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Disrupted physiological reactivity among children with a history of suicidal ideation: Moderation by parental expressed emotion-criticism

Kiera M. James*, Mary L. Woody, Cope Feurer, Anastacia Y. Kudinova, Brandon E. Gibb

Center for Affective Science, Binghamton University (SUNY), USA

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ABSTRACT

Objective: The goal of this study was to examine physiological reactivity during parent-child interactions in children with and without a history of suicidal ideation (SI), a group known to be at increased risk for suicidal thoughts and behaviors in the future. We also examined the potential moderating role of parental expressed emotion-criticism (EE-Crit) to determine whether the presence of parental criticism may help to identify a subgroup of children with a history of SI most at risk for physiological dysregulation.

Method: Participants were 396 children (age 7–11; 54% male, 71.7% Caucasian) and their biological parent. Children's levels of high frequency heart rate variability (HF-HRV) were assessed during a resting baseline period followed by a positive and negative discussion with their parent. Additionally, parents completed the Five-Minute Speech Sample to determine levels of EE-Crit toward their child, and children completed an interview assessing their history of SI.

Results: Consistent with our hypothesis, we found that exposure to parental criticism moderated the relation between a child's history of SI and their HF-HRV reactivity to the discussions. Specifically, while most children exhibited the typical pattern of HF-HRV suppression from baseline to both interactions, the highest risk children (i.e., children with a history of SI who also had highly critical parents) did not display any change in HF-HRV across the tasks, suggesting a failure to engage a typical psychophysiological response during emotional contexts.

Conclusions: These results suggest a specific physiological mechanism that may place these children at risk for suicidal thoughts and behaviors in the future.

Suicide is the third leading cause of death among 10–14 year olds (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2015) and rates of suicide have increased over the last couple of decades. Indeed, the 2014 suicide rate for 10–14 year old non-Hispanic white females is more than three times higher than the rate in 1999, and suicide rates for non-Hispanic white males increased by 57% between 1999 and 2014 (Curtin, Warner, & Hedegaard, 2016). In addition, a large survey of high school students found that, in the last year, 17% had seriously considered suicide, 14% had made a suicide plan, and 8% had attempted suicide at least once (Kann et al., 2016). Another large study examining rates of suicidality in 13–18 year olds found lifetime prevalence rates of 12.1% for suicidal ideation (Nock et al., 2013). Although the prevalence of suicidal thoughts and behaviors among adolescents has been well established, research examining suicidal thoughts and behaviors in younger children has been more limited. However, one study examining suicidal ideation (SI) in a community sample of 6–12 year old children found that rates of current SI across European countries ranged from 9.9% to 26.84 (Kovess-Masfety et al., 2015). Indeed, there is evidence that children as young as three years old report SI (Whalen, Dixon-Gordon, Belden, Barch, & Luby, 2015) and, though rare, death by suicide does occur in children younger than 10 years old (for a review, see Durand & McGuinness, 2016). Understanding factors associated with SI in children is of great importance because there is evidence that individuals (including children and adolescents) with a history of SI are at increased risk for future SI and suicide attempts (Nock et al., 2013; Shaffer et al., 1996; Whalen et al., 2015).

One potentially important factor in the development of SI is the ability to regulate affective and physiological responses in emotional or stressful contexts (cf. Coryell & Schlesser, 2001; Jokinen & Nordström, 2009; Wilson et al., 2016). Indeed, there is growing evidence for the link between difficulties in emotion regulation and suicidality in adults and adolescents (Kudinova et al., 2015; Pisani et al., 2013; Rajappa, Gallagher, & Miranda, 2012; Rodriguez & Kendall, 2014). However, relatively little is known about this relation in children. In addition, the majority of prior research has focused on self-report assessments of

* Corresponding author at: Department of Psychology, Binghamton University (SUNY), Binghamton, NY 13902-6000, USA.
E-mail address: kjames16@binghamton.edu (K.M. James).

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emotion regulation, which may be subject to response bias. More recent research, therefore, has focused on more objective measures of emotion regulation. One of these measures is respiratory sinus arrhythmia (RSA), which is thought to index one's capacity for emotion regulation (Beauchaine, 2001; Beauchaine, 2012; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Specifically, RSA is a marker of autonomic nervous system functioning, accounting for the impact of both parasympathetic and sympathetic activity on cardiac rhythm. Accordingly, RSA reflects parasympathetic cardiac vagal control (e.g., Berntson et al., 1997; Porges, 2007; Porges et al., 1996). According to the Polyvagal theory's concept (Porges, 1995; Porges, 2007; Porges et al., 1996), the vagal system is integral to the maintenance of physiological homeostasis so that an individual can preserve resources at rest and respond flexibly and appropriately to external stressors. The theory distinguishes resting RSA from RSA reactivity in response to demanding or stressful experiences by suggesting that resting RSA reflects an individual's capacity for maintaining homeostasis while RSA reactivity reflects an individual's vagal regulation in response to a stressor. Indeed, RSA suppression (i.e., decreases in RSA from baseline) during difficult circumstances, such as experiences of interpersonal stress or a sad mood induction, is considered a normal, adaptive physiological response (Lovallo, 2015), and is associated with better capacity for emotion regulation (Gentzler, Santucci, Kovacs, & Fox, 2009; Porges et al., 1996).

Consistent with this research, a recent meta-analysis examining RSA in children found that greater RSA suppression was associated with fewer internalizing problems and that children from clinical/at-risk samples exhibited less RSA suppression in response to challenging tasks (e.g., negative mood inductions, cognitive tasks, social tasks) than children from community samples (Graziano & Derefinko, 2013; but see also Beauchaine, 2015). Similarly, another meta-analysis found that, during dyadic social interactions, whereas children without psychopathology exhibited RSA suppression during social disengagement, children at risk for psychopathology and those currently exhibiting high levels of psychopathology did not exhibit this RSA suppression (Shahrestani, Stewart, & Quintana, 2014). These results suggest that failure to exhibit RSA suppression in challenging contexts is a marker of risk in youth, perhaps due to problems with emotional dysregulation. Indeed, there is research examining physiological reactivity during a conflict discussion via changes in RSA as an index of capacity for emotion regulation in adolescents with depression (e.g., Crowell et al., 2014); however, to our knowledge, no study has examined changes in physiological reactivity during a conflict discussion of children who are suicidal or have a history of SI.

To date, however, only a handful of studies have examined the specific relation between RSA and suicidality. Further, the findings from these studies are mixed. For example, in terms of resting RSA, there is evidence that the presence of suicidal ideation in adults with major depression is associated with lower levels of resting RSA (Chang et al., 2012; Rottenberg et al., 2002). In terms of RSA reactivity, there is evidence that adults with a history of suicide attempt exhibit less RSA suppression in response to a stressor than non-suicidal controls (Wilson et al., 2016). In contrast, one study examining RSA reactivity in adolescents found that adolescents ages 14–18 with a history of either SI or non-suicidal self-injury (NSSI) had greater RSA suppression following a negative mood induction than adolescents without a history of either SI or NSSI (Crowell et al., 2005). Therefore, although these studies provide preliminary evidence for a relation between RSA reactivity and suicidality, the direction of this relation remains unclear. Given the mixed results of the extant literature, it is possible that there are contextual moderators of RSA reactivity for those individuals with a history of suicidal ideation or attempt.

One potentially important moderator, particularly for children, is the presence of parental criticism. Indeed, theories of the development of emotion regulation highlight the role of negative family environments suggesting that such environments may impact the development of children's ability to effectively regulate their response to stressful situations. For example, Repetti, Taylor, and Seeman (2002) proposed that chronic exposure to the stress of a negative family environment may result in increased activation of the sympathetic adrenal medulla system, which may, in turn, have a lasting impact on sympathetic and parasympathetic functioning, both of which are reflected by RSA. Focusing more specifically on the role of parental criticism, theorists have suggested that the development of dysfunctional emotion regulation may mediate the link between parental criticism and later negative mental and physical health outcomes (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Supporting these theories, there is evidence that exposure to negative parenting behaviors, including parental criticism, disapproval, and derision, is associated with autonomic indices of emotion dysregulation, including lower levels of RSA suppression among 2–5 year old children (Hastings, Nuselovici, Utendale, & Coutya, 2008). Further, research in children ages 3–4 years of age suggests that negative parenting behaviors in early childhood may shape the development of a child's biological systems that are involved in self-regulation (Rothbart, Sheese, Rueda, & Posner, 2011). In particular, the experience of negative parenting behaviors during infancy is linked to lower RSA and greater emotion dysregulation in children ages 5–12 (Williams & Woodruff-Borden, 2015). To date, however, no study, of which we are aware, has examined whether parental criticism moderates the link between SI and RSA in children.

The current study, therefore, had two primary goals. The first was to examine levels of physiological reactivity in children with and without a history of SI. Second, we examined the potential moderating role of exposure to parental criticism with the goal of determining whether contextual factors, such as the presence of parental criticism, may help to explain the mixed findings in the RSA literature. In examining the potential moderating role of parental criticism, our goal was to determine whether we could identify a subgroup of children with a history of SI who is at greatest risk for exhibiting physiological dysregulation. Also, because parental criticism is a modifiable risk factor, such research might help to identify a promising target for reducing physiological dysregulation in youth with a history of suicidality. In our study, we focused interviewer-coded levels of expressed emotion-criticism rather than parent or child self-reports of parental criticism to minimize any potential response bias associated with self-report. In addition, to provide a stronger evaluation of contextual influences on children's RSA, we assessed RSA levels during three tasks: (i) a resting, baseline period, (ii) a positive parent-child discussion, and (iii) a negative discussion. Specifically, because there is heterogeneity in what might be experienced as a stressor, particularly for children with a critical parent, we considered the potential moderating influence of the context in which RSA was measured (i.e., during a resting state task versus during a parent-child interaction task). Indeed, children with a critical parent may experience any interaction with their parent as a challenging social engagement, regardless of the nature of the interaction, whereas children without a critical parent may not experience simply interacting with their parent as demanding or stressful, and instead be more affected by the nature of the interaction (i.e., positive versus negative). Despite the limited and mixed literature on RSA reactivity and suicidality and the lack of any previous research on RSA reactivity and SI in children, the broader literature strongly suggests that lack of RSA suppression during challenge is associated with psychopathology in children. Thus, we predicted that children with a history of SI would exhibit less RSA suppression than other children while interacting with their parents. Moreover, we hypothesized that parental criticism would moderate this relation, such that children with a history of SI who are also exposed to parental criticism would exhibit less RSA suppression than children with a history of SI, but no parental criticism. Because the present study is the first to examine RSA reactivity in children with SI during multiple types of parent-child interactions, we did not make hypotheses about differences in RSA levels between the two discussion tasks.

1. Method

1.1. Participants

Participants were 396 children ages 7–11 and their biological parents recruited from the community who were participating in a larger study focused on correlates of psychopathology in children. This age range was selected because it provides an opportunity to examine the described constructs prior to the surge in rates of suicidality that occurs during adolescence (Bolger, Downey, Walker, & Steininger, 1989; Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2015; Hawton, Saunders, & O'Connor, 2012). Exclusion criteria were the presence of developmental disabilities in the child that would preclude study participation (per parent report) and parent history of bipolar or psychotic disorder assessed via diagnostic interview. Children participated in the study with either their mother or their father. Of the participating dyads, 89.6% were mother-child pairs while the remaining dyads were father-child pairs. For children in our sample, the average age was 9.39 years (SD = 1.48) and 46% were female. In terms of children's race/ethnicity, 71.7% were Caucasian, 13.5% were African American, 13.5% were multiracial, and the remaining children were from other racial/ethnic groups. The average age of parents in our sample was 36.98 years (SD = 6.27, Range = 24-71) and, as mentioned above, 89.6% were female. In terms of parents' race/ethnicity, 75.4% were Caucasian, 15.9% were African American, 2.4% were multiracial, and the remainder were from other racial/ethnic groups. Of the parents, 52.3% were married and 13.5% were divorced. In terms of education completed, 93.0% of the parents had completed high school and 49.4% had received a college degree (associates or bachelors). The median annual family income was $30,000-$35,000.

1.2. Measures

The Structured Clinical Interview for *DSM-IV* Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1995) was used to assess for parents' psychiatric diagnoses. As noted above, none of the parents in this sample met criteria for a bipolar or psychotic disorder. However, 22 (5.6%) of parents met criteria for current MDD and 58 (14.7%) met criteria for a current anxiety disorder (Generalized Anxiety Disorder: n = 12; Post Traumatic Stress Disorder: n = 6; Obsessive Compulsive Disorder: n = 8; Social Anxiety Disorder: n = 31). To assess for children's history of psychopathology, parents and their children were interviewed separately using the Schedule for Affective Disorders and Schizophrenia for School-Age Children − Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1997). Two (0.5%) of the children met criteria for current MDD and 17 (4%) met criteria for a current anxiety disorder (Generalized Anxiety Disorder: n = 4; Post Traumatic Stress Disorder: n = 1; Obsessive Compulsive Disorder: n = 3; Social Anxiety Disorder: n = 10; Separation Anxiety Disorder: n = 7). Interviewers for this project were trained to reliability standards and interviews were videotaped so that inter-rater reliability could be calculated. To assess inter-rater reliability, a subset of 20 SCID-I and 20 K-SADS-PL interviews from this project was coded by a separate rater and kappa coefficients for depression and anxiety diagnoses in parents (κs = 0.89 and 0.86, respectively) and children (κs = 1.0 and 1.0, respectively) were good.

Children's history of SI was assessed using questions from K-SADS-PL and the Children's Depression Inventory (CDI; Kovacs, 1981). Specifically, as part of the K-SADS interview, both parents and children were asked, "Sometimes children who get upset or feel bad think about dying or even killing themselves. Have you [your child] ever had these types of thoughts?" On the CDI, children's SI was assessed with item 9 and children responding, "I think about killing myself but would not do it" or "I want to kill myself" were coded as having SI. Both assessment methods were included because previous research suggests that some individuals may feel more comfortable reporting SI in one format versus the other (Koplin & Agathen, 2002). Thus, we used a multi-method assessment approach to maximize the likelihood of identifying suicidal children who may feel more comfortable responding to one assessment format than the other. We should also note that parents of children reporting current suicidal ideation were informed of the child's thoughts and offered a list of referrals in the area. If a child endorsed SI on either measure, the interviewer asked follow-up questions to ensure that the child was specifically endorsing thoughts of suicide and not thoughts of death more generally (i.e., considering doing something to kill themselves rather than only thinking that they may be better of dead). Children who endorsed passive thoughts of death, but not active suicidal ideation were excluded from the SI group. Children who indicated they had a history of SI on either measure were included in the SI group (n = 71).[1] This rate of SI (17.9%) is similar to that observed in other community-based studies of youth (Bolger et al., 1989; Kann et al., 2016; Klimes-Dougan, 1998; Kovess-Masfety et al., 2015; Nock et al., 2013).

Children's depressive and anxiety symptoms were assessed using the Children's Depression Inventory (CDI; Kovacs, 1981) and Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). Both the CDI and MASC demonstrated good internal consistency (α = 0.88 and α = 0.83, respectively).

The Five Minute Speech Sample (FMSS; Magaña et al., 1986) was used to assess parents' levels of expressed emotion-criticism (EE-Crit). For the FMSS, the parent is asked to speak for five uninterrupted minutes about the child and how the parent and child get along together. The response is audiotaped and coded by an independent rater for levels of EE-Crit. Parents are rated as high on EE-Crit if any of the following three criteria are met: Their initial statement about the child is negative, they report a negative relationship, or they report one or more criticisms as defined by the FMSS coding system. Parents are rated as borderline critical if they express dissatisfaction with the child not severe enough to be rated as a criticism. Responses to the FMSS were assigned values of 2, 1, and 0 to reflect high, borderline-high, and low EE-Crit respectively. A number of studies have supported the reliability and validity of the FMSS EE-Crit subscale (e.g., Asarnow, Tompson, Woo, & Cantwell, 2001; Burkhouse, Uhrlass, Stone, Knopik, & Gibb, 2012; Magaña et al., 1986; McCarty, Lau, Valeri, & Weisz, 2004; Rogosch, Cicchetti, & Toth, 2004; Silk et al., 2009), including concurrent validity with observer's ratings of parent criticism in a separate interaction task (Calam & Peters, 2006; Moore & Kuipers, 1999). In this study, the FMSS was coded by individuals trained to reliability standards by the creator of the FMSS (Ana Magaña-Amato) and coding was consistent with the creator's framework. Coders were blind to the other study variables and all samples were independently coded by two raters. When discrepancies arose, a third rater was consulted and a consensus rating was reached. Inter-rater reliability for EE-Crit ratings, which was assessed with a subset of 40 (10.1%) of the speech samples, was good (κ = ·90)· Consistent with recommendations based on evidence that the FMSS, if anything, tends to under-identify high EE individuals (Hooley & Parker, 2006), and with previous studies of EE-Crit (Gar & Hudson, 2008; Kershner et al., 1996), responses were dichotomized such that parents exhibiting borderline or high EE-Crit were classified as critical (n = 103), while parents exhibiting low EE-Crit were classified as not critical (n = 293).

Children and their parents also completed a standardized Discussion Paradigm, which included positive and negative interactions (Robin & Foster, 1989). Before the Discussion Paradigm, each parent

[1] Twenty-four children (or their parent) endorsed SI only during K-SADS, 32 children endorsed SI only on the CDI, and 20 children endorsed SI on both the K-SADS and the CDI. Of the children (or their parent) who endorsed SI during the K-SADS, 21 endorsed current SI, while the remainder endorsed past SI.

and child separately completed an Issues Checklist, which lists several common topics of disagreement (homework, bedtime, chores, etc.) and were asked to endorse the frequency and intensity of their conflicts over each topic. Then, they completed the Discussion Paradigm. First, participants engaged in a 2-min rest period during which they watched a nature video featuring landscape scenes from Olympic National Park. Then, they completed a 4-min Vacation-planning task, for which they were asked to plan a "dream vacation" for the two of them. Following this conversation, the issue from the checklist that was mutually endorsed with the highest frequency and intensity ratings was selected for a 6-min Issues Discussion, during which they were asked to talk about the issue, describe a recent disagreement, and attempt to come up with a resolution.

During each phase of the Discussion Paradigm, electrocardiogram (ECG) data were obtained simultaneously for the parent and child using Biopac BioNomadix wireless systems and recorded with Acqknowledge v4.2 software. ECG was recorded via a standard 3-electrode (lead II) set-up and ECG data were sampled at 1000 Hz. MindWare HRV 3.0.12 was used to inspect, transform, and analyze the ECG signal. ECG data were visually inspected for artifacts (e.g., temporary loss of signal, large movements, or an unusual R–R interval) and artifacts were corrected manually. Consistent with previous research (Woody, Feurer, Sosoo, Hastings, & Gibb, 2016), epochs with more than 10% artifacts (i.e., 10% of R-waves estimated within an epoch) were excluded, and tasks (i.e., rest, vacation-planning, or issues discussion tasks) with more than 50% epochs were counted as missing. Also consistent with previous research (e.g., Wilson et al., 2016), RSA was estimated using high frequency heart rate variability (HF-HRV; Berntson et al., 1997). To calculate HF-HRV, spectral power analyses were performed with a fast Fourier transformation. Consistent with Steve Porges' (1986) recommendations for children, HF-HRV was defined as power density in the 0.12-1.00 Hz frequency band and was calculated by averaging across the 30-s sections from each interaction task, resulting in separate HF-HRV averages for the 2-min rest period, 4-min Vacation-planning task, and the 6-min Issues Discussion.

Finally, participants rated their state sadness and anxiety using a Visual Analog Scale (VAS). Specifically, parents and children independently rated how they were feeling from "very happy" to "very sad" and from "very calm" to "very anxious" on a scale measuring 100 mm after each phase of the Discussion Paradigm (rest, vacation-planning, issues discussion). To calculate VAS sadness and anxiety scores, participants' ratings were measured from left to right on the 100 mm scale, and each respective sadness and anxiety rating from 1 to 100 was recorded with higher numbers indicating greater state sadness and anxiety.

1.3. Procedure

Upon arrival at the laboratory, parents were asked to provide informed consent and children were asked to provide assent to be in the study. Immediately after consent/assent, the parent completed the FMSS. Following the FMSS, parents and their children separately completed the diagnostic interview and questionnaire assessments in adjacent interview rooms. As noted above, the parent and child were interviewed separately using K-SADS-PL. Questionnaires, including the CDI, were read aloud to children to ensure complete comprehension of the items. Finally, participants completed the Discussion Paradigm during which HF-HRV and VAS ratings were collected. As part of the larger study, parents were compensated $80 and children received a $10 gift card to a local store. All study procedures were approved by the University's Institutional Review Board.

1.4. Analysis plan

As a first step in our analyses, we conducted two separate 2 (SI: yes, no) × 2 (EE-Crit: low, high) × 3 (Task: resting, vacation, issues) repeated measures ANOVAs with VAS ratings serving as the dependent variable to examine changes in state affect across the Discussion Paradigm. Separate analyses were conducted for VAS sadness and for VAS anxiety. Next, to test our primary hypotheses regarding differences in children's HF-HRV levels across the Discussion Paradigm, we conducted a 2 (SI: yes, no) × 2 (EE-Crit: low, high) × 3 (Task: resting, vacation, issues) repeated measures ANOVAs with HF-HRV levels serving as the dependent variable. Significant interactions were followed by post hoc tests. Finally, a series of exploratory analyses were conducted to examine the potential moderating effects of children's age, children's sex, and parents' sex.

2. Results

A preliminary inspection of the data revealed the presence of some missing data with up to 11.3% missing for any given variable (i.e., 11.3% for HF-HRV Issues, 9.6% for HF-HRV Rest, 7.1% for HF-HRV Vacation). Given the presence of missing data, we examined whether the data were missing at random, thereby justifying the use of data imputation methods for estimating missing values (cf. Schafer & Graham, 2002). Little's missing completely at random (MCAR) test, for which the null hypothesis is that the data are MCAR (Little & Rubin, 1987) was nonsignificant, $\chi^2(769) = 750.24$, $p = 0.68$, providing support for the imputation of missing values. Given these results, maximum likelihood estimates of missing values were created

Table 1
Means and Standard Deviations for Study Variables for Each Group of Children.

	Children with both SI and EE-Crit (n = 20)	Children with SI and No EE-Crit (n = 51)	Children with EE-Crit and No SI (n = 83)	Children with No EE-Crit and No SI (n = 242)
Child Age	8.89 (1.27)	8.91 (1.34)	9.42 (1.50)	9.54 (1.52)
Child Sex (% girls)	35%	44.2%	32.5%	51.9%
Child Race (% Caucasian)	75.0%	82.7%	73.5%	70.1%
Family Income (Median)	$35K-$40 K	$30K-$35 K	$40K-$45 K	$25K-$30 K
CDI	4.79 (4.34)	4.92 (4.52)	9.00 (6.27)	10.37 (10.49)
MASC	42.83 (14.99)	41.63 (18.87)	51.28 (17.05)	40.94 (15.36)
HF-HRV: Rest	7.85 (1.29)	7.54 (1.22)	7.75 (1.13)	7.79 (1.19)
HF-HRV: Vacation	7.75 (1.08)	7.19 (0.97)	7.43 (1.05)	7.53 (1.05)
HF-HRV: Issues	7.74 (1.04)	7.08 (0.88)	7.24 (1.05)	7.33 (1.01)
VAS Sadness: Rest	16.05 (17.45)	14.88 (16.35)	20.07 (26.13)	12.38 (9.55)
VAS Sadness: Vacation	13.03 (17.75)	11.07 (15.57)	15.46 (19.81)	14.50 (19.09)
VAS Sadness: Issues	19.50 (22.66)	18.32 (20.80)	19.72 (26.55)	30.29 (39.38)
VAS Anxiety: Rest	17.71 (22.84)	16.46 (22.92)	23.43 (28.12)	27.88 (31.34)
VAS Anxiety: Vacation	16.80 (21.33)	13.78 (21.72)	27.50 (33.62)	21.25 (29.42)
VAS Anxiety: Issues	19.09 (23.35)	21.68 (27.49)	27.89 (32.43)	23.85 (28.96)

Note: CDI = Children's Depression Inventory. MASC = Multidimensional Anxiety Scale for Children. HF-HRV = High Frequency Heart Rate Variability. VAS = Visual Analog Scale.

and used in all subsequent analyses (see Schafer & Graham, 2002). Means and standard deviations for all study variables are presented in Table 1. To facilitate comparison with other studies, values presented in the table are based on untransformed data.

Preliminary analyses were then conducted to examine differences in state affect during the tasks. Specifically, we conducted two separate 2 (SI: yes, no) × 2 (EE-Crit: low, high) × 3 (Task: resting, vacation, issues) repeated measures ANOVAs with VAS ratings serving as the dependent variable. Separate analyses were conducted for VAS sadness and for VAS anxiety. In these analyses, there was a significant main effect of SI on VAS anxiety, $F(1, 392) = 6.10$, $p = 0.01$, $\eta_p^2 = 0.02$, with children who had a history of SI reporting higher levels of anxiety across the tasks than children without a history of SI. There was also a significant main effect of task on VAS anxiety, $F(2, 784) = 3.60$, $p = 0.03$, $\eta_p^2 = 0.01$, with posthoc tests revealing that anxiety levels were significantly lower in vacation planning than during the issues discussion ($p = 0.005$). None of the other comparisons were significant for VAS anxiety (lowest $p = 0.14$). None of the other effects were significant for VAS anxiety and there were no significant main or interactive effects for VAS sadness (lowest $p = 0.22$).

Next, to test our primary hypothesis, we conducted a 2 (SI: yes, no) × 2 (EE-Crit: low, high) × 3 (Task: resting, vacation, issues) repeated measures ANOVA with children's HF-HRV serving as the dependent variable. The three-way SI × EE-Crit × Task interaction was significant, $F(2, 784) = 3.14$, $p = 0.04$, $\eta_p^2 = 0.01$. Examining the form of this interaction, we assessed change in HF-HRV from baseline to each of the discussion tasks separately in the two EE-Crit groups as a function of children's SI history (see Fig. 1).

Among adolescents with low EE-Crit parents, there was a significant main effect of Task, $F(2, 582) = 58.29$, $p < 0.001$, $\eta_p^2 = 0.17$, with children exhibiting a significant reduction in RSA from baseline to the vacation discussion and a further reduction from the vacation to the issues discussion (all $ps < 0.001$). In contrast, the main effect of SI, $F(1, 291) = 3.36$, $p = 0.07$, $\eta_p^2 = 0.01$, and the SI × Task interaction, $F(2, 582) = 0.66$, $p = 0.52$, $\eta_p^2 = 0.002$, were both nonsignificant. Among adolescents with high EE-Crit parents, although the main effect of SI was nonsignificant, $F(1, 101) = 1.39$, $p = 0.24$, $\eta_p^2 = 0.01$, there was a significant main effect of Task, $F(2, 202) = 10.33$, $p < 0.001$, $\eta_p^2 = 0.09$, which was qualified by a significant SI × Task interaction, $F(2, 202) = 4.09$, $p = 0.02$, $\eta_p^2 = 0.04$. Examining this relation further, we found that, among children with a high EE-Crit parent without a history of SI, the main effect of task was significant, $F(2, 164) = 34.39$, $p < 0.001$, $\eta_p^2 = 0.30$. These children exhibited similar reductions in HF-HRV from baseline to the vacation discussion to the issues discussion as was seen in children of low EE-Crit parents (all $ps < 0.001$). In contrast, among children of high EE-Crit parents with a history of SI, the main effect of task was not significant, $F(2, 38) = 0.56$, $p = 0.58$, $\eta_p^2 = 0.03$, indicating no change in HF-HRV from the baseline to either of the discussions.

Looking at the significant SI × EE-Crit × Task interaction a different way, we tested the SI × EE-Crit interaction in each task separately. Although the SI × EE-Crit interaction was not significant for children's HF-HRV during rest, $F(1, 392) = 1.11$, $p = 0.29$, $\eta_p^2 = 0.003$, it was significant for the vacation, $F(1, 392) = 4.66$, $p = 0.03$, $\eta_p^2 = 0.01$, and issues, $F(1, 392) = 6.70$, $p = 0.01$, $\eta_p^2 = 0.02$, discussions. Breaking this interaction down further, we found that EE-Crit was associated with children's HF-HRV in the vacation task for children with a history of SI, $F(1, 69) = 4.40$, $p = 0.04$, $\eta_p^2 = 0.06$, but not for children without a history of SI, $F(1, 323) = 0.54$, $p = 0.46$, $\eta_p^2 = 0.002$. Similarly, in the issues discussion, EE-Crit was associated with HF-HRV for children with a history of SI, $F(1, 69) = 7.43$, $p < 0.01$, $\eta_p^2 = 0.10$, but again not for children with no history of SI, $F(1, 323) = 0.51$, $p = 0.48$, $\eta_p^2 = 0.002$. Therefore, although there were no HF-HRV differences at baseline, children with a history of both SI and EE-Crit exhibited the highest levels of HF-HRV during the both the vacation planning and issues discussion.

Examining the robustness of these results, we found that the group difference in HF-HRV (i.e., children with SI and EE-Crit versus all other children) was maintained when statistically controlling for the influence of children's current symptoms of depression (CDI) and anxiety (MASC), and VAS sadness and anxiety ratings during the issues discussion, $F(1,390) = 5.07$, $p = 0.04$, $\eta_p^2 = 0.01$, but not during the vacation task, $F(1,390) = 1.10$, $p = 0.29$, $\eta_p^2 = 0.003$. Finally, we tested to see if the relations were moderated by children's age, children's sex, or parent's sex. None of the analyses were significant.

3. Discussion

The primary goal of this study was to examine the association between children's history of SI and their levels of RSA during parent-child discussions, and to determine if this relation was moderated by two different contextual factors: children's exposure to parental criticism and the context in which RSA was measured. In doing so, our goal was to evaluate whether presence of parental criticism would help us determine which children with a history of SI would be most likely to exhibit disrupted physiological activity during parent-child

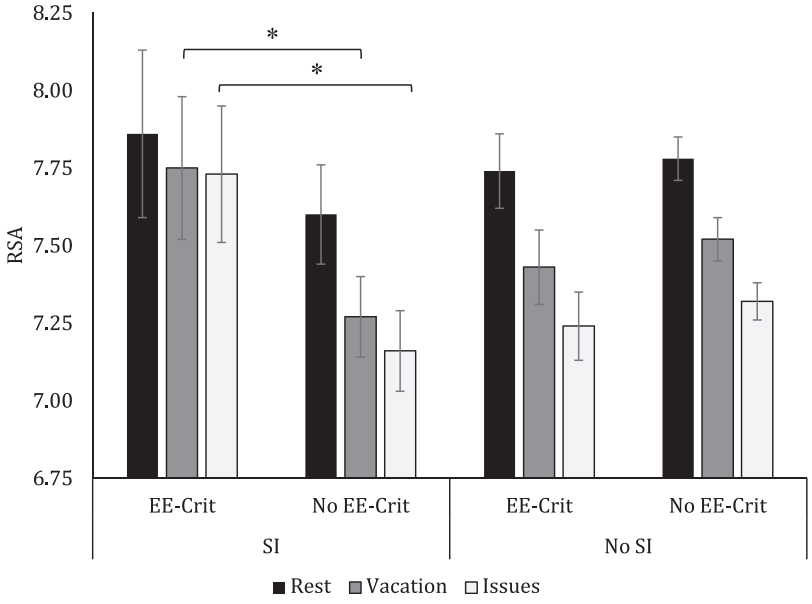

Fig. 1. Children's HF-HRV levels as a function of SI and EE-Crit across the three tasks. SI = Suicidal ideation. EE-Crit = Expressed emotion-criticism. EE-Crit and SI: $n = 20$. No EE-Crit and SI: $n = 52$. EE-Crit and No SI: $n = 83$. No EE-Crit and No SI: $n = 241$. Error bars represent ± 1standard error of the mean.

interactions. We found that the prototypical response of children in our study was to exhibit RSA suppression from the baseline to each of the interaction tasks, with greater suppression during the issues than the vacation planning discussion. However, children with history of SI who also had a critical parent failed to display this typical physiological response. Rather, these children maintained their baseline level of RSA across the two discussion tasks. Indeed, whereas there were no group differences during the baseline rest period, children with a history of SI and a critical parent exhibited higher RSA levels than all other children during the vacation planning and issues tasks. Thus, the fact that there were significant group differences during both the vacation and issues discussions, but not the resting baseline task, suggests that for children with a history of SI, simply interacting with a critical parent may result in a disrupted physiological response, not just interactions intended to address conflict. These findings were maintained when we statistically controlled for self-reported state sadness and anxiety, suggesting that they are at least partially independent of the child's current mood during the issues discussion, but not during the vacation-planning task. These results suggests that, although children with a history of SI and a critical parent may exhibit physiological dysregulation during interactions with their parent, the content of the interaction (i.e. an issues discussion compared to a vacation planning task) may influence the robustness of this effect. This type of investigation in children is important given the increasing rates of death by suicide over the last couple of decades. Identification of a specific physiological mechanism that may place children at risk for suicidal thoughts and behaviors in the future may be crucial to the development of effective intervention that can be implemented prior to the surge in rates of suicidality that occurs during adolescence.

These findings are consistent with previous literature suggesting that parental criticism is associated with autonomic indices of emotion regulation such as RSA, which have shown that children exposed to parental criticism display less RSA suppression than children who are not exposed to parental criticism (Hastings et al., 2008). The current results also support research suggesting that a history of suicidality is associated with deficits in the ability to regulate physiological responses to stress (Wilson et al., 2016). Finally, the findings are consistent with research suggesting that greater RSA suppression is associated with better emotion regulation in children (Gentzler et al., 2009) in that only the highest risk children (those with SI and a critical parent) failed to display RSA suppression during the task. The fact that this dysregulated stress response was only present for children with both a history of SI and a critical parent, but not for children with only one of these risk factors, indicates that a history of SI and exposure to parental criticism may combine to increase children's vulnerability for emotion dysregulation and subsequent physiological stress response.

Although the current results are consistent with previous research suggesting a lack of RSA suppression in children with psychopathology (for reviews, see Graziano & Derefinko, 2013; Shahrestani et al., 2014) and those with suicidality (Wilson et al., 2016), they contradict the findings of one previous study suggesting that adolescents with a history of SI or NSSI have *greater* decreases in RSA following a negative mood induction than adolescents without a history of either SI or NSSI (Crowell et al., 2005). Although the exact reason for the difference in findings is not clear, our results suggest that the relation between youth SI and RSA is moderated by family contextual variables, such as high levels of criticism, which were not included in the Crowell et al. (2005) study. It is also possible that patterns of RSA suppression differ in response to a mood induction versus an interaction task with one's parents. As noted above, we observed group differences in RSA despite no significant change in sad or anxious affect across the discussion paradigm. Also, our results are consistent with previous research suggesting that reduced, rather than greater, RSA suppression is associated with greater risk in children (Graziano & Derefinko, 2013; Shahrestani et al., 2014).

The current results may also have implications for the types of laboratory-based contexts used to examine the relation between suicidality and physiological reactivity in children. Specifically, previous studies in this area have focused on physiological reactivity to a negative mood induction. However, such tasks may not induce the type of interpersonal stress most salient to children. Instead, given the strong evidence for the link between parental criticism and suicidality in adolescents (Wedig & Nock, 2007), an issues discussion with a parent might be a more salient stressor for a child with a history of SI, particularly those with a critical parent. As noted above, these differences in methodology (i.e., the use of negative mood induction vs. parent-child interaction) may be one possible explanation for the discrepant findings between the current study and those from Crowell et al. (2005).

The current study displayed several strengths, including the relatively large sample size, the multi-method assessment of children's SI history, the use of interviewer-coded levels of EE-Crit and the focus on RSA during actual parent-child interactions. Despite its strengths, there were some limitations in this study that highlight areas for future research. The primary limitation is the cross-sectional design of the study. Therefore, we cannot determine whether RSA disruption is a cause, consequence, or merely correlate of children's SI (or parental criticism). Although we predict that this physiological dysregulation increases children's future risk for suicidal thoughts and behavior, additional prospective research is needed to test this hypothesis. Another limitation is the lack of standardization of conversations across participants during the interaction task. Accordingly, it is possible that interactions involving a critical parent were more negative or less interactive than those that did not involve a critical parent, which may have contributed to altered RSA reactivity.

It is also important to note that, although we assessed physiological reactivity using HF-HRV, respiration rate data are not available. Therefore, we were unable to confirm whether participants were breathing in the defined spectral range of HF-HRV. Future research should examine physiological reactivity accounting for respiration rate data in addition to other indices of emotion (dys)regulation in children with a history of suicidal thoughts or behaviors. Another important consideration is that active SI can range from normative to impairing, consuming, or life threatening. The current sample comprised children with all forms of active SI. By these standards, approximately 18% of the sample endorsed active SI, which is consistent with the rates reported in previous studies of community youth (Bolger et al., 1989; Kann et al., 2016; Klimes-Dougan, 1998; Kovess-Masfety et al., 2015). Future research with larger sample sizes should assess the impact of severity of SI on this relation. Another potential limitation is that, although we observed significant group differences, many of the effect sizes are small. Future studies are needed, therefore, to identify additional moderators of these relations. Related to this, given our sample size, our power to examine the potential moderating role of child sex was limited; the moderating role of child sex should be examined in future research. Finally, although there are a number of important influences on child functioning, including childhood adversity (e.g., physical, sexual, emotional abuse and neglect by parent or caregivers, peer violence, witnessing community violence, and exposure to collective violence), the present study was not designed to thoroughly examine these factors. Future research including these factors is warranted.

In conclusion, the current results suggest that children with a history of SI, specifically those who are also exposed to parental criticism, exhibit a blunted physiological response during parent-child interactions. If replicated and extended in longitudinal studies, these results could provide a better understanding of the mechanisms by which a history of SI and exposure to parental criticism increase risk for the development of future suicidality in children and adolescents. This line of research could also lead to more targeted interventions for at-risk youth.

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References

Asarnow, J. R., Tompson, M., Woo, S., & Cantwell, D. P. (2001). Is expressed emotion a specific risk factor for depression or a nonspecific correlate of psychopathology? *Journal of Abnormal Child Psychology, 29*(6), 573–583. http://dx.doi.org/10.1023/A:1012237411007.

Beauchaine, T. P. (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology, 13*(2), 183–214. http://dx.doi.org/10.1017/S0954579401002012.

Beauchaine, T. P. (2012). Physiological markers of emotional and behavioral dysregulation in externalizing psychopathology. *Monographs of the Society for Research in Child Development, 77*(2), 79–86. http://dx.doi.org/10.1111/j.1540-5834.2011.00665.x.

Beauchaine, T. P. (2015). Respiratory sinus arrhythmia: A transdiagnostic biomarker of emotion dysregulation and psychopathology. *Curr Opin Psychol, 3*, 43–47. http://dx.doi.org/10.1016/j.copsyc.2015.01.017.

Berntson, G. G., Bigger, J. T., Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., ... van der Molen, M. W. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology, 34*(6), 623–648. http://dx.doi.org/10.1111/j.1469-8986.1997. tb02140.x.

Bolger, N., Downey, G., Walker, E., & Steininger, P. (1989). The onset of suicidal ideation in childhood and adolescence. *Journal of Youth and Adolescence, 18*(2), 175–190. http://dx.doi.org/10.1007/BF02138799.

Burkhouse, K. L., Uhrlass, D. J., Stone, L. B., Knopik, V. S., & Gibb, B. E. (2012). Expressed emotion-criticism and risk of depression onset in children. *Journal of Clinical Child & Adolescent Psychology, 41*(6), 771–777. http://dx.doi.org/10.1080/15374416.2012.703122.

Calam, R., & Peters, S. (2006). Assessing expressed emotion: Comparing Camberwell Family Interview and Five-Minute Speech Sample ratings for mothers of children with behaviour problems. *International Journal of Methods in Psychiatric Research, 15*(3), 107–115. http://dx.doi.org/10.1002/mpr.187.

Centers for Disease Control and Prevention, & National Center for Injury Prevention and Control (2015). *Web-based injury statistics query and reporting system*. Retrieved from https://www.cdc.gov/injury/images/lc-charts/leading_causes_of_death_age_group_2015_1050w740h.gif.

Chang, H. A., Chang, C. C., Chen, C. L., Kuo, T. B., Lu, R. B., & Huang, S. Y. (2012). Heart rate variability in patients with fully remitted major depressive disorder. *Acta Neuropsychiatrica,* 33–42. http://dx.doi.org/10.1111/j.1601-5215.2012.00658.x.

Coryell, W., & Schlesser, M. (2001). The dexamethasone suppression test and suicide prediction. *American Journal of Psychiatry, 158*(5), 748–753. http://dx.doi.org/10.1176/appi.ajp.158.5.748.

Crowell, S. E., Beauchaine, T. P., McCauley, E., Smith, C. J., Stevens, A. L., & Sylvers, P. (2005). Psychological, autonomic, and serotonergic correlates of parasuicide among adolescent girls. *Development and Psychopathology, 17*(4), 1105–1127. http://dx.doi.org/10.1017/s0954579405050522.

Crowell, S. E., Baucom, B. R., Yaptangco, M., Bride, D., Hsiao, R., McCauley, E., & Beauchaine, T. P. (2014). Emotion dysregulation and dyadic conflict in depressed and typical adolescents: Evaluating concordance across psychophysiological and observational measures. *Biological Psychology, 98*(1), 50–58. http://dx.doi.org/10.1016/j.biopsycho.2014.02.009.

Curtin, S. C., Warner, M., & Hedegaard, M. (2016). *Suicide rates for females and males by race and ethnicity: United States, 1999 and 2014.* NCHS Health E-Stat. National Center for Health Statistics.

Durand, S. C., & McGuinness, T. M. (2016). Suicide in childhood. *Journal of Psychosocial Nursing and Mental Health Services, 54*(10), 27–30. http://dx.doi.org/10.3928/02793695-20160920-05.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1995). *Structured clinical interview for DSM-IV axis i disorders-patient edition (SCID-I/P).* New York: Biometrics Research Department, NY State Psychiatric Institute.

Gar, N. S., & Hudson, J. L. (2008). An examination of the interactions between mothers and children with anxiety disorders. *Behaviour Research and Therapy, 46*(12), 1266–1274. http://dx.doi.org/10.1016/j.brat.2008.08.006.

Gentzler, A. L., Santucci, A. K., Kovacs, M., & Fox, N. A. (2009). Respiratory sinus arrhythmia reactivity predicts emotion regulation and depressive symptoms in at-risk and control children. *Biological Psychology, 82*(2), 156–163. http://dx.doi.org/10.1016/j.biopsycho.2009.07.002.

Graziano, P., & Derefinko, K. (2013). Cardiac vagal control and children's adaptive functioning: A meta-analysis. *Biological Psychology, 94*(1), 22–37. http://dx.doi.org/10.1016/j.biopsycho.2013.04.011.

Hastings, P., Nuselovici, J., Utendale, W., & Coutya, J. (2008). Applying the polyvagal theory to children's emotion regulation: Social context, socialization, and adjustment. *Biological Psychology, 3*(79), 299–306. http://dx.doi.org/10.1016/j.biopsycho.2008.07.005.

Hawton, K., Saunders, K. E. A., & O'Connor, R. C. (2012). Self-harm and suicide in adolescents. *The Lancet, 379*(9834), 2373–2382. http://dx.doi.org/10.1016/s0140-6736(12)60322-5.

Hooley, J. M., & Parker, H.a. (2006). Measuring expressed emotion: An evaluation of the shortcuts. *Journal of Family Psychology, 20*(3), 386–396. http://dx.doi.org/10.1037/0893-3200.20.3.386.

Jokinen, J., & Nordström, P. (2009). HPA axis hyperactivity and attempted suicide in young adult mood disorder inpatients. *Journal of Affective Disorders, 116*(1), 117–120. http://dx.doi.org/10.1016/j.jad.2008.10.015.

Kann, L., McManus, T., Harris, W. A., Shanklin, S. L., Flint, K. H., Hawkins, J. H., ... Zaza, S. (2016). Youth risk behavior surveillance — United States, 2015. *Morbidity and Mortality Weekly Report, 65*(6), 1–51. http://dx.doi.org/10.15585/mmwr.ss6506a1.

Kaufman, J., Birmaher, B., Brent, D., Rao, U., Flynn, C., Moreci, P., ... Ryan, N. D. (1997). Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): Initial reliability and validity data. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*(7), 980–988. http://dx.doi.org/10.1097/00004583-199707000-00021.

Kershner, J. G., Cohen, N. J., & Coyne, J. C. (1996). Expressed emotion in families of clinically referred and nonreferred children: Toward a further understanding of the expressed emotion index. *Journal of Family Psychology, 10*(1), 97–106. http://dx.doi.org/10.1037//0893-3200.10.1.97.

Klimes-Dougan, B. (1998). Screening for suicidal ideation in children and adolescents: Methodological considerations. *Special Issue: Adolescent Suicide: Risk, Assessment, and Treatment, 21*(4), 435–444. http://dx.doi.org/10.1006/jado.1998.0166.

Koplin, B., & Agathen, J. (2002). Suicidality in children and adolescents: A review. *Current Opinion in Pediatrics, 14*(6), 713–717. http://dx.doi.org/10.1097/00008480-200212000-00013.

Kovacs, M. (1981). Rating scales to assess depression in school-aged children. *Acta Paedopsychiatrica, 46*(5–6), 305–315.

Kovess-Masfety, V., Pilowsky, D. J., Goelitz, D., Kuijpers, R., Otten, R., Moro, M. F., ... Carta, M. G. (2015). Suicidal ideation and mental health disorders in young school children across Europe. *Journal of Affective Disorders, 177*, 28–35. http://dx.doi.org/10.1016/j.jad.2015.02.008.

Kudinova, A. Y., Owens, M., Burkhouse, K. L., Barretto, K. M., Bonanno, G. A., & Gibb, B. E. (2015). Differences in emotion modulation using cognitive reappraisal in individuals with and without suicidal ideation: An ERP study. *Cognition & Emotion, 30*(5), 1–9. http://dx.doi.org/10.1080/02699931.2015.1036841.

Little, R. J. A., & Rubin, D. B. (1987). *Statistical analysis with missing data.* New York, NY: Wiley.

Lovallo, W. R. (2015). *Stress and health: Biological and psychological interactions.* Thousand Oaks, CA: Sage Publications.

Magaña, A. B., Goldstein, M. J., Karno, M., Miklowitz, D. J., Jenkins, J., & Falloon, I. R. H. (1986). A brief method for assessing expressed emotion in relatives of psychiatric patients. *Psychiatry Research, 17*(3), 203–212. http://dx.doi.org/10.1016/0165-1781(86)90049-1.

March, J. S., Parker, J., Sullivan, K., Stallings, P., & Conners, C. (1997). The multidimensional anxiety scale for children (MASC): Factor structure, reliability, and validity. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*, 554–565. http://dx.doi.org/10.1097/00004583-199704000-00019.

McCarty, C. A., Lau, A. S., Valeri, S. M., & Weisz, J. R. (2004). Parent-child interactions in relation to critical and emotionally overinvolved expressed emotion (EE): Is EE a proxy for behavior? *Journal of Abnormal Child Psychology, 32*(1), 83–93. http://dx.doi.org/10.1023/B:JACP.0000007582.61879.6f.

Moore, E., & Kuipers, E. (1999). The measurement of expressed emotion in relationships between staff and service users: The use of short speech samples. *The British Journal of Clinical Psychology/the British Psychological Society, 38*(Pt 4), 345–356. http://dx.doi.org/10.1348/014466599162953.

Morris, A. S., Silk, J. S., Steinberg, L., Myers, S. S., & Robinson, L. R. (2007). The role of the family context in the development of emotion regulation. *Social Development, 16*(2), 361–388. http://dx.doi.org/10.1111/j.1467-9507.2007.00389.x.

Nock, M. K., Green, J. G., Hwang, I., McLaughlin, K. A., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2013). Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents. *JAMA Psychiatry, 70*(3), 300–310. http://dx.doi.org/10.1001/2013.jamapsychiatry.55.

Pisani, A. R., Wyman, P. A., Petrova, M., Schmeelk-Cone, K., Goldston, D. B., Xia, Y., & Gould, M. S. (2013). Emotion regulation difficulties, youth-adult relationships, and suicide attempts among high school students in underserved communities. *Journal of Youth and Adolescence, 42*(6), 807–820. http://dx.doi.org/10.1007/s10964-012-9884-2.

Porges, S. W. (1986). Respiratory sinus arrhythmia: Physiological basis quantitative methods, and clinical implications. In P. Grossman, K. Janssen, & D. Vaitl (Eds.). *Cardiorespiratory and cardiosomatic psychophysiology* (pp. 101–115). New York, NY: Plenum Press.

Porges, S. (1995). Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A polyvagal theory. *Psychophysiology, 32*, 301–318. http://dx.doi.org/10.1111/j.1469-8986.1995. tb01213.x.

Porges, S. (2007). The polyvagal perspective. *Biological Psychology, 74*(2), 116–143. http://dx.doi.org/10.1016/j.biopsycho.2006.06.009.

Porges, S. W., Doussard-Roosevelt, J. A., Portales, A. L., & Greenspan, S. I. (1996). Infant regulation of the vagal "brake" predicts child behavior problems: A psychobiological model of social behavior. *Developmental Psychobiology, 29*(8), 697–712.

Rajappa, K., Gallagher, M., & Miranda, R. (2012). Emotion dysregulation and vulnerability to suicidal ideation and attempts. *Cognitive Therapy and Research, 36*(6),

833–839. http://dx.doi.org/10.1007/s10608-011-9419-2.
Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*(2), 330–366. http://dx.doi.org/10.1037//0033-2909.128.2.330.
Robin, A. L., & Foster, S. L. (1989). *Negotiating parents-Adolescent conflict: A behavioral-family systems approach*. New York, NY: Guilford Press.
Rodriguez, K.a. O., & Kendall, P. C. (2014). Suicidal ideation in anxiety-disordered youth: Identifying predictors of risk. *Journal of Clinical Child and Adolescent Psychology, 43*(1), 51–62. http://dx.doi.org/10.1080/15374416.2013.843463.
Rogosch, F. A., Cicchetti, D., & Toth, S. L. (2004). Expressed emotion in multiple subsystems of the families of toddlers with depressed mothers. *Development and Psychopathology, 16*(3), 689–709. http://dx.doi.org/10.1017/S0954579404004730.
Rothbart, M. K., Sheese, B. E., Rueda, M. R., & Posner, M. I. (2011). Developing mechanisms of self-regulation in early life. *Emotion Review: Journal of the International Society for Research on Emotion, 3*(2), 207–213. http://dx.doi.org/10.1177/1754073910387943.
Rottenberg, J., Wilhelm, F. H., Gross, J. J., & Gotlib, I. H. (2002). Respiratory sinus arrhythmia as a predictor of outcome in major depressive disorder. *Journal of Affective Disorders, 71*(1), 265–272. Retrieved from www.elsevier.com.
Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7*(2), 147–177. http://dx.doi.org/10.1037//1082-989x.7.2.147.
Shaffer, D., Gould, M. S., Fisher, P., Trautman, P., Moreau, D., Kleinman, M., ... D, K (1996). Psychiatric diagnosis in child and adolescent suicide. *Archives of General Psychiatry, 53*(4), 339. http://dx.doi.org/10.1001/archpsyc.1996.01830040075012.
Shahrestani, S., Stewart, E., & Quintana, D. (2014). Heart rate variability during social interactions in children with and without psychopathology: A meta-analysis. *Journal of Child Psychology and Psychiatry, 55*(9), 981–989.
Silk, J. S., Ziegler, M. L., Whalen, D. J., Dahl, R. E., Ryan, N. D., Dietz, L. J., ... Williamson, D. E. (2009). Expressed emotion in mothers of currently depressed, remitted, high-risk, and low-risk youth: Links to child depression status and longitudinal course. *Journal of Clinical Child and Adolescent Psychology, 38*(1), 36–47. http://dx.doi.org/10.1080/15374410802575339.
Wedig, M. M., & Nock, M. K. (2007). Parental expressed emotion and adolescent self-injury. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*(9), 1171–1178. http://dx.doi.org/10.1097/chi.0b013e3180ca9aaf.
Whalen, D. J., Dixon-Gordon, K., Belden, A. C., Barch, D., & Luby, J. L. (2015). Correlates and consequences of suicidal cognitions and behaviors in children ages 3–7 years. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(11), 926–937. http://dx.doi.org/10.1016/j.jaac.2015.08.009.
Williams, S. R., & Woodruff-Borden, J. (2015). Parent emotion socialization practices and child self-regulation as predictors of child anxiety: The mediating role of cardiac variability. *Child Psychiatry and Human Development, 46*(4), 512–522. http://dx.doi.org/10.1007/s10578-014-0492-0.
Wilson, S. T., Chesin, M., Fertuck, E., Keilp, J., Brodsky, B., Mann, J. J., & Stanley, B. (2016). Heart rate variability and suicidal behavior. *Psychiatry Research, 240*, 241–247. http://dx.doi.org/10.1016/j.psychres.2016.04.033.
Woody, M. L., Feurer, C., Sosoo, E. E., Hastings, P. D., & Gibb, B. E. (2016). Synchrony of physiological activity during mother?child interaction: Moderation by maternal history of major depressive disorder. *Journal of Child Psychology and Psychiatry, 57*(7), 843–850. http://dx.doi.org/10.1111/jcpp.12562.