviations: MDD = major depressive disorder; RSA = respiratory sinus arrhythmia

Epidemiologically, suicidal ideation emerges during early adolescence and quickly increases in prevalence from 12 to 18 years old (Glowinski et al., 2001; Nock et al., 2013). The prevalence of suicidal ideation in adolescence is estimated between 12 and 33% (Brezo et al., 2007; Nock et al., 2013; Orri et al., 2020), compared to approximately 9% in the general population (Nock et al., 2008). Interpersonal stress is a well-known risk factor for suicidal ideation throughout the lifespan (King & Merchant, 2008; Mueller et al., 2021), but its effects may be particularly relevant to consider in adolescence given that this developmental period is considered critical for the effects of interpersonal stress on mental health outcomes (Blakemore & Mills, 2014; Sisk & Gee, 2022).

The interpersonal theory of suicide (IPTS; Joiner, 2005; Van Orden et al., 2010) suggests that unmet interpersonal needs are key risk factors for suicidal ideation. This theory proposes that disruptions in the intrinsic human need to belong and feel connected to others, e.g. perceptions of social disconnectedness, isolation, or loneliness, contribute to a state of *thwarted belongingness* that promotes suicidal ideation. Second, this theory suggests that *perceived burdensomeness,* i.e. the perception that one is not needed and that others may be better off if they were dead, is an interpersonally-related cognition contributing to suicidal ideation. Empirical studies report both main and interaction effects of thwarted belongingness and perceived burdensomeness in predicting suicidal ideation cross-sectionally and longitudinally (Chu et al., 2017), including among adolescents (Stewart et al., 2017).

Many interpersonal risk factors have been associated with individual differences in perceptions of unmet interpersonal needs in adolescence, including peer victimization (Brailovskaia et al., 2020), poor perceived social support (Sparks et al., 2023), negative in-person and online interactions (Donker et al., 2014; Moberg and Anestis, 2015), and chronic

interpersonal stress (Buitron et al., 2016). However, thwarted belongingness and perceived burdensomeness are also considered dynamic experiences fluctuating in intensity over time, including over hours and days (Kleiman et al., 2017; Van Orden et al., 2010). Within-person fluctuations are considered independent from between-person differences, and within-person effects may differ in magnitude or direction from between-person effects (Wang & Maxwell, 2015). Yet, few studies have examined predictors of within-person, short-term fluctuations in unmet interpersonal needs. Two studies using intensive longitudinal designs showed that, among adults with mood and psychotic disorders, being in the physical presence of others was associated with decreased perceptions of thwarted belongingness, but increased perceived burdensomeness (Hallensleben et al., 2020; Parrish et al., 2021). Another study showed that adolescents at high risk for suicidal ideation reported greater thwarted belongingness the day after negative social interactions with family members (Glenn et al., 2021). This study did not examine changes in perceived burdensomeness. Still, another qualitative study with community adolescents experiencing high burdensomeness showed that relationship conflict is an important source of perceptions of burdensomeness (Hill, Hunt, et al., 2019). Two experimental studies also showed increased perceptions of burdensomeness following negative feedback about one's performance compared to that of teammates (Hartley et al., 2019; Wirth et al., 2021). These findings highlight the importance of better understanding the associations between negative social interactions and daily fluctuations in both thwarted belongingness and burdensomeness among adolescents. Moreover, little work has examined moderators of within-person fluctuations in unmet interpersonal needs.

Respiratory sinus arrhythmia (RSA) is a measure of cardiac vagal tone considered a trans-diagnostic marker of self-regulation and vulnerability to stress (Beauchaine, 2015; Porges,

2003; Thayer & Lane, 2000). RSA represents the variability in beat-to-beat time intervals resulting from vagally-mediated parasympathetic output at the sinoatrial node of the heart (Berntson et al., 1997). Meta-analyses indicate that lower resting RSA is associated with greater internalizing psychopathology (Chalmers et al., 2014; Koenig et al., 2016), and lower self-control (Holzman & Bridgett, 2017; Zahn et al., 2016). Conversely, higher RSA is associated with better regulation of emotional and cognitive responses to interpersonal stress. For example, among adults, higher RSA was associated with better social integration in the face of acculturation stress (Doucerain et al., 2022, 2016), greater positive affect in response to positive interactions and social support (Diamond et al., 2011; Hopp et al., 2013), and less hostility during conflicts (Gyurak & Ayduk, 2008). Moreover, children and adolescents with lower resting RSA demonstrated more externalizing (El-Sheikh et al., 2011; Mikolajewski & Scheeringa, 2022; Van der Graaff et al., 2016; Zhang & Gao, 2015) and internalizing symptoms in response to interpersonal stress (Fagundes et al., 2012; Khurshid et al., 2019; McLaughlin et al., 2015; Wetter & El-Sheikh, 2012). Thus, resting RSA is associated with differential emotional, behavioural, and cognitive responses to interpersonal stressors (Muhtadie et al., 2015), and may be associated with subsequent perceptions of unmet interpersonal needs.

No research to date has examined the association between RSA and unmet interpersonal needs of thwarted belongingness or perceived burdensomeness. Emerging research has nonetheless shown that RSA is associated with feelings of loneliness, an important facet of thwarted belongingness (Van Orden et al., 2010). For example, adolescent boys with lower RSA reported greater loneliness over time in the context of hostile and coercive parenting practices (Cai & Tu, 2020). Mothers with lower resting heart rate variability parameters also reported greater loneliness during pregnancy and the post-partum period (Sarhaddi et al., 2022).

Furthermore, self-reported resilience to stress was inversely associated with loneliness only among college students with lower resting RSA (Zhao et al., 2022). Thus, more research is needed to examine whether RSA may be directly associated with individual differences in unmet interpersonal needs, and whether RSA moderates the association between within-person negative social interactions and fluctuations in unmet interpersonal needs.

Prior work indicates that the strength of the association between RSA and psychosocial outcomes may differ between clinical and community samples, with larger associations being observed in clinical samples (Graziano & Derefinko, 2013). Furthermore, adolescents with major depressive disorder (MDD) may be considered at higher risk for suicidal ideation, compared to adolescents without MDD. Indeed, there is an increase prevalence of suicidal ideation among adolescents with MDD, compared to their counterparts without MDD (e.g. 85% versus 12-33%; Brezo et al., 2007; Cash and Bridge, 2009; Orri et al., 2020). Adolescents with MDD also experience more interpersonal stress (Hammen, 2009), as well as more negative emotional and cognitive reactions to interpersonal stressors (Gunthert et al., 2007; Krackow & Rudolph, 2008). Depressive symptoms are also moderately positively correlated with perceptions of unmet interpersonal needs among adults and adolescents alike (Bell et al., 2018; Elledge et al., 2021; Nalipay & Ku, 2019; Silva et al., 2015; Smith et al., 2018). Thus, these differences in risk for suicidal ideation among adolescents with and without MDD may moderate the association between RSA and psychosocial outcomes, including the associations between RSA and perceptions of thwarted belongingness and perceived burdensomeness.

The first aim of this study was to examine fluctuations in unmet interpersonal needs in response to daily negative social interactions, as well as the moderating role of resting RSA across adolescents at lower and higher risk for suicidal ideation. The second aim of this study

was to examine the role of RSA as a predictor of between-person differences in perceptions of unmet interpersonal needs across adolescents at lower and higher risk for suicidal ideation. To capture a range of risk for suicidal ideation, this sample included adolescents with MDD (i.e., higher-risk group) and without MDD (i.e., lower-risk group). Baseline measures of suicidal ideation and resting RSA were obtained during a laboratory visit. Participants then completed 10 consecutive daily diaries assessing negative social interactions, perceived burdensomeness, and loneliness (used as a proxy for thwarted belongingness in this study) in the last 24 hours. It was hypothesized that (1) more daily negative social interactions would be associated with greater daily perceptions of loneliness and burdensomeness, and (2) that this association would be stronger among those with lower RSA and among the higher-risk group. It was also hypothesized that those with lower resting RSA would report greater average loneliness and burdensomeness, and that this association would be stronger among the higher-risk group.

Method

Participants

Participants aged 12 to 18 years of age, having attained puberty based on self-reported beginning of menstruation for female participants and the development of body hair and voice maturation for male participants, and having daily access to internet during the study period were eligible to participate. Two groups of participants were recruited based on their risk for experiencing suicidal ideation on any given day. The Higher-Risk group (n=24) were recruited from a psychiatric outpatient clinic. Participants in this group had received a priori diagnosis of MDD during their routine intake assessment with a psychologist or psychiatrist in the clinic. The "Lower-Risk" group comprised 32 adolescents recruited from the community via flyers and social media. During a phone interview to determine eligibility, control participants were required to respond "no" to the following questions to be included in the study: have you felt sad

or depressed almost every day, for most of the day, in the last two weeks; have you felt less pleasure or interest in your activities most days, for most of the day, in the last two weeks; are you currently in psychotherapy or counseling; have you or someone around you thought you needed professional help currently or in the past to deal with your emotions or how you were behaving. Overall, 56 participants were recruited into the study, but one participant from the higher-risk group did not complete the daily diary component of the study. Thus, a total of 55 participants were included in the present study.

On average, participants were 15.55 years old (SD = 1.55, range: 12-18). Participants in the higher-risk group were older (M = 16.13, SD = 1.22) than those in the lower-risk group (M = 15.13, SD = 1.641); $t(53) = -2.485$, $p = .016$). The lower-risk group was 65.6% female, and the higher-risk group was 86.96% female ($\chi^2 = 3.209$, $p = .07$). Both groups were predominantly White (lower-risk group: 78.12%; higher-risk group: 69.57%, $\chi^2 = 0.517$, $p = .472$). Participants in the higher-risk group were more likely to report smoking at least one cigarette daily (26% of the group) compared to the lower-risk group (3%; $\chi^2 = 6.352$, $p = .012$). No participants in the lower-risk group reported taking psychotropic medications, whereas 69.57% of the higher-risk group were prescribed at least one medication for mental health difficulties ($\chi^2 = 31.39$, $p < .001$). Participants from both groups had parents with similar levels of education (Bachelor's degree or higher; lower-risk group: 37.5%; higher-risk group: 43.48%, $\chi^2 = 3.196$, $p = .670$).

Measures

Unmet Interpersonal Needs

Perceived burdensomeness. Perceived burdensomeness was measured daily using an item taken from the Interpersonal Needs Questionnaire (INQ; Van Orden et al., 2012).

Participants selected the statement that applied best to them in the past 24 hours from the following: 0 – I think that people in my life are happier when I'm around; 1 – I do not think that people in my life would be happier if I were gone; 2 – I wonder that people in my life would be happier if I were gone; 3 – I am sure that people in my life would be happier if I were gone. This item has high construct validity, demonstrating the highest item-total correlation among all perceived burdensomeness items on the INQ (Van Orden et al., 2006). Intraclass correlation (ICC) for this item was .673, suggesting that 33.7% of the variance in this item is explained by within-person differences and 67.3% is explained by between-person differences (Bonito et al., 2012; Stapleton et al., 2016).

Loneliness. A single-item measure of loneliness devised for this study was used as a proxy for daily thwarted belongingness. Loneliness refers to the feeling of distress when one perceives their social needs are not being met (Hawkley & Cacioppo, 2010). Loneliness loaded strongly with the thwarted belongingness subscale of the INQ (r=.914), but not the perceived burdensomeness subscale (r=-.078) in a sample of young adults, supporting its discriminant validity as a proxy construct for thwarted belongingness (Van Orden et al., 2012). Moreover, evidence suggests that single-item measures of loneliness are valid and reliable in adolescence (Asher & Paquette, 2003; Mund et al., 2022). Participants rated the extent to which they felt lonely today on a 5-point Likert-type scale ranging from 0 (Not at all) to 4 (Extremely). Approximately half of the variance in loneliness was explained by within-person differences (ICC = .525).

Negative Social Interactions. Daily negative social interactions were measured using items adapted from Ruehlman & Karoly (1991). Participants selected with whom they had experienced the following four negative social interactions during the last 24 hours: (1) [the other person] did

not take your problem seriously or belittled you, (2) gave you unhelpful or unsolicited advice, (3) ignored you or withdrew from you, (4) criticized or argued with you. Participants indicated whether they had each interaction with their best friend, other friends, boyfriend or girlfriend, parents, other family members, classmates or coworkers, teachers, or other professionals. Each endorsement was coded as 1. Participants could also select that they had not had this interaction today (i.e. no one), which was coded as 0. Endorsements were added across social groups per interaction, and added again across interactions to obtain an overall score of daily negative social interactions, with higher scores representing more negative social interactions that day. The ICC for this item was .794, suggesting that approximately 20% of the variance in this item is explained by within-person differences and approximately 80% is explained by between-person differences.

Suicidal Ideation. Suicidal ideation was measured via the Suicidal Ideation Questionnaire – Junior, Short Form (SIQ-JR; Reynolds, 1987). This measure contains 15-items measuring the spectrum of suicidal ideation ranging from passive thoughts of death (e.g. I thought about death) to active suicidal planning (e.g. I thought about how I would kill myself). Participants rated the extent to which each thought "was on their mind" on a Likert-type scale ranging from 0 (I never had this thought) to 6 (Almost every day) in the last 30 days. Individual items are summed to obtain an overall score of past-month suicidal ideation, with higher scores representing greater suicidal ideation. Internal reliability of this measure within this sample was high (Cronbach's α = .964). Of note, suicidal ideation was not measured in the daily diary portion of this study, precluding investigation of within-person fluctuations in this outcome.

Apparatus

Psychophysiological data was collected using the Biopac MP36/35 Four Channel Data Acquisition System (Biopac Systems Inc., California, 2016). Participants wore three chest electrodes in a Lead-II position (right collarbone, left and right bottom ribs) to measure cardiac activity. They were also fitted with a respiratory belt (Biopac SS5LB Respiratory Effort Transducer) that measures respiration via the change in thoracic circumference associated with inspiration and expiration. Continuous electrocardiogram and respiration data were recorded at a sampling rate of 1000Hz.

Respiratory Sinus Arrhythmia. RSA was analyzed using the Mindware HRV analysis software, Version 3.1 (Mindware Technologies Ltd). R-peaks from successive QRS complexes in the electrocardiogram recording were identified using the HRV software's automated algorithm. Recordings were also visually screened for recording artifacts and corrected where necessary by two independent raters (ICC = .99). RSA was calculated using the Fast Fourier transformation that computes the natural log of the .15 to .40-Hz frequency band of each 30s-epoch during the resting period. RSA was averaged across all 30s epochs to obtain a measure of vagally-mediated parasympathetic influences on the heart while at rest.

Respiration Rate. Respiration rate was extracted using the BSL Pro Software, version 4.1 (Biopac Systems Inc., California, 2016), given that respiration can alter the association between RSA and cardiac vagal modulation (Quintana et al., 2016). Linear interpolation was used to down-sample respiration data to 62.50 samples per second. A band pass finite impulse response filter was applied with a low pass threshold fixed at 0.05Hz and a high pass threshold fixed at 1Hz. Respiration recordings were smoothed using the mean value across 45 samples. Respiration peaks (inhalations) were identified by the software's automated algorithm and visually screened

and corrected as necessary. Resting respiration rate (in breaths per minute) was extracted from the mean of the width in time between successive breaths during the resting period[3].

Procedure

Participants attended a two-hour laboratory session during which they provided demographic information and completed self-reported measures (SIQ-JR). Respiration and RSA were collected during a 5-minute "vanilla" resting period during which participants viewed a video of scenic landscapes without sound. Participants were asked to stay seated, minimize movement, avoid falling asleep, and breathe normally during this period. Other tasks were also completed during this laboratory visit as part of the larger study. Afterwards, participants were given instructions about the daily diary portion of the study. Starting that same evening, participants were asked to complete a daily diary questionnaire every evening for the next 10 days, in which they rated their daily negative interactions, perceived burdensomeness, and loneliness in the last 24-hours. To encourage adherence, participants who missed an entry were emailed the following morning with a reminder to complete their next diary that evening. A total of 492 entries were completed, with on average 8.94 daily diary entries per participant (*SD* = 2.31; range = 1 to 14 entries). Participants received $15CAD for the laboratory visit and $15CAD for the daily diary portion of the study. This study was approved by the institutional ethics review boards of Concordia University (#30006535) and of the Douglas Mental Health University Institute (IUSMD#16-10). Participants and their legal guardian provided informed assent and consent, respectively.

[3] Resting respiration rate could not be obtained for one participant due to poor recording quality. This missing value was replaced with the sample mean to avoid listwise deletion during analyses. Results were the same with this participant excluded from analyses.

Statistical analyses

Assumptions for linear regression were checked in the data. The assumption of normality of residuals was met in models predicting perceived burdensomeness, but not in models predicting loneliness. Data transformations did not correct for violation of this assumption, thus the non-transformed, raw data was used for all subsequent analyses. These results must therefore be interpreted with caution. Preliminary descriptive analyses explored group differences in RSA, loneliness, burdensomeness, and suicidal ideation. Non-parametric Spearman's rho correlations were used to describe the associations among study variables across groups.

Multilevel modeling was used to explore the effect of within- and between-person association between negative social interactions on daily loneliness and perceived burdensomeness, as well as the moderating effects of resting RSA and higher-risk group (versus lower-risk group). Centering strategies were used to differentiate the between-person (level-2) and within-person (level-1) deviations in negative social interactions. Daily negative social interaction scores were averaged across the 10 diary days to obtain person-means. Person-means were centered around the sample mean to obtain between-person deviations, with higher scores representing more negative social interactions during the entire daily diary period relative to the entire sample. Next, individual daily negative social interaction scores were centered around the person-mean to obtain within-person deviations on this measure, with higher scores representing greater daily negative social interactions than usual for a given participant. These within- and between-person differences in negative social interactions are considered independent using this disaggregation method (Curran & Bauer, 2011). Participants were required to have at least 3 entries to compute personal averages and obtain within-person fluctuations for each variable. Two participants (one higher-risk and one lower-risk participant) were removed for these within-

person analyses as they had less than 3 daily diary entries. Results were identical when these two participants were included in the analyses.

Models 1 examined the main effects of level-2 predictor between-person negative interactions and level-1 predictor, within-person fluctuations in negative interactions on same-day loneliness and burdensomeness. Models 2 examined the additional main effects of resting RSA and higher-risk group. Models 3 added the two-way interaction effects between negative social interactions with moderators resting RSA and higher-risk group on same-day unmet interpersonal needs. Models 4 included the three-way interaction among between-person negative social interactions, resting RSA, and higher-risk group, as well as within-person negative social interactions, resting RSA, and higher-risk group on daily loneliness and burdensomeness. Age was included as a covariate in the main models. The simple slopes of significant interaction terms were calculated to depict the interaction. An unstructured covariance structure was specified for all models, and degrees of freedom were estimated using the between-within method for fixed effects. Statistical analyses were conducted using SAS PROC MIXED, version 9.4 (Cary, North Carolina, USA).

Between-person associations between resting RSA and loneliness and perceived burdensomeness across the daily diary period were also examined. Loneliness and perceived burdensomeness scores were averaged across the 10 daily diaries to obtain individual participant means. The moderation models tested the association of resting RSA on average perceived burdensomeness and loneliness, and the moderating effect of higher-risk group (versus lower-risk group). The simple slopes of significant interaction terms were calculated to depict significant interactions. Age was included as a covariate to account for group differences on this

variable. All continuous covariates and predictors were sample mean-centered. These analyses were conducted using the PROCESS macro version 4.0 for SPSS (Hayes, 2022).

Sensitivity analyses were conducted testing the above-described models with the following covariates to determine the robustness of main analyses: ethnicity (coded White=0 vs. non-White=1), sex (coded male=0 vs. female=1), smoker (coded no=0 vs. yes=1), taking psychotropic medication (coded no=0 vs. yes =1), and resting respiration rate. These latter three covariates were included due to their potential impact on reducing RSA (Guo et al., 2022; Henje Blom et al., 2010), and to account for the covariation between RSA and respiration rate (Quintana et al., 2016). For all analyses, statistical significance was set at $\alpha < .05$. Given the small sample size limiting the statistical power to explore interaction effects, data trends were also explored when $\alpha < .10$.

Results

Table 1 provides the descriptive statistics and Spearman rho correlations between RSA, suicidal ideation, average unmet interpersonal needs, and average negative social interactions across groups. The higher-risk group reported a significantly worse psychosocial profile than the lower-risk group. There was a trend towards group differences in resting RSA, with the lower-risk group having higher resting RSA than the higher-risk group ($t(53) = -1.737$, $p = .088$). In contrast, there were no group differences in resting respiration rate ($t(53) = -0.26$, $p = .979$). In both groups, there were moderate to large positive associations between loneliness, burdensomeness, and suicidal ideation. Negative social interactions were moderately and positively associated with unmet interpersonal needs in both groups, and moderately associated with suicidal ideation in the higher-risk group. Of note, there were significant associations of RSA with suicidal ideation and burdensomeness in the higher-risk group, such that lower RSA

was associated with greater suicidal ideation and burdensomeness in this group; these associations were not significant in the lower-risk group.

Results from multilevel analyses examining the between- and within-person effects of negative social experiences on daily unmet interpersonal needs, and the moderating effects of higher-risk group and RSA are presented in Table 3. For burdensomeness, there were independent between-person and within-person main effects of negative social interactions. Participants reported more burdensomeness on days when they experienced more negative social interactions. Also, participants who experienced more negative social interactions on average across the daily dairy period also reported stronger daily perceptions of burdensomeness. In model 2, higher-risk group and within-person effects of negative social interactions were independent predictors of daily burdensomeness, but the between-person effect of negative social interactions was no longer significant. In model 3, a significant interaction between higher-risk group and within-person negative interactions emerged. As depicted in Figure 1, Panel A, participants in the higher-risk group reported greater burdensomeness on days when they reported more negative social interactions than usual for them, while this association was not significant in the lower-risk group. The between-person interaction between RSA and higher-risk group (see Figure 2) was a significant predictor of daily burdensomeness. In Model 4, a trending interaction between within-person negative interactions, resting RSA, and higher-risk group was found. As depicted in Figure 1, Panel B, participants in the higher-risk group reported greater burdensomeness on days when they reported more negative interactions than usual, but this within-person effect was attenuated among those in the higher-risk group with higher RSA. There was no association between RSA and within-person negative interactions in the lower-risk

group. No two-way nor three-way interactions emerged between RSA, higher-risk group, and between-person negative social interactions.

In the loneliness models, between- and within-person negative interactions as well as higher-risk group were significant independent predictors of daily loneliness. Participants reported more loneliness on days when they experienced more negative social interactions. Also, participants who experienced more negative social interactions on average across the daily dairy period also reported greater daily loneliness. Participants in the higher-risk group also reported more loneliness than the lower-risk group, regardless of the amount of negative social interactions. When examining potential interactions with higher-risk group and RSA, model fit decreased in models including the two-way and three-way interactions. Therefore, models with interaction effects were not further interpreted.

Results from analyses examining the effect of resting RSA on between-person differences in unmet interpersonal needs, and the moderating effect of higher-risk group, are presented in Table 3. RSA and higher-risk group were independent predictors of burdensomeness, and a significant interaction emerged, depicted in Figure 2. Participants in the higher-risk group with higher RSA had lower burdensomeness than their counterparts with lower RSA. No association between RSA and burdensomeness was observed in the lower-risk group. RSA and higher-risk group were also significant independent predictors of loneliness. Higher RSA was associated with lower loneliness across both groups (no interaction effect).

For both sets of models, sensitivity analyses were conducted. In the multilevel models, although the main effects were somewhat weakened, the pattern of results remained the same. In the between-person models, although the covariates were not independently associated with burdensomeness ($\Delta R^2 = 0.01$, $p = .932$), the RSA by higher-risk group interaction was weakened

(p = .062), likely due to loss of power in the fully adjusted model. Similarly, although covariates were not significantly associated with loneliness (ΔR^2 = 0.039, p = .413), the association between RSA and loneliness was weaker (p = .085) in the fully adjusted model.

Discussion

This study explored the within-person fluctuations in unmet interpersonal needs in response to negative social interactions, and the moderating effect of resting RSA across adolescents who are at higher- and lower-risk for suicidal ideation. Within-person fluctuations in negative social interactions were independent predictors of same-day loneliness in both groups and of perceived burdensomeness in the higher-risk group. Furthermore, there was a trending 3-way interaction suggesting that resting RSA may moderate the association of within-person negative social interactions with perceived burdensomeness in the higher-risk group. Among adolescents at higher risk for suicidal ideation, those with higher resting RSA tended to report less daily perceived burdensomeness, especially on days when they reported fewer negative social interactions than usual for them. When examining between-person differences, resting RSA was inversely associated with loneliness in both groups, and between-person differences in perceived burdensomeness in the higher-risk group. These results provide support for negative social interactions as important predictors of daily fluctuations in unmet interpersonal needs, and identify resting RSA as a moderator of loneliness and burdensomeness in response to interpersonal stress among adolescents.

The current study replicates findings of Glenn and colleagues (2021), showing that within-person differences in negative social interactions were associated with daily fluctuations in loneliness in both the lower- and higher-risk groups, but also extends these findings by showing that negative social interactions were associated with daily fluctuations in perceived

burdensomeness among adolescents with MDD who are at higher-risk for suicidal ideation. Perceptions of loneliness are very common in adolescence, with up to 70% of adolescents and young adults reporting feeling lonely "sometimes" or "often" (Qualter et al., 2015). In contrast, no data is available about the prevalence of perceptions of burdensomeness in adolescence, nor their developmental trajectory (Hill & Pettit, 2014). Perceived burdensomeness is a consistently stronger independent predictor of suicidal ideation across studies with adolescents, compared to thwarted belongingness (Calear et al., 2021; Hill & Pettit, 2014; Horton et al., 2016; Podlogar et al., 2017; Rogers & Joiner, 2019). In this context, loneliness may be a more normative experience of unmet interpersonal needs that fluctuates based on daily social experiences, whereas perceived burdensomeness may be a more extreme unmet interpersonal need, thereby remaining quite low in adolescents without MDD.

Adolescents with MDD may exhibit cognitive distortions influencing their interpretation of social interactions, often resulting in the activation of core beliefs that they are not needed by, or make things worse for, others (Van Orden et al., 2010). Indeed, greater difficulty reappraising negative social interpretations in light of disconfirming evidence predicted greater perceived burdensomeness over one week (Everaert et al., 2021). Moreover, adolescents with MDD may be more likely to appraise neutral or ambiguous social interactions as more negative and/or interpret positive interactions as less positive (Everaert, 2021). Such distorted interpretations may lead to adolescents with MDD perceiving more frequent negative social interactions, as observed in this study, and subsequently experiencing more frequent perceptions of burdensomeness. Thus, distorted interpretations of negative social interactions may contribute to enhanced perceived burdensomeness among adolescents with MDD who are at higher risk for suicidal ideation.

Resting RSA was also associated with between- and within-person differences in unmet interpersonal needs. At the between-person level, higher resting RSA was associated with decreased average loneliness in both groups, and with decreased average burdensomeness among adolescents at higher risk for suicidal ideation. A similar pattern of results emerged at the within-person level, such that resting RSA emerged as a potential moderator of the within-person association between daily negative social interactions and perceived burdensomeness among the higher-risk group. Although these within-person results were not statistically significant ($p <$ .10), likely due to the small sample size limiting statistical power for the detection of interaction effects, this similar pattern of results at the between- and within-person level provide preliminary insight into potential mechanisms via which resting RSA may modulate risk for unmet interpersonal needs, and subsequently suicidal ideation (Van Orden et al., 2010). Prior work suggests that higher resting RSA is associated with more adaptive cognitive and emotional responses to interpersonal stress (e.g., Fagundes et al., 2012; Khurshid et al., 2019; McLaughlin et al., 2015; Muhtadie et al., 2015). Adolescents with lower RSA may have greater difficulties down-regulating negative affective states and reappraising cognitive distortions in general and in response to negative social interactions specifically, enhancing perceptions of loneliness and burdensomeness. Those with higher resting RSA may be better able to self-regulate, protecting them against more intense perceptions of burdensomeness, and potentially reducing risk for more severe suicidal ideation over time.

Of note, resting RSA was inversely correlated with past-month severity of suicidal ideation only among adolescents in the higher risk group (see Figure 3 for a depiction of this interaction effect). These results are consistent with past meta-analytic evidence suggesting that the association between RSA and socio-emotional outcomes are stronger in clinical than in

community samples (Graziano & Derefinko, 2013). Although higher resting RSA has been associated with better social and emotional outcomes (Beauchaine, 2015; Graziano & Derefinko, 2013; Koenig et al., 2016), past research examining the association between resting RSA and suicidal ideation has been mixed. Among adults, various parameters of resting heart rate variability, including RSA, were reduced among individuals with past or current suicidal ideation, compared to non-clinical control participants (Adolph et al., 2018; Chang et al., 2017; Chang et al., 2012, 2013; Khandoker et al., 2017; Tsypes et al., 2018; Wilson et al., 2016). Moreover, resting RSA was inversely correlated with suicidal ideation within both clinical and non-clinical samples (Forkmann et al., 2016; Rottenberg et al., 2002). However, others studies reported a small positive association (Lin et al., 2015) or no association (Gutierrez et al., 2016) between RSA and suicidal ideation. Among clinical and non-clinical samples of children and adolescents, most studies to date found no association between resting RSA and suicidality (Giletta et al., 2017; James et al., 2017; Wielgus et al., 2016), although one study found decreasing RSA among adolescents with increasing suicidal ideation over a one-week period (Sheridan et al., 2021). The present findings suggest that differences across studies on the association between RSA and suicidal risk may be related to differences in unmet interpersonal needs. Thus, more research is needed to examine the association of resting RSA with between-person and within-person differences in unmet interpersonal needs and suicidal ideation across clinical and community samples.

Although the inclusion of two groups is a strength of this study in order to capture a wider range of unmet interpersonal needs and risk for suicidal ideation, the complex statistical modeling including three-way interactions in this study requires large sample sizes to achieve adequate power. Moreover, the higher-risk group tended to be older and have a greater

proportion of female participants than the lower-risk group. Although this sex and age distribution accurately reflects the greater propensity of older female adolescents to both suffer from depressed mood and seek help compared to younger and male adolescents (Sen, 2004), further research is needed among larger, more generalizable samples. Also, the statistical assumption of normality of residuals were not satisfied in all analyses. These results must therefore be interpreted with caution and reinforce the importance of replication in larger samples. This study also used single-item daily measurements of loneliness and burdensomeness that may not capture the multi-dimensional aspects of thwarted belongingness (e.g., social isolation, absence of reciprocal care) and perceived burdensomeness (e.g., self-hate, shame, perceptions of burdensomeness on family; Van Orden et al., 2010). Indeed, while loneliness is highly prevalent in adolescence, multi-dimensional, cumulative experiences of thwarted belongingness may not be. Therefore, future research could include more comprehensive assessments of these constructs using the validated Interpersonal Needs Questionnaire (Van Orden et al., 2012). Future research should also include daily assessments of suicidal ideation to better understand how RSA is associated with prospective between- and within-person differences in this outcome, in addition to unmet interpersonal needs.

Despite these limitations, this study provides evidence that negative social interactions are associated with increased perceived burdensomeness, especially among higher-risk adolescents with MDD. Furthermore, these findings provide preliminary evidence for the utility of resting RSA as a risk factor for between-person differences in unmet interpersonal needs in adolescence. This study also shed light on a potential mechanism via which resting RSA modulates responses to negative social interactions, impacting daily burdensomeness. This pathway may inform interventions targeting unmet interpersonal needs that have demonstrated

mixed efficacy in reducing perceived burdensomeness (Hill & Pettit, 2019; Webb et al., 2022; Zullo et al., 2021). More work is needed to identify how to modify emotional reactions and cognitive distortions in response to daily negative social interactions, and to examine whether and how RSA predicts longitudinal changes in unmet interpersonal needs and suicidal ideation among lower and higher risk adolescents.

Table 1. Descriptive statistics and Spearman Rho correlations among study variables.

	M (SD) : Lower-Risk Group	M (SD): Higher-Risk Group	1.	2.	3.	4.	5.	6.
1. Past-Month Suicidal Ideation	3.09 (3.35)	31.65 (19.12)[a]		.76***	.56**	.30	-.41*	.11
2. Average Burdensomeness	0.17 (0.27)	1.33 (0.72)[a]	.53**		.61**	.43*	-.51*	.43*
3. Average Loneliness	0.33 (0.39)	1.77 (0.88)[a]	.35*	.38*		.50*	-.27	.33
4. Average Negative Social Interactions	0.41 (0.48)	1.02 (1.54)[a]	.06	.35*	.29		-.26	.32
5. Resting RSA	6.95 (1.06)	6.40 (1.32)[b]	.15	<.01	-.08	-.18		-.48*
6. Respiration rate	15.45 (3.79)	15.42 (2.87)	.04	.18	.01	-.15	-.27	

*p<.05; **p<.01; ***p<.001; a significant group difference at p<.001; b trending group difference at p<.09.

RSA = Respiratory Sinus Arrhythmia; Correlations above the diagonal represent associations within the clinical group (n = 23) and correlations below the diagonal represent associations within the control group (n = 32).

Table 2. Multilevel Regression Models Predicting Daily Unmet Interpersonal Needs (n=489).

	Perceived Burdensomeness				Loneliness			
Fixed Effects	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Intercept	0.63 (0.09)***	0.71 (0.06)***	0.69 (0.07)*	0.70 (0.06)***	0.90 (0.10)***	0.98 (0.06)***	0.98 (0.07)***	0.98 (0.07)***
Age	0.10 (0.06)^{t}	-0.03 (004)	-0.03 (0.04)	-0.02 (0.04)	0.08 (0.06)	-0.05 (0.04)	-0.06 (0.04)	-0.06 (0.04)
BP Negative Interactions	0.25 (0.08)**	0.11 (0.06)^{t}	0.11 (0.08)	0.11 (0.08)	0.43 (0.09)***	0.26 (0.06)***	0.24 (0.09)*	0.24 (0.09)*
WP Negative Interactions	0.08 (0.02)***	0.08 (0.02)***	0.09 (0.02)***	0.09 (0.02)***	0.13 (0.04)***	0.13 (0.04)***	0.15 (0.04)***	0.15 (0.04)***
H-R Group		0.50 (0.07)***	0.51 (0.06)***	0.49 (0.06)***		0.59 (0.07)***	0.60 (0.07)***	0.59 (0.07)***
RSA		-0.08 (0.05)	-0.08 (0.05)	-0.06 (0.05)		-0.07 (0.06)	-0.09 (0.06)	-0.07 (0.06)
RSA X WP Negative Interactions			0.03 (0.02)	0.03 (0.02)			0.05 (0.03)^{t}	0.05 (0.03)^{t}
H-R Group X WP Negative Interactions			0.08 (0.02)***	0.09 (0.02)***			-0.02 (0.04)	-0.02 (0.04)
RSA X BP Negative Interactions			0.02 (0.05)	0.09 (0.07)			0.05 (0.06)	0.08 (0.08)
H-R Group X BP Negative Interactions			-0.01 (0.08)	-0.01 (0.08)			0.03 (0.10)	0.02 (0.09)
H-R Group X RSA			-0.12 (0.05)*	-0.12 (0.05)*			-0.07 (0.06)	-0.07 (0.06)
H-R Group X RSA X WP Negative Interactions				0.03 (0.02)^{t}				0.01 (0.03)
H-R Group X RSA X BP Negative Interactions				-0.10 (0.07)				-0.04 (0.08)
Random Effects								
Intercept	0.37 (0.08)***	0.15 (0.03)***	0.14 (0.03)***	0.13 (0.03)***	0.43 (0.10)***	0.14 (0.04)***	0.14 (0.04)***	0.13 (0.04)***
Residuals	0.24 (0.02)***	0.24 (0.02)***	0.23 (0.02)***	0.23 (0.02)***	0.62 (0.04)***	0.62 (0.04)***	0.61 (0.04)***	0.61 (0.04)***
Model Fit Statistics								
AIC	843.0	804.6	794.8	793.9	1270.0	1227.6	1232.3	1236.0
BIC	854.9	820.3	820.4	823.5	1281.8	1243.3	1257.9	1265.5

t < .10; *p<.05; **p<.01; ***p<.001; RSA = Respiratory Sinus Arrhythmia; BP = Between-Person; WP = Within-Person; H-R Group = Higher-Risk Group

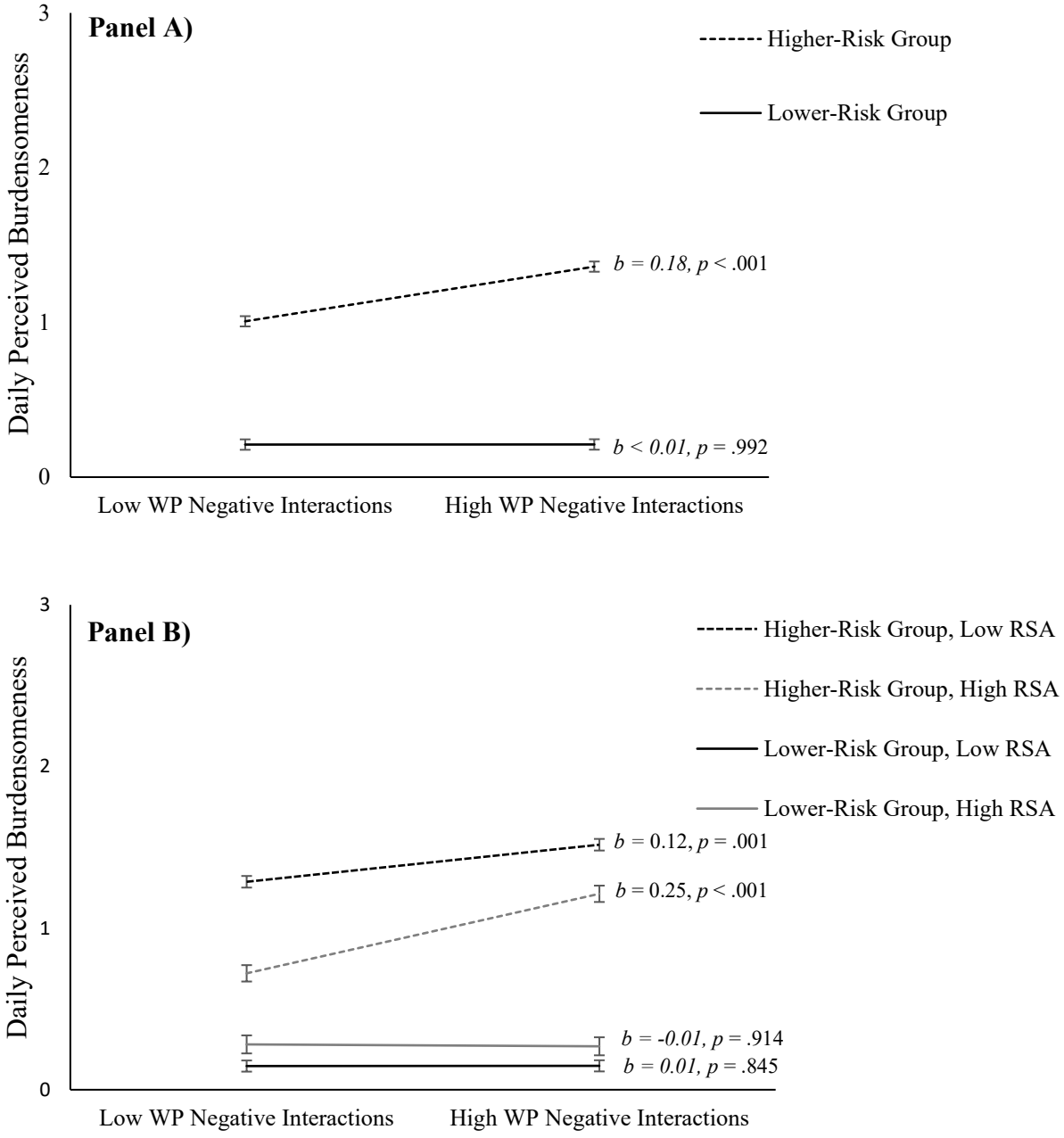


Figure 1. Interactions between negative social interactions, RSA, and group predicting burdensomeness.

Note: Panel A illustrates the two-way, cross-level interactions of within-person (WP) negative interactions and group predicting daily perceived burdensomeness. Panel B illustrates the three-way interaction between higher-risk group, RSA, and within-person negative interactions predicting daily perceived burdensomeness.

Table 3. Moderation Models Predicting Between-Person Unmet Interpersonal Needs and Suicidal Ideation (N=55).

	Perceived Burdensomeness	**Loneliness**	**Suicidal Ideation**
	Effects (SE)	Effects (SE)	Effects (SE)
Intercept	0.71 (0.07)***	1.02 (0.06)***	16.23 (1.60)***
Age	-0.04 (0.04)	-0.08 (0.06)	-0.93 (1.06)
Resting RSA	-0.12 (0.06)*	-0.14 (0.07)*	-2.98 (1.33)*
H-R Group	1.57 (0.07)***	0.72 (0.09)***	39.84 (9.14)***
H-R Group X Resting RSA	-0.14 (0.06)*	-0.10 (0.07)	-3.88 (1.34)**
Fit Statistics			
R^2	.653	.623	.663

SE = Standard Error; RSA = Respiratory Sinus Arrhythmia; H-R Group = Higher-Risk Group

t < .09; *p<.05; **p<.01; ***p<.001

Note: This table presents only conditional main effects and interaction effects. The pattern of results for covariate and main effect models were identical.:

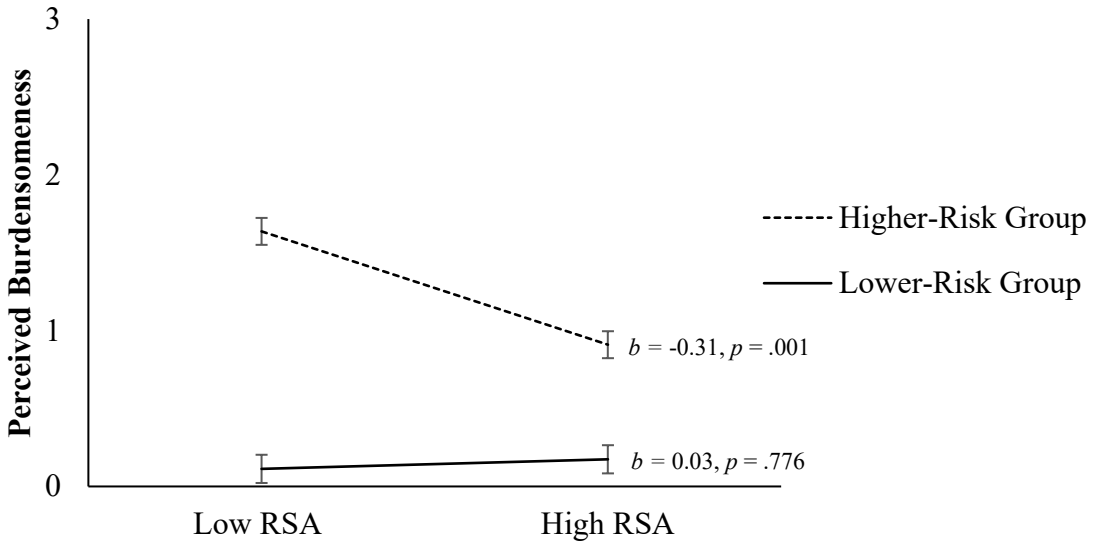


Figure 2. Resting RSA and higher-risk group interaction predicting average perceived burdensomeness

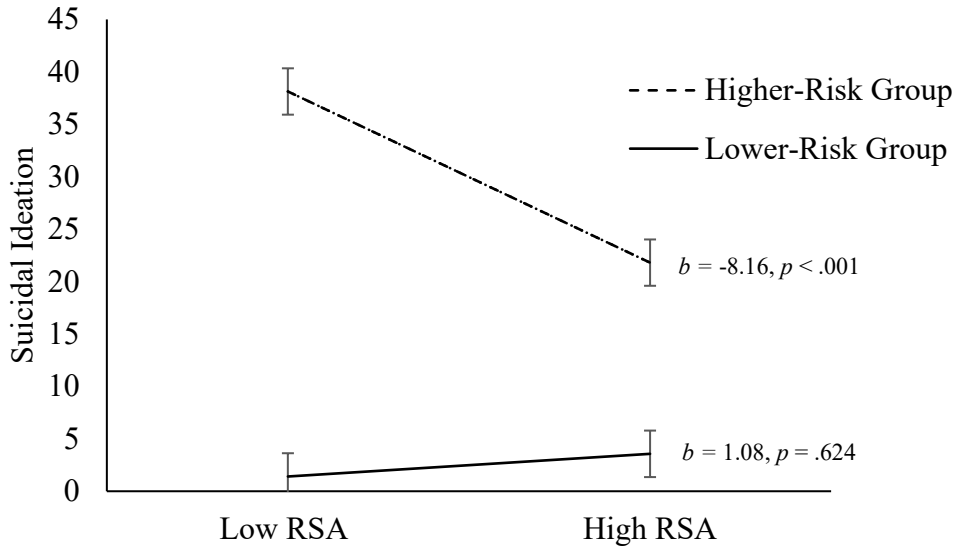


Figure 3. Resting RSA and higher-risk group interaction predicting past-month suicidal ideation.

Chapter 4: General Discussion

The goal of this dissertation was to explore the between- and within-person risk factors for and emotional consequences of unmet interpersonal among adolescents with and without MDD, who may be considered on different ends of a spectrum of clinical risk for suicidal ideation. Study 1 described the frequency, severity, and variability of unmet interpersonal needs among adolescents with and without MDD, as well as average and daily associations with emotional pain across these two groups. The results from this study indicated that adolescents at higher-risk for suicidal ideation reported more frequent occurrence, greater severity, and greater day-to-day variability in unmet interpersonal needs and emotional pain, compared to adolescents at lower-risk. These differences in the severity of unmet interpersonal needs mediated group differences in between-person emotional pain. Furthermore, at the within-person level, daily fluctuations in unmet interpersonal needs independently and interactively predicted daily emotional pain, with greatest emotional pain reported by participants in both groups on days when they experienced greater loneliness *and* burdensomeness than usual for them. Study 2 examined the association of daily negative social interactions with fluctuations in unmet interpersonal needs, as well as the moderating role of resting RSA across groups. Within-person fluctuations in negative social interactions were independent predictors of same-day loneliness in both groups and of perceived burdensomeness in the higher-risk group. Furthermore, the pattern of results suggested a trending 3-way interaction whereby resting RSA moderated the association of within-person negative social interactions with perceived burdensomeness in the higher-risk group. In this group, those with higher resting RSA reported less daily perceived burdensomeness, especially on days when they reported fewer negative social interactions than usual for them. A similar pattern was observed at the between-person level, such that resting RSA was inversely associated with average loneliness in both groups, and average

burdensomeness in the higher-risk group. Taken together, these findings highlight that although adolescents with MDD report more unmet interpersonal needs than adolescents without MDD, the daily process through which loneliness and burdensomeness lead to daily emotional pain is similar among adolescents across the spectrum of clinical risk for suicidal ideation. Moreover, this study provides evidence that negative social interaction are associated with increased perceived burdensomeness, especially among higher-risk adolescents with MDD. Lastly, this dissertation provides preliminary evidence for resting RSA as a between-person factor moderating perceptions of unmet interpersonal needs in response to interpersonal stress.

Unmet interpersonal needs were associated with both the average and daily severity of emotional pain among adolescents with and without MDD, at the between- and within-person levels respectively. These findings extend prior between-person studies by indicating that the co-occurrence of loneliness and burdensomeness on a given day is associated with greater emotional pain at the within-person level. To be a true risk factor for suicidal ideation, the experience of unmet interpersonal needs must precede the emergence of suicidal ideation (Franklin et al., 2017; Van Orden et al., 2010). Although prior research has shown that between-person differences in the severity of unmet interpersonal needs are associated with the severity of suicidal ideation (Chu et al., 2017; Stewart et al., 2017), little research has sought to understand the experience of unmet interpersonal needs in adolescence prior to the emergence of suicidal ideation. This dissertation sought to better understand the experience of unmet interpersonal needs among adolescents with MDD, as well as among adolescents recruited specifically based on the absence of MDD and psychological distress, considered at higher and lower-risk for suicidal ideation, respectively. Past research has shown that thwarted belongingness was more prevalent in the general population than perceived burdensomeness (Hallensleben et al., 2016). Thwarted

belongingness refers to feelings of loneliness, social isolation, or social disconnection that disrupt the basic human need to feel connected to others, whereas perceived burdensomeness refers to feelings that one is not needed by and makes things worse for others (Van Orden et al., 2010). In study 1, adolescents without MDD in the lower-risk group endorsed greater perceptions of loneliness compared to burdensomeness. In turn, adolescents with MDD in the higher-risk group tended to report similar prevalence of both loneliness and burdensomeness. Thus, the current research demonstrated that perceptions of loneliness and burdensomeness also occur among adolescents at lower risk for suicidal ideation, albeit to a lesser frequency and at a consistently lower level than adolescents with MDD.

Although adolescents without psychopathology present with a lower base rate of suicidal ideation than patient samples (Cash & Bridge, 2009), they may still experience emotional pain. Emotional pain refers to the intensity and frequency of negative emotions, as well as feelings of intolerability and loss of control over the negative emotional state (Mee et al., 2011; Orbach et al., 2003; Pachkowski et al., 2019; Schneidman, 1998). Emotional pain is closely associated with the emergence of suicidal ideation (Klonsky & May, 2015), and is also experienced by non-patient populations to a more tolerable extent (Orbach et al., 2003). In study 1, unmet interpersonal needs were associated with group differences in emotional pain as well as within-person fluctuations in emotional pain during the study period. These results extend the mechanisms described by the IPTS to demonstrate that unmet interpersonal needs predict emotional pain, a sub-clinical indicator of suicide risk, among adolescents at both higher-risk and lower-risk for suicidal ideation. The difference between adolescents with and without MDD therefore seems to be a matter of degree across a spectrum of severity, rather than differences in kind.

Together, the studies comprising this dissertation outlined a mechanism for within-person variability in unmet interpersonal needs and emotional pain over time. Negative social interactions were associated with increased feelings of loneliness in both groups, and increased feelings of burdensomeness among higher-risk adolescents with MDD (Study 2), which were subsequently associated with increased daily emotional pain in both groups (Study 1). Appraisal theories of emotions and psychopathology highlight that emotional states are influenced by subjective evaluations of the personal significance of a situation (Scherer, 1999). Appraisals of social disconnection and lack of belongingness may be a more normative response to interpersonal stress in adolescence, as suggested by the emergence and rise in the prevalence of loneliness during this developmental period (Qualter et al., 2015). Additionally, individuals who are more lonely tend to be more vigilant to social threat, affecting subsequent appraisals of neutral or ambiguous interpersonal situations as more negative (Hawkley & Cacioppo, 2010). These mechanisms may be amplified among adolescents with MDD who demonstrate more cognitively distorted appraisals of negative social interactions, such as over-evaluating the severity of the situation, their responsibility for the situation (i.e. dependency), and under-evaluating their coping abilities (Everaert, 2021; Mehu & Scherer, 2015), potentially leading to greater perceptions of thwarted belongingness and burdensomeness in this population. Indeed, research has demonstrated that children and adolescents experience negative emotions and negative self-cognitions in response to interpersonal stress, and that these emotional and cognitive responses are greater among children and adolescents with greater depressive symptoms. (Cole et al., 2019; Krackow & Rudolph, 2008). In both groups, such biased appraisals may lead to more intense emotional reactivity to negative or ambiguous interpersonal

events, and to more frequently evoked negative emotional experiences (Kuppens & Tong, 2010), contributing to daily feelings of emotional pain.

In addition to within-person processes leading to variability in emotional pain over time, between-person differences in social-emotional regulation abilities, as indexed by RSA, were shown to moderate risk for unmet interpersonal needs and suicidal ideation. Resting RSA moderated the within-person association between negative social interactions and burdensomeness among higher-risk adolescents with MDD. Specifically, adolescents with MDD and higher resting RSA reported less burdensomeness than their counterparts with lower resting RSA, particularly on days with fewer negative social interactions. Higher resting RSA was also associated with decreased between-person loneliness among adolescents with and without MDD, and with decreased between-person burdensomeness among adolescents with MDD. These results provide preliminary evidence for resting RSA as a moderator of perceptions of unmet interpersonal needs in adolescence. These findings are consistent with past research showing that resting RSA is associated with social and emotional outcomes in response to interpersonal stress, particularly among clinical samples (Beauchaine, 2015; Graziano & Derefinko, 2013; Koenig et al., 2016). For example, lower resting RSA is associated with stronger emotionally painful responses to interpersonal stress (Diamond et al., 2011; McLaughlin et al., 2015; Trull et al., 2022). Lower resting RSA is also associated with decreased daily use of socially-adaptive emotion regulation strategies (e.g. social support seeking) and more disengagement coping, such as acceptance or avoidance (Geisler et al., 2013), and more hostile appraisals of others' behaviours during interpersonally stressful situations (Okruszek et al., 2017; Wang et al., 2016). Therefore, adolescents with MDD and lower RSA may have greater difficulty interpreting others' emotions and intentions, thereby leading to distorted appraisals of negative social

interactions. Adolescents with lower RSA may then have greater difficulties reappraising these cognitive distortions and down-regulating negative affective states, enhancing perceptions of loneliness and burdensomeness. In turn, those with higher resting RSA may be better able to appraise negative social interactions and self-regulate, protecting them against more intense perceptions of burdensomeness and potentially reducing risk for more severe suicidal ideation over time. Future research is needed to test these potential cognitive, emotional, and interpersonal mechanisms via which higher resting RSA serves as a protective factor against unmet interpersonal needs and subsequent suicidal ideation within this vulnerable population.

Within-person variability in the short-term is thought to contribute to within-person change over the long-term (Nesselroade, 1991). Different theoretical perspectives provide insight into potential mechanisms via which within-person variability in unmet interpersonal needs and emotional pain may contribute to an individual's progression along the spectrum of clinical severity, towards accrued risk for suicidal ideation over time. Behavioural sensitisation models of depression suggest that, compared to prior episodes of suicidality, subsequent episodes of suicidal ideation and behaviour require less external stimuli to be triggered (Lau et al., 2004). In support of this theory, past research has shown that individuals with a history of multiple suicide attempts experience longer and more frequent suicidal crises independently from negative life events, whereas those with a history of one or no suicide attempt experience suicidal crises that are shorter and more closely associated to negative life events (Joiner Jr. & Rudd, 2000). Limited research has examined the behavioral sensitization of unmet interpersonal needs and suicidal ideation specifically. However, past research has shown that lonelier individuals tend to more negatively appraise their interpersonal interactions, leading to greater increases in negative affect (Cacioppo & Hawkley, 2009; Hawkley et al., 2003; van Roekel et al., 2014). Thus, greater a

priori perceptions of unmet interpersonal needs may sensitize future negative affective states via distorted appraisals of interpersonal relationships, contributing to emotional pain and suicidal ideation. Moreover, adolescents with lower resting RSA exhibit weaker top-down inhibitory control over the vagal nerve, resulting in greater sensitivity and activation of sympatho-excitatory influences (Thayer & Friedman, 2002) and greater emotional, cognitive, and behavioural responses to the environment compared to their counterparts with higher RSA (Gyurak & Ayduk, 2008; Okruszek et al., 2017; Wang et al., 2016). Research explicitly examining whether perceptions of thwarted belongingness and burdensomeness become triggered more easily in response to repeated negative social interactions, and the moderating role of RSA, would be important to clarify the behavioural sensitization mechanisms inching the individual closer to the onset of suicidal ideation (Nesselroade, 1991).

In addition, the stress generation hypothesis of depression (Hammen, 2005) argues that individuals with depression contribute to stressful interpersonal experiences that repeat, maintain, and enhance their depressive states. This hypothesis distinguishes between independent stressful life events, which are not associated with an individual's behaviour (e.g. loss of a loved one, natural disaster), from dependent stressful life events, which may occur as a result of an individual's behaviour or due to their current mental health (e.g. relationship conflict; Hammen, 2005). Results from this dissertation align with past research to demonstrate that unmet interpersonal needs fluctuate in response to daily interpersonal stress (Glenn et al., 2021; Hallensleben et al., 2020; Le et al., 2020). Although the current research did not measure the extent to which participants contributed to or elicited negative social interactions, past research has shown that adolescents with more suicide attempts exhibited higher rates of stress resulting from their own behaviours (Liu & Spirito, 2019), suggesting that adolescents may inadvertently

elicit interpersonal stress that contributes to their suicidal crises. Enhanced states of unmet interpersonal needs in response to interpersonal stress may subsequently contribute to heightened vigilance for social threats which can interfere with individual desire for and attempts to reconnect, leading to individuals choosing to isolate to avoid further social threats (Goossens, 2018; Hapenny & Fergus, 2017). This self-isolation may subsequently lead to greater perceptions of unmet interpersonal needs (Hallensleben et al., 2020), emotional pain, and risk for suicidal ideation over time. Lower resting RSA may further compound stress generation. Individuals with lower resting RSA have been shown to react more aggressively and have less control over their emotions during social threat (Gyurak & Ayduk, 2008; Puhalla et al., 2020; Zhang & Gao, 2015), potentially worsening interpersonal relationships via their own reactions. Thus, at a within-person level, when they are feeling more lonely or burdensome than usual, adolescents may contribute to interpersonal situations that deteriorate relationships and enhance feelings of unmet interpersonal needs, influencing longitudinal accumulation of emotional pain and suicide risk. Research is needed to more clearly examine how unmet interpersonal needs fluctuate in response to interpersonal stress that is dependent versus independent of the individual and the moderating role of RSA, as well as how these experiences contribute to cumulative emotional pain and risk for suicidal ideation longitudinally.

These between-person factors and within-person mechanisms associated with increasing chronicity and magnitude of unmet interpersonal needs over time could inform strategies to prevent the emergence of suicidal ideation or to intervene to reduce these symptoms among adolescents with and without MDD. Interventions to reduce unmet interpersonal needs are emerging, with a particular focus on targeting perceived burdensomeness given the stronger association between this factor and suicidal ideation (Hill & Pettit, 2014). Such interventions

have included components of psychoeducation regarding the basic human need for social interaction and debunking myths about perceived burdensomeness and thwarted belongingness (e.g. talking to others about your problems makes you a burden); cognitive restructuring components to promote more adaptive appraisals of ambiguous social interactions or challenging beliefs of being a burden or isolated using evidence; and behavioural activation via the planning of shared pleasant activities or planning of activities meant to contribute to someone else's well-being (Allan et al., 2018; Buitron et al., 2022; Hill & Pettit, 2019; Short et al., 2019). Additional interventions among youth have also included increasing supportive interactions with caregivers and having caregivers write letters outlining youths' contributions to their lives to challenge perceptions of burdensomeness (Buitron et al., 2022; Zullo et al., 2021). Among clinical adolescent and adult populations, such interventions have been associated with reductions in perceived burdensomeness and subsequent decreases in suicidal ideation (Allan et al., 2018; Buitron et al., 2022; Hill & Pettit, 2019; Short et al., 2019) although results were mixed for thwarted belongingness (Allan et al., 2018; Short et al., 2019; Zullo et al., 2021). Future interventions could reduce behavioural sensitisation and stress generation mechanisms leading to increasing suicide risk by reducing avoidant coping and promoting support seeking or constructive conflict resolution strategies in response to negative social interactions to elicit belongingness and reduce momentary burdensomeness. In addition, preliminary evidence suggests that supportive family reactions to disclosure of suicidal ideation are associated with reductions in unmet interpersonal needs (Frey & Fulginiti, 2017). Thus, future interventions with youth may seek to include a family treatment component to assist family members in developing adaptive response styles to youth in order to reduce unmet interpersonal needs.

Given that adolescents without psychopathology also experience the within-person mechanisms of increased unmet interpersonal needs contributing to greater emotional pain, interventions to mitigate the onset of suicidal ideation among this population are also important. The *Better Off With You* campaign is one such pilot intervention which used online platforms to share stories of individuals with a history of feelings of burdensomeness receiving social and professional support in order to challenge perceptions of burdensomeness in the community (*Better Off With You*, 2019). Evaluation of this prevention campaign showed that exposure to campaign materials was not associated with changes in perceived burdensomeness, potentially due to the lower base rate of this unmet interpersonal need in a community sample (Webb et al., 2022). Based on the current findings, adolescents without psychopathology tend to report perceptions of loneliness at twice the rate of burdensomeness. Thus, whereas interventions in clinical populations focus on reducing burdensomeness, community interventions to decrease loneliness and perceptions of thwarted belongingness more broadly may be most relevant. Interventions among this population may thus seek to mitigate behavioural sensitization and interpersonal stress generation via prevention campaigns or school interventions targeting thwarted belongingness specifically. Potential interventions may include interpersonal conflict resolution strategies to reduce avoidance coping and social isolation, cognitive restructuring of social isolation appraisals in response to negative social interactions, psychoeducation about typical interpersonal changes in adolescence (Collins & Laursen, 2004; Collins & Steinberg, 2008; Smetana et al., 2006), and the promotion of extracurricular or shared peer and familial activities (Bauer et al., 2018).

In addition to targeting within-person intra- and inter-personal processes, the current research suggests that interventions aimed at increasing resting RSA may also be useful to

mitigate risk for unmet interpersonal needs, emotional pain, and future suicidal ideation. RSA is a malleable psychophysiological marker that may be targeted via different interventions to increase flexibility in social and emotional regulation. Evidence suggests that RSA is positively associated with physical activity in adolescence (Sharma et al., 2015). Moreover, evidence among older adults demonstrates that behavioral activation leads to improvements in subthreshold depressive symptoms via increases in RSA (Ayudhaya et al., 2022). Future research is needed to determine whether physical activity may be used as an adjunct to current clinical interventions to increase resting RSA among adolescents at high risk for suicidal ideation. In addition, biofeedback interventions aim to increase RSA by using techniques such as slow or diaphragmatic breathing in response to live feedback to attain individuals' optimal RSA (Dormal et al., 2021). Research among adults has demonstrated that biofeedback is associated with short-term increases in various indicators of heart rate variability and concurrent improvements in depressive symptoms (Caldwell & Steffen, 2018; Karavidas et al., 2007; Siepmann et al., 2008). Although there is limited evidence of lasting effects of biofeedback on changes in RSA over time, a growing body of evidence supports the utility of this adjunct intervention to support longer-lasting clinical improvements among children, adolescents, and adults (Dormal et al., 2021; Wheat & Larkin, 2010). The utility of biofeedback in the clinical treatment of suicidal ideation specifically is an important future direction.

The results of this dissertation should be considered within the context of certain limitations. Although the inclusion of two groups is a strength of this study in order to capture a wider range of unmet interpersonal needs, emotional pain, and suicidal ideation, the complex statistical modeling including three-way interactions and mediation in this dissertation requires large sample sizes to achieve adequate power. Moreover, the clinical group tended to be older

and have a greater proportion of female participants than the control group. Although this sex and age distribution accurately reflects the greater propensity of older female adolescents to both suffer from depressed mood and seek help compared to younger and male adolescents (Sen, 2004), further research is needed among larger, more generalizable samples. Relatedly, longitudinal, population-based studies are needed to understand the developmentally normative prevalence, intensity, and variability of unmet interpersonal needs and emotional pain, as well as to establish norms for RSA to guide the clinical utility of this psychophysiological index. This dissertation also relied upon single-item daily measurements of loneliness and burdensomeness that may not capture the multi-dimensional aspects of thwarted belongingness (e.g., social isolation, absence of reciprocal care) and perceived burdensomeness (e.g., self-hate, shame, perceptions of burdensomeness on family; Van Orden et al., 2010). Indeed, while loneliness is highly prevalent in adolescence, multi-dimensional and cumulative experiences of thwarted belongingness may not be. Similarly, this dissertation used a measure of emotional pain that may not capture the broader cognitive-affective dimensions of this experience (Mee et al., 2011; Orbach et al., 2003; Pachkowski et al., 2019; Schneidman, 1998). Future research could use validated multidimensional measures of these constructs, as well as daily measures of suicidal ideation to examine subsequent within-person associations with this clinical outcome.

Taken together, this dissertation highlights that although adolescents with MDD report more unmet interpersonal needs than adolescents without MDD, the daily process through which loneliness and burdensomeness lead to daily emotional pain was similar across groups. Therefore, differences in unmet interpersonal needs between adolescents with and without depression seem mostly a matter of degree rather than kind. These results support the importance of identifying *when* specific risk factors are associated with enhanced suicide ideation, given that

these mechanisms leading to enhanced suicidal risk over time are also observed among adolescents who are otherwise deemed at low risk. Moreover, this dissertation shed light on a potential mechanism via which resting RSA modulates responses to interpersonal stress, impacting daily burdensomeness. This pathway may inform interventions targeting unmet interpersonal needs that have demonstrated mixed efficacy in reducing perceived burdensomeness among clinical and non-clinical populations (Hill & Pettit, 2019; Webb et al., 2022; Zullo et al., 2021).

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