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Discrete Emotion Regulation Strategy Repertoires and Parasympathetic Physiology Characterize Psychopathology Symptoms in Childhood

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Certain psychopathologies are often linked to dysregulation of specific emotions (e.g., anxiety is associated with dysregulation of fear), but few studies have examined how regulatory repertoires for specific emotions (e.g., the strategies a person uses to regulate fear) relate to psychopathology, and fewer still have examined this in childhood. A total of 106 7- to 11-year-olds (M = 9.37 years; SD = 1.30; 44% girls) participated in a multimethod investigation of emotion regulation and psychopathology. Parents reported on family characteristics and children's symptoms. Resting parasympathetic function (respiratory sinus arrhythmia; RSA) was measured to assess physiological regulation. Children were interviewed about past experiences that made them feel anger, fear, and sadness, and reported what they had done to make themselves feel better in each emotion context. The strategies children described were summed to create an emotion regulation strategy repertoire measure for each emotion. Children's resting RSA interacted with age to predict externalizing symptoms, such that low resting RSA was associated with more externalizing symptoms for younger children only. In contrast, the link between RSA and anxiety was qualified by both strategy repertoire for fear and age, such that higher resting RSA was most strongly associated with fewer anxiety symptoms for older children with larger strategy repertoires for fear. Contrary to our expectations, neither resting RSA nor strategy repertoire for sadness related to children's depressive symptoms. Findings underscore the importance of considering children's discrete emotion regulation strategy repertoires to more fully characterize the dysregulated affective processes associated with psychopathology in childhood.

Keywords: anxiety, discrete emotions, emotion regulation, externalizing, RSA

Certain psychopathologies are linked to dysregulation of specific emotions (e.g., anxiety is associated with dysregulation of fear), but few studies have examined how discrete emotion regulatory repertoires (e.g., the strategies used to regulate fear) relate to psychopathology, and fewer still have examined this in childhood. Emotion dysregulation is implicated in the development and maintenance of psychopathology symptoms (Mennin, Turk, Heimberg, & Carmin, 2004), as is resting physiology (Calkins & Keane, 2004; Hinnant & El-Sheikh, 2013). But, greater consideration of difficulties with the use of emotion regulation strategies, including having a limited repertoire of strategies from which to select a regulatory response, represents a promising direction for research. Examining the range of strategies children generate and use to regulate emotion can provide greater insight into what precisely is "dysregulated" about emotional processes in childhood psychopathology, and can suggest possible targets for intervention. The current study provides such an examination.

A functionalist view of emotions holds that emotions are contextually bound and goal-oriented (Campos, Mumme, Kermoian, & Campos, 1994), and thus, different emotions will be elicited based on how an event is appraised in relation to those goals (e.g., whether the goal is blocked, threatened, or lost). Emotion regulation refers to any attempt to change an emotional experience by decreasing or increasing one's response to the event in service of our goals or to maintain the body's homeostatic state (Gross, 2015; Nigg, 2017). Emotion regulation can be intrinsically or extrinsically motivated, explicit or implicit, and involves processes such as forecasting how one will feel, reconciling conflicting emotions, and selecting acceptable responses from a repertoire of potential reactions (Campos, Mumme, Kermoian, & Campos, 1994; Cole, Martin, & Dennis, 2004; Gross, 2015). Throughout early life, emotion regulation choices become more complex and strategy toolboxes become larger (Cole, 2014). Because effective emotion regulation would be supported by having many potential strategies from which to draw, having a broad repertoire of known strategies that could be tailored to the emotional context and implemented as needed would be important and adaptive. To our knowledge, no study has explored the relation between emotion regulation strategy repertoires and various types of psychopathology symptoms. The current study aimed to provide clarity about whether this foundational component of adaptive emotion regulation might be constrained or dysregulated in children with psychopathology symptoms.

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Difficulty with emotion regulation strategies, whether in the form of smaller strategy repertoires from which to choose, an inability to effectively deploy emotion regulation strategies, or reliance on maladaptive strategies contributes strongly to risk for emerging psychopathology symptoms. Given that children acquire and refine their use of emotion regulation strategies across development (Braungart & Stifter, 1991; Cole, 2014; Davis, Levine, Lench, & Quas, 2010), we examined the interrelation of physiology and emotion regulation strategy use to characterize psychopathology across a wide range of ages in childhood. Specifically, we examined whether emotion regulation strategy repertoires for anger, fear, and sadness were associated with children's concurrent internalizing (i.e., anxiety, depression) and externalizing symptoms, directly and in conjunction with physiology.

Childhood Psychopathology

Psychopathology symptoms in childhood are often subdivided into internalizing (e.g., anxiety, depression) and externalizing (e.g., oppositional defiant disorder, conduct disorders) symptoms (Lahey et al., 2008). Although there is variability in when these symptoms typically emerge, the manifestation of symptoms early in life often predicts both the maintenance or worsening of symptoms, and the emergence of new symptoms later (e.g., Hinnant & El-Sheikh, 2009; Hinnant & El-Sheikh, 2013). Early psychopathology symptoms have also been linked to problems in long-term social adjustment, delinquency and drug use later in life, as well as other maladaptive outcomes (e.g., Dodge & Pettit, 2003; Helmsen, Koglin, & Petermann, 2012). In a community sample of 800 children who were followed prospectively, 29% of girls and 28% of boys who experienced clinical levels of externalizing or internalizing symptoms at age 3 were still in the clinical range at age 12 (Pihlakoski et al., 2006), indicating that psychopathology symptoms early in childhood show considerable stability for some children. Similar findings have been reported by others (Caspi, Moffitt, Newman, & Silva, 1996; Hofstra, van der Ende, & Verhulst, 2000; Mesman & Koot, 2001). Of course, not all children with early appearing symptoms experience psychopathology later in life, underscoring the necessity of identifying markers of risk for emerging psychopathology as well as protective factors.

Poorer Physiological Regulation Is Associated With Psychopathology

Respiratory sinus arrhythmia (RSA) is a cardiac measure of parasympathetic nervous system influence over the heart that has been extensively used in developmental research to study regulatory capacity. It refers to high-frequency heart rate variation controlled by efferent fibers of the vagus nerve during the respiratory cycle (Calkins & Keane, 2004; Obradović, Bush, Stamperdahl, Adler, & Boyce, 2010). Resting RSA has been linked to psychopathology (Hinnant & El-Sheikh, 2013; Wetter & El-Sheikh, 2012), such that lower resting levels appear to mark risk for psychopathology symptoms (Calkins & Dedmon, 2000; El-Sheikh & Hinnant, 2011; Scott & Weems, 2014). Because resting RSA is thought to represent children's capacity for appropriate engagement and reactivity to the environment, poorer physiological regulation (represented by low resting RSA), would be an index of decreased capacity to adaptively respond to challenging situations (Porges, 1991). Poorer physiological regulation and higher psychopathology symptoms have been linked concurrently (Calkins & Dedmon, 2000) and longitudinally (El-Sheikh & Hinnant, 2011). Higher resting RSA, in contrast, has been associated with better emotion regulation and social competence (Obradović et al., 2010), and appears to mitigate risk for psychopathology (Beauchaine et al., 2013). Specifically, studies have often shown that children with higher resting RSA or who show more adaptive RSA reactivity during a challenging situation tend to use more effective emotion regulation strategies (Calkins & Keane, 2004). Perhaps more interesting is the fact that RSA and emotion regulation seem to be *jointly* important for understanding the emergence of psychopathology early in childhood (Gentzler, Santucci, Kovacs, & Fox, 2009). Children with higher resting RSA levels also tend to show better emotion regulation (Calkins & Keane, 2004). We used resting RSA as our measure of physiological regulation in this study, because it appears to be an important marker of regulatory capacity to engage with challenges in childhood.

Emotion Dysregulation Is Associated With Psychopathology

Psychopathology symptoms are often associated with problems in emotion expression and effective modulation of emotional responses (Mennin, Turk, Heimberg, & Carmin, 2004; Röll, Koglin, & Petermann, 2012; Zeman, Shipman, & Suveg, 2002). This link has been found for externalizing symptoms (Hill, Degnan, Calkins, & Keane, 2006) as well as anxiety (Suveg & Zeman, 2004). For example, Helmsen and colleagues (2012) demonstrated that maladaptive emotion regulation was positively correlated with aggressive response generation, evaluation, decision-making, and behavior in children. Similarly, Suveg and Zeman (2004) found that 8- to 12-year-olds with anxiety had impaired emotion regulation skills compared to same-age children without anxiety. Other studies with children have found that the development of anxiety is associated with problems with emotion regulation, even when controlling for emotional reactivity (Cisler, Olatunji, Feldner, & Forsyth, 2010). Zeman, Shipman, and Suveg (2002) showed that an inability to identify emotional states, the inhibition of anger, the dysregulated expression of anger and sadness, and maladaptive anger coping were all significant predictors of internalizing symptoms in elementary school-age children.

Although emotion dysregulation is a hallmark of many psychopathology disorders, research focus has begun to shift toward examination of how specific emotion regulation strategies relate to mental health (e.g., life satisfaction, positive affect, depression, anxiety). A meta-analysis published in 2014 included samples of children, adolescents, and adults, and showed that use of reappraisal or cognitive reframing (changing how one thinks about something) was positively correlated with positive indicators of mental health (e.g., life satisfaction, positive affect), whereas use of suppression (suppressing the behavioral expression of emotion) was negatively correlated with positive indicators of mental health (Hu, Zhang, Wang, Mistry, Ran, & Wang, 2014). Although this quantitative review represents an informative starting point for the contemporary investigation of emotion regulation strategies, significant limitations to our current understanding remain. In particular, the role of discrete negative emotions (e.g., anger, fear, sadness) has been underexplored in linking emotion regulation

strategies to emotion dysregulation and psychopathology—investigating the regulation of discrete emotional states may enable greater specificity in identification of risk. For instance, some evidence suggests that people experiencing psychopathology symptoms show attentional biases toward stimuli that are affectively congruent with their symptoms (e.g., Cole, Zapp, Fettig, & Perez-Edgar, 2016; Thai, Taber-Thomas, & Perez-Edgar, 2016; Williams, Mathews, & MacLeod, 1996). The ability to regulate discrete emotions, especially those that align with specific psychopathology symptoms, may be particularly important for buffering against risk.

Emotion regulation strategies are specific behaviors and thoughts used to change either an upsetting situation or how one feels about it. These can include strategies aimed at selecting or modifying a situation, redirecting attention, changing thoughts, or changing responses (Gross, 2015). Some strategies, such as attentional deployment (e.g., redirecting attention away from a distressing stimulus), can be seen even in toddlerhood (Braungart & Stifter, 1991). More sophisticated strategies, however, such as cognitive reframing (e.g., thinking in a different way about something), emerge later in childhood (Davis et al., 2010). Thus, children use a variety of strategies from young ages, and acquire and use other strategies as they grow older. Research with adults suggests that different strategies are differentially effective at reducing the intensity of an emotional experience (i.e., self-reported, observed, and physiological measures of emotion; Webb, Miles, & Sheeran, 2012), but no studies have examined whether and to what extent the emotion regulation strategy repertoires that children build over childhood carry consequences for healthy development.

Adding complexity to our understanding of children's developing emotion regulation skills is the fact that different emotions likely require different ways of regulating. Distinct emotions are elicited by individuals' interpretations of how events relate to one's goals (Campos, Mumme, Kermoian, & Campos, 1994). Because different emotions are elicited by different appraisals of events (e.g., is the goal merely threatened, or is it lost entirely?), adaptive regulatory responses would vary. For example, thinking about something else might be particularly useful when a goal has been lost (e.g., a pet dies and a child feels sad), compared with when a goal has been blocked (e.g., an older brother takes away a toy and a child feels angry). Research suggests that people do prefer some strategies over others depending on the discrete emotion at hand (Sheppes, Scheibe, Suri, & Gross, 2011; Shipman, Zeman, Nesin, & Fitzgerald, 2003). Importantly, a tendency to tailor the use of strategies to discrete emotion contexts appears to be present even in childhood (Davis et al., 2010; Shipman, Zeman, Nesin, & Fitzgerald, 2003; Zeman & Shipman, 1997), suggesting that children's regulatory repertoires for discrete emotions may include different types and numbers of strategies. Our study is the first to explore the role of repertoire for *specific* emotions on psychopathological symptoms associated with dysregulation of that emotion (e.g., regulation of fear for anxiety).

Recently, emotion regulation choice, strategy repertoire, and flexibility have emerged as promising indicators of adaptive regulatory abilities (Bonanno & Burton, 2013; Sheppes & Levin, 2013; Sheppes et al., 2014). Studies with adults have shown that greater regulatory flexibility is linked to enhanced adaptation to environmental demands, fewer psychopathology symptoms, and other positive outcomes (Aldao, Sheppes, & Gross, 2015). Strategy repertoire is an important component of regulatory flexibility (Bonanno & Burton, 2013) and can be thought of as one facet of the regulatory resources a person possesses. We conceptualize emotion regulation repertoire as the ability to use diverse strategies (e.g., number of strategies, variety in categories of strategies; Aldao et al., 2015; Bonanno & Burton, 2013), and adaptive emotion regulation as the application of context-appropriate emotion regulation strategies to the emotional context at hand. Although most studies of strategy repertoire, flexibility, or emotion regulation choice have focused on adults, one study of strategy repertoire in adolescence found that having a limited (and rigid) repertoire was related to internalizing symptoms (Lougheed & Hollenstein, 2012), underscoring the need for research that clarifies the implications of emotion regulation repertoires in the earlier years. Given that children use an expanding range of behavioral and cognitive strategies from the preschool years onward, a larger repertoire of regulatory strategies would ostensibly be a sign of healthy development.

The Current Study

The goal of the current study was to determine whether children's discrete emotion regulation strategy repertoires and resting RSA were associated with psychopathology symptoms. The study capitalizes on data from 106 seven- to 11-year-olds who responded to a structured interview about emotional experiences, parent reports of children's psychopathology symptoms, and children's resting RSA. We considered SES and gender as potentially important covariates, as previous studies have shown that level of psychopathology symptoms varied based on SES (Spence, Najman, Bor, O'Callaghan, & Williams, 2002) and gender (Bongers, Koot, Van Der Ende, & Verhulst, 2004). Last, because children's age has been associated with all variables of interest, we explored age differences in the patterns of associations between emotion regulation and resting RSA on psychopathology symptoms. We expected to find that lower resting RSA levels would be related to greater symptomatology, replicating prior research. We expected that breadth of strategy repertoire would be negatively associated with symptomatology in each context, such that children with smaller adaptive repertoires would be reported as having more symptoms. Specifically, we examined (a) whether strategy repertoires to regulate anger predicted externalizing symptoms, (b) whether strategy repertoires to regulate fear predicted anxiety symptoms, and (c) whether strategy repertoires to regulate sadness predicted depressive symptoms. We also hypothesized that children with smaller repertoires to regulate a given emotion *and* lower resting RSA would have the most psychopathology symptoms, because of the cross-domain regulatory deficits this pattern would indicate. And, we expected age to interact with strategy repertoire and resting RSA, such that smaller repertoires and low resting RSA would relate to psychopathology more strongly for older children.

Method

Participants

One hundred six children between the ages of 7 and 11 years (M = 9.37 years; SD = 1.30; 44% girls) and their caregivers participated in a larger study on socioemotional development. The

larger study from which this sample was drawn included an experimental manipulation with three conditions that took place later in the visit (after all tasks described in this report), for which 35–36 children per condition were needed. Data were collected until this minimum number was reached in each condition. Families were recruited from public events, child development centers, and by posting fliers in public places in the Inland Empire region of Southern California.

The sample was ethnically diverse and representative of the area; parents reported children's race/ethnicity as multiracial/multiethnic (36%), Hispanic (31%), White (18%), African American (13%), Asian (1%), or other (1%). Eighty-seven mothers and 18 fathers participated with their child; 1 parent did not self-report gender. Parents self-identified their race/ethnicity as Hispanic (42%), White (24%), multiracial/multiethnic (13%), African American (8%), or other (4%), Asian (3%), and 7% of parents did not report race/ethnicity. Household income for our sample ranged from less than $15,000 (14%) to more than $100,000 annually. Forty percent (40%) reported a family income between $16,000 and $50,000, and 14% of the sample declined to report income. For parental education, 12% of fathers and 9% of mothers reported "some high school" or less as the highest education level achieved. An additional 38% of fathers and 30% of mothers were high school graduates, 40% of fathers and 60% of mothers had a technical, college, or advanced degree. Information about educational attainment was not reported for 9% of fathers and 1% of mothers. Annual household income and parental education were included in analyses as proxy covariates for families' SES. For families who reported both mother and father education, a composite parental education variable averaging the two values was included in analyses ($n = 96, 91\%$); for the rest of the participants ($n = 9, 9\%$) we used education data from the reporting parent only. Children completed the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 2007) at the beginning of the study to assess receptive vocabulary. The average age-standardized score in our sample was 101.45, $SD = 14.54$, suggesting that our diverse sample was at the normed average for English vocabulary for their age (normed $M = 100$; $SD = 15$; Dunn & Dunn, 2013).

Procedure

Families came to the lab for a single visit. Informed consent was obtained from parents, and assent (verbal and written) was obtained from the children at the beginning of the study. Parents completed questionnaires about themselves and their child (e.g., demographics, psychopathology symptoms) and children took part in several structured tasks in an adjacent room, including the interview about their experiences of negative emotions that is the focus of this study. Cardiovascular electrocardiogram (ECG) data were acquired continuously during a 5-min resting baseline at the beginning of the visit. Self-adhesive electrodes were placed on the children's torsos, and ambulatory devices wirelessly transmitted the signal to a nearby computer. The university's institutional review board approved all study procedures (University of California, Riverside, Protocol #12–0008: Biobehavioral Correlates of Emotion Regulation in Childhood). Families received a small honorarium for their participation and children took home a toy the end of the visit. All procedures were in English.

Stimuli and Measures

Child emotion regulation repertoire interview. About 30 min after arrival, and before any emotion-eliciting tasks took place as part of the larger study, children were interviewed by an experimenter (77% of the visits were conducted by women, so gender was not necessarily matched between child and experimenter) about past autobiographical events that made them feel anger, fear, and sadness. The order of the emotions was fixed across participants, such that children were always asked about a sad event first, followed by a scary, and then angry event. Specifically, the experimenter said, "*We are interested in how people think and feel about different things. So now I am going to ask you about times that you felt certain ways. First, I'd like to know about a time recently that you felt VERY* [ANGRY/SCARED/SAD]. *Please take a few moments to think about and remember a time recently when you felt VERY* [ANGRY/SCARED/SAD]. *Think about what happened and about all of the little details you can remember about it.*" Children were then given a minute to think about *a recent event* and were offered a piece of paper and writing/drawing implements to use if they liked. Children were prompted to think about a "recent" event with no specific time frame, because we were most interested in children's recall of subjectively evocative events, and children may not have had a relevant emotional experience to describe from a specified time frame. Children were asked the same question for each emotion separately. After the children gave all the details they could remember about the event, the experimenter asked them to report what they had done to make themselves feel better by saying, "*When you felt that way, what did you try to do or think about to make yourself feel LESS* [ANGRY/SCARED/SAD]?" Two prompts for additional information were provided (e.g., "*What else did you do?*", "*What other things did you do or think about?*"), so children were asked to provide information about strategy use three times for each discrete emotion phase of the interview.

Responses were transcribed and strategies were reliably coded using a coding scheme modeled after similar investigations, modified to encompass the wide range of responses given by the older children in our sample (e.g., Davis et al., 2010). The coding scheme consisted of seven broad categories: *problem-solving, changing thoughts*, *changing goals*, *changing physiology*, *social support*, *religious activity*, and "*experiencing the emotion without trying to change it*" that were used only as an organizational heuristic for coders. Each broad category contained multiple strategies. Because of our interest in capturing strategy repertoire variability, the specific strategies within each category rather than the seven broad categories were used to create the strategy repertoire measures (see Table 1). For example, the *changing thoughts* category was composed of *cognitive reframing*, *cognitive distraction*, *thought suppression*, *sleep/change mental state*, *imagined social support*, and *changing thoughts-other*. Because children could answer by saying they did not do anything to change how they felt about the situation, some children described no codeable strategies even though they completed the interview. A total of 7 children said they did not do anything during the anger interview, and 1 child gave a response that was uncodable. A total of 7 children said they did not do anything for the fear interview, and 3 reported not remembering. Last, a total of 8 children said they did not do anything during the interview about a sad event and 1

Table 1
Emotion Regulation Strategy Coding

Emotion regulation strategy	Example
Problem-focused/Problem-solving	
Goal reinstatement	"I turned on the light"
Agent focused	"I kicked him back"
Change thoughts	
Cognitive reframing	"I was thinking about how it wasn't real"
Cognitive distraction	"I thought about ice cream"
Thought suppression	"I forgot about it"
Sleep/Change mental state	"I took a nap"
Imagined social support	"I thought someone was sleeping right next to me"
Other	
Change goals	
Goal substitution	"Went around Sea World with family to see everything instead of going on the ride"
Goal forfeit	"I decided not to play anymore"
Expressive suppression	"I tried not to cry"
Avoidance/Withdrawal	"I tried to leave the funeral"
Behavioral distraction	"Just sat there and watched tv"
Social support	
Sought	"Talked to my mom"
Received	"Mom came inside to watch me play"
Other	
Did nothing	
Acceptance of emotion	"I just cried"
Did nothing	"I didn't do anything"
Religious activity	
Prayed	"I prayed"
Religious ritual	"Went to church"
Change physiological experience	
Breathing	"Took a breath"
Calm down	"Try to calm down"
Other	

reported not remembering. The interrater reliability for this coding was calculated on 30% of responses and was very good ($k = .87$).

We operationalized strategy repertoire as the number of unique strategies used (e.g., cognitive reframing, cognitive distraction), and created emotion-specific repertoire scores by combining all the strategies reported for a given emotion. If a child endorsed the same strategy more than once during a single emotion phase (e.g., fear), it counted only once toward the repertoire measure for that emotion (e.g., fear repertoire). Although the coding included a large number of strategies, we only included strategies that are adaptive for the given emotion in each repertoire calculation. We started with a core set of 6 adaptive strategies that would be expected to work well in any of the discrete emotion contexts: cognitive distraction, behavioral distraction, imagined social support, seeking social support, breathing, and calming down. We refined the repertoire for each emotion drawing on empirical work suggesting that children describe or preferentially use some strategies over others depending on the emotional context.

For example, Davis et al. (2010) showed that 5- and 6-year-olds described using cognitive reframing strategies more often to regulate sadness and fear than anger, so cognitive reframing was added to the sadness and fear repertoires (but not included in the anger repertoire). Because sadness is characterized by an irrevocably lost goal, we added acceptance to the sadness repertoire (but not to the anger or fear repertoires, because these emotions are characterized by the possibility of a goal still being in play). Waters and Thompson (2014) showed that 6- to 9-year-olds reported using problem solving preferentially to regulate anger (compared to sadness), thus our anger repertoire includes strategies we coded that are most like problem solving (goal reinstatement and agent-focused coping), but our repertoire measure for sadness does not. Because fear is an emotion characterized by uncertainty about whether a goal is lost or merely threatened, we included goal reinstatement and agent-focused coping in the fear repertoire as well. Our final sadness repertoire included cognitive reframing, cognitive distraction, imagined social support, behavioral distraction, seeking social support, acceptance, breathing, and calming down. The fear repertoire was similar, but did not include acceptance and did include reinstating a goal, and agent-focused coping. The anger repertoire was similar to the fear repertoire, with the exception that cognitive reframing was not included for anger.

Child psychopathology. Parents reported on children's externalizing and depressive symptoms with the *MacArthur Health and Behavior Questionnaire* (HBQ; Essex et al., 2002), which consists of 170 items assessing mental and physical health, social functioning, and school functioning with multiple subscales. The externalizing subscale consists of 31 items (e.g., "Defiant, talks back to adults"). Parents indicated the extent to which a given statement was true for their child using a 3-point scale ranging from 0 (*never or not true*) to 2 (*often or very true*). Responses were averaged for the subscale and higher values indicate more externalizing symptoms. The internal consistency for the externalizing subscale was excellent ($\alpha = .904$). The depression subscale consisted of 7 items (e.g., "unhappy, sad, or depressed") and was scored using the same

procedure as the externalizing subscale. The internal consistency for the depression subscale was adequate ($\alpha = .684$). Although there are no explicit clinical thresholds for the HBQ scales, general proposed cutoffs are .68 for the externalizing subscale, and .72 for the internalizing symptoms (the depression subscale is part of the broader internalizing subscale; Lemery-Chalfant et al., 2007). Using these cutoffs, 11.4% of the children in this study scored above the clinical threshold for externalizing (12 children), and 9.4% scored above the threshold for depression (using the internalizing cutoff; 10 children).

Children's anxiety was measured using the *Screen for Child Anxiety Related Disorders* (SCARED; Birmaher et al., 1995). The SCARED consists of 41 items that assess various types of anxiety disorders. The questionnaire yields a general score and 5 subscales that represent specific subtypes of anxiety (Panic Disorder, Generalized Anxiety Disorder, Separation Anxiety, Social Anxiety Disorder, Significant School Avoidance). For this study, we focused on the general score. Parents responded on a 3-point scale how much their child was like the child described in each statement from 0 (*not true or hardly ever true*) to 2 (*very true or often true*). The threshold for clinically meaningful scores on the general scale is 25; 8.7% of the children in this sample scored above this threshold (9 children). The internal consistency for the general score was excellent ($\alpha = .911$).

Child physiological regulation. Noninvasive resting electrocardiogram (ECG) data were collected for five minutes at the beginning of the visit, after the children developed rapport with the experimenter and acclimated to the laboratory, but before any challenging tasks took place. Seven self-adhesive electrodes were placed on the torso, three of which collected ECG (the other four were to acquire impedance cardiography, not considered in this report). Ambulatory devices acquired the ECG and transmitted the signal wirelessly to a computer in an adjacent room of the laboratory. For the resting baseline, children were asked to sit quietly, look at a book, or color a picture. These instructions quieted children and minimized gross motor movements. RSA was calculated offline using the MindWare Heart Rate Variability software program (HRV 3.0.21) as the natural log of the integral power within the respiratory frequency bandwidth. The HF range for children in this sample (middle childhood) was derived from estimates of 7- to 11-year-olds' average respiration rates (i.e., between 16 and 25 breaths per minutes) and set at .15-.80Hz (e.g., Johnson et al., 2017). This relatively conservative HF range was selected to bridge early childhood (.24–1.04Hz; Bar-Haim, Marshall, & Fox, 2000) and adult (.12-.40Hz; Porges, 1986) recommendations for the HF band-pass range. Adjusting the HF parameters to fall between the infant and adult ranges is an approach that has been used in other studies with wide age ranges (Porges et al., 2013). RSA was scored in 30-s epochs and resting RSA was calculated by averaging all available epochs (~10 per child from the 5-min baseline). All physiology data were visually inspected and scored by reliable coders. RSA values for each 30-s epoch obtained by two coders had to fall within .1 of each other to be considered reliable (percent agreement for RSA values within 0.1 = 98%; e.g., Davis, Quinones-Camacho, & Buss, 2016).

Missing data. Only income was missing for a substantial number of participants ($n = 15$; 14%). We tested whether families who reported versus did not report income differed on any variable, and found no significant differences. Resting RSA was the next most commonly missing variable ($n = 5$). This missingness was due to equipment malfunction or unusable data (e.g., electrodes came loose during acquisition). All other variables had five or fewer participants with missing data. We chose to multiply impute missing data, to retain all participants for analyses (Royston, 2004). Ten imputed data sets were computed using SPSS 24.0 and pooled estimates are reported in analyses.

Results

Preliminary Analyses

Gender differences. There were no child gender differences in resting RSA ($t_{(99)} = .395$, $p = .693$, $d = .079$), anxiety symptoms ($t_{(101)} = .504$, $p = .615$, $d = .100$), general strategy repertoire ($t_{(102)} = -1.186$, $p = .238$, $d = -.235$), anger strategy repertoire ($t_{(103)} = -.032$, $p = .974$, $d = -.006$), fear strategy repertoire ($t_{(103)} = -1.400$, $p = .164$, $d = -.276$), or sadness strategy repertoire ($t_{(103)} = -1.587$, $p = .116$, $d = -.313$). There were, however, gender differences in children's externalizing symptoms ($t_{(103)} = 2.521$, $p = .013$, $d = .497$), such that boys had higher levels of externalizing symptoms. As well, we found a gender difference in children's depression symptoms ($t_{(98)} = 2.444$, $p = .016$, $d = .493$), such that boys had higher levels of depressive symptoms. Thus, we covaried gender in analyses.

Descriptive statistics. Table 2 displays descriptive statistics for study variables, and Table 3 shows intercorrelations among all variables. Externalizing symptoms and anxiety symptoms were positively correlated, $r = .449$, $p < .001$, as were externalizing symptoms and depressive symptoms, $r = .623$, $p < .001$, and anxiety symptoms and depressive symptoms, $r = .577$, $p < .001$. As expected, lower levels of resting RSA were associated with more externalizing, $r = -.266$, $p = .006$ and more anxiety symptoms, $r = -.239$, $p = .006$. However, RSA was not associated with depressive symptoms, $r = -.144$, $p = .120$. Anger strategy repertoire was associated with externalizing symptoms, $r = -.255$, $p = .010$, such that smaller anger repertoires were associated with more externalizing symptoms.

RSA, Emotion Regulation Strategy Repertoire, and Age Predicting Psychopathology

We created separate hierarchical regression models for each of the psychopathology outcomes (externalizing, anxiety, depres-

Table 2
Means and Standard Deviations of Key Study Variables

Variable	Mean	*SD*	Range
Child resting RSA	6.40	1.11	1.92–9.50
Fear strategy repertoire	1.52	.83	.00–4.00
Anger strategy repertoire	1.56	.92	.00–4.00
Sad strategy repertoire	1.70	1.00	.00–4.00
Externalizing symptoms	.32	.28	.00–1.21
Anxiety symptoms	12.79	9.86	.00–48.00
Depressive symptoms	.30	.32	.00–1.29

Note. RSA = Respiratory sinus arrhythmia. Descriptive statistics shown here are for the original sample before doing multiple imputations.

Table 3
Correlations Among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Child resting RSA	—										
2. Fear strategy repertoire	−.193	—									
3. Anger strategy repertoire	.005	.214*	—								
4. Sad strategy repertoire	−.049	.230*	.074	—							
5. Externalizing symptoms	−.266**	−.087	−.262**	−.083	—						
6. Anxiety symptoms	−.239*	−.019	−.035	.012	.459**	—					
7. Depressive symptoms	−.144	.046	−.144	−.036	.633**	.583**	—				
8. Age	−.041	.083	.056	.139	−.085	.088	.155	—			
9. Income	.026	−.112	.135	−.029	−.314**	−.235*	−.262*	.038	—		
10. Parental education	−.009	.014	.028	−.070	−.007	−.048	−.047	−.067	.432**	—	
11. Child gender	−.044	.120	.120	.000	−.234*	−.050	−.222*	−.083	.183	.072	—

Note. RSA = Respiratory sinus arrhythmia. Child gender variable coded as boys = 0 and girls = 1.
* $p < .05$. ** $p < .01$.

sion). Predictors were mean-centered before inclusion in the models and interaction terms. At step 1, we entered income, gender, parental education, the word count (i.e., length of utterance) for children's description of the emotional event (as a measure of verbal ability), and the other two psychopathology variables.[1] At step 2, we entered age, resting RSA, and the strategy repertoire variable for the relevant discrete emotion (e.g., fear repertoire for the anxiety model).[2] At step 3, we entered the 2-way interactions of age and strategy repertoire, age and resting RSA, and resting RSA and strategy repertoire. In step 4, we entered the 3-way interaction of strategy repertoire, resting RSA, and age.

Externalizing symptoms. Step 1 resulted in a significant model $F(6, 99) = 13.55$, $p < .001$(see Table 4). Level of depressive symptoms was the only significant covariate, ($b = .456$, $t = 5.229$, 95% CI [.285, .627]), such that more depressive symptoms was associated with more externalizing symptoms. Step 2 resulted in a significant change to the model $\Delta F(3, 96) = 4.886$, $p = .005$. Resting RSA was a significant predictor ($b = -.045$, $t = -2.356$, 95% CI [−.082, −.008]), such that children with lower resting baselines had more externalizing symptoms. Age was also a significant predictor ($b = -.035$, $t = -2.055$, 95% CI [−.068, −.002]). Step 3 resulted in a significant change to the model $\Delta F(3, 93) = 3.386$, $p = .027$. At this step, depressive symptoms, age, and resting RSA were still significant predictors. The 2-way interaction between age and resting RSA was significant ($b = .035$, $t = 2.364$, 95% CI [.006, .064]; Figure 1). Continuous variables in all interactions were plotted at ±1SD (conventionally, corresponding to low and high levels) from the mean (Aiken, West, & Reno, 1991). For older children, resting RSA was not associated with externalizing symptoms ($b = -.015$, $t = -.559$, $p = .551$), whereas for younger children, lower resting RSA was associated with more externalizing symptoms ($b = -.105$, $t = -3.632$, $p < .001$). Step 4 resulted in a nonsignificant change to the model $\Delta F(1, 92) = .178$, $p = .738$.

Anxiety symptoms. Step 1 resulted in a significant model, $F(6, 99) = 1.516$, $p < .001$,(see Table 5). Level of depressive symptoms was the only significant covariate, ($b = 15.209$, $t = 4.679$, 95% CI [8.837, 21.580]), such that more depressive symptoms was associated with more anxiety symptoms. Step 2 resulted in a nonsignificant change to the model, $\Delta F(3, 96) = 1.499$, $p = .244$. Step 3 resulted in a nonsignificant change to the model $\Delta F(3, 93) = 1.740$, $p = .156$. But, the inclusion of the 3-way interaction in Step 4 resulted in a significant change to the model $\Delta F(1, 92) = 4.001$, $p = .050$. Level of depressive symptoms was still a significant predictor at this step. The 3-way interaction of age, resting RSA, and strategy repertoire for fear was also significant ($b = -1.559$, $t = -1.990$, 95% CI [−3.094, −.024]). A test of the simple slopes (see Figure 2) revealed that for older children with larger strategy repertoires to regulate fear, higher resting RSA was associated with fewer anxiety symptoms ($b = -3.883$, $t = -3.402$, $p = .001$), whereas for younger children with larger strategy repertoires for fear, resting RSA was not associated with anxiety symptoms ($b = -1.411$, $t = -1.075$, $p = .285$). For children with smaller strategy repertoires for fear, resting RSA did not relate to anxiety symptoms, regardless of age (Older: $b = 1.903$, $t = 1.304$, $p = .196$; Younger: $b = -1.861$, $t = -.890$, $p = .376$).

Depressive symptoms. Step 1 resulted in a significant model, $F(6, 99) = 15.652$, $p < .001$, $R^2 = .513$ (see Table 6). Externalizing and anxiety symptoms were significant predictors of depressive symptoms (externalizing: $b = .493$, $t = 5.047$, $p < .001$, 95% CI [.302, .685]; anxiety: $b = .012$, $t = 4.665$, $p < .001$, 95% CI [.007, .017]), such that higher externalizing and anxiety symptoms were

[1] We ran these same models with all the same predictors except the two covaried measures of other psychopathology. For the externalizing model, the third step was still the last significant step, $\Delta F(3, 93) = 4.561$, $p = .015$, but the interaction of resting RSA and age was no longer significant ($b = .029$, $p = .103$), instead, the interaction of anger repertoire and resting RSA was significant ($b = .095$, $SE\ b = .036$, $t = 2.653$, $p = .008$, 95% CI [.025, .166]). The pattern for this interaction was that the combination of lower resting RSA and smaller anger repertoires was associated with more externalizing symptoms. For the anxiety model, the pattern of results was the same, and the 3-way interaction was still significant and followed the same pattern as the results described in the text ($b = -2.029$, $SE\ b = .939$, $t = -2.162$, $p = .031$, 95% CI [−3.869, −.189]). For the depression model, excluding the other psychopathology measures still resulted in a significant first step, $F(6, 99) = 3.187$, $p = .017$, $R^2 = .112$, but nonsignificant steps when the predictors of interest were added to the model, following the same pattern as described in the text.

[2] Models were also run including the emotion regulation repertoires for the other discrete emotions as covariates for each model (e.g., fear, sadness, and anger for externalizing). All nontarget repertoires (e.g., fear repertoire in the externalizing model) were not significant and results did not change when these repertoires were included in the model, thus, models presented here do not include all discrete emotion repertoires for parsimony.

Table 4
Regression Model Predicting Externalizing Symptoms

Variable	Step 1			Step 2			Step 3			Step 4		
R^2	.451			.523			.566			.571		
ΔR^2	.451			.072			.043			.005		
ΔF	13.55			4.886			3.386			.178		
	b	*SE b*	*p*	*B*	*SE b*	*p*	*b*	*SE b*	*p*	*b*	*SE b*	*p*
Constant	.345*	.029*	<.001	.357*	.028*	<.001	.355*	.027*	<.001	.355	.027	<.001
Gender	−.044	.045	.330	−.070	.043	.108	−.063	.043	.139	−.063	.043	.148
Income	−.012	.008	.123	−.009	.008	.222	−.009	.000	.241	−.009	.008	.238
Parental education	.030	.030	.305	.022	.028	.431	.030	.028	.282	.030	.028	.289
Length anger utterance	.000	.000	.179	.000	.000	.737	.000	.000	.643	.000	.000	.648
Anxiety symptoms	.003	.003	.293	.003	.003	.353	.002	.003	.345	.002	.003	.361
Depressive symptoms	.456*	.087*	<.001*	.446*	.085*	<.001*	.433*	.084*	<.001*	.433	.085	<.001
Age				−.035*	.017*	.040*	−.034*	.016*	.039*	−.034	.017	.042
Resting RSA				−.045*	.019*	.019*	−.060*	.019*	.002*	−.060	.019	.002
Anger strategy repertoire				−.051	.026	.051	.047	.030	.122	−.066	.026	.012
Age × Resting RSA							.035*	.015*	.018*	.035	.015	.020
Age × Anger strategy repertoire							.014	.020	.496	.014	.021	.512
Resting RSA × Anger strategy repertoire							.047	.030	.122	.046	.032	.145
Age × Resting RSA × Anger strategy repertoire										.001	.027	.980

Note. RSA = Respiratory sinus arrhythmia.
* $p < .05$.

associated with more depressive symptoms. Steps 2 [$\Delta F(3, 96) = 1.848$, $p = .147$, $\Delta R^2 = .027$], 3 [$\Delta F(3, 93) = 1.618$, $p = .212$, $\Delta R^2 = .023$], and 4 all resulted in nonsignificant changes to the model $\Delta F(1, 92) = 1.294$, $p = .280$, $\Delta R^2 = .006$.

Discussion

The goal of this study was to determine whether and how children's emotion regulation strategy repertoires and resting RSA were associated with concurrent psychopathology symptoms. Results largely supported our hypotheses. We found that a smaller discrete emotion regulation strategy repertoire for anger was associated with more externalizing symptoms, but only in bivariate correlations, as this was not the case after inclusion of all covariates in the regression model. As predicted, we found that lower resting RSA was associated with more anxiety and externalizing symptoms, both in bivariate correlations and in the full regression models. Contrary to expectations, results for the depression model failed to reach significance, however, the lower reliability of this scale may have limited our ability to find these associations. The hypothesis that lower resting RSA and smaller strategy repertoires would jointly predict higher symptomatology was supported, but only for anxiety symptoms, and this was qualified by age. We had hypothesized that the combination of a smaller repertoire and lower RSA would be especially maladaptive for older children (associated with more psychopathology symptoms). Age was a significant moderator only in predicting anxiety symptoms, and the pattern contrasted with our hypothesis—we had originally hypothesized that low resting RSA and small repertoires would be most strongly related to psychopathology in older children. Instead we found that the combination of a larger repertoire and higher resting RSA was associated with the fewest anxiety symptoms for older children, suggesting a protective effect of larger fear regulation repertoires. These findings are novel, albeit preliminary, as they each suggest the importance of adaptive strategy repertoires for regulating discrete emotions (jointly with RSA) in characterizing children's psychopathology symptoms. We discuss each of these findings below.

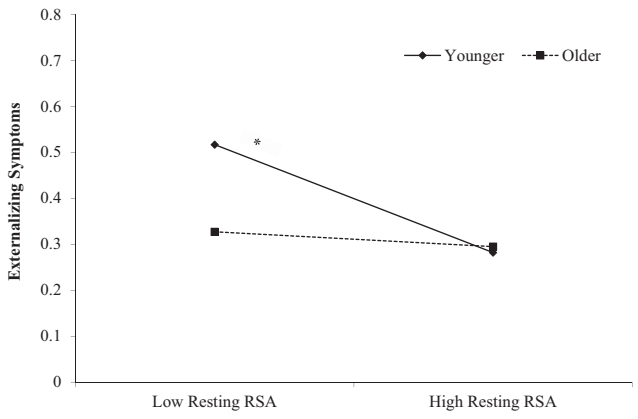

Figure 1. Two-way interaction of resting RSA and age predicting externalizing symptoms. Younger children: $b = -.105$, $t = -3.632$, $p < .001$. Older children: $b = -.015$, $t = -.559$, $p = .551$ * $p < .001$.

Like other studies looking at psychopathology in childhood, our externalizing, depression, and anxiety measures were positively correlated (Hinnant & El-Sheikh, 2013). Correlations among these measures suggest general maladaptation present in children experiencing some level of psychopathology symptoms. But, differences in the type of symptoms that are manifested more strongly may depend on the specific nature of the child's affective dysregulation. Our findings are preliminary evidence for this, showing the emotion-specific patterns found for some of these symptoms. Our sample was diverse in terms of socioeconomic status, and family income was, in fact, an important covariate that explained substantial variance in psychopathology, especially externalizing. A similar pattern has been found in previous studies (Bradley &

Table 5
Regression Model Predicting Anxiety Symptoms

Variable	Step 1			Step 2			Step 3			Step 4		
R^2	.364			.393			.425			.449		
ΔR^2	.364			.029			.032			.024		
ΔF	9.472			1.499			1.740			4.001		
	b	*SE b*	*p*	*B*	*SE b*	*p*	*b*	*SE b*	*p*	*b*	*SE b*	*p*
Constant	11.747*	1.102*	<.001*	11.819	1.104	<.001	11.662	1.110	<.001	11.363*	1.086*	<.001
Gender	2.327	1.683	.167	2.268	1.702	.183	2.052	1.693	.226	2.718	1.693	.108
Income	−.193	.305	.526	−.284	.311	.360	−.131	.323	.686	−.153	.317	.628
Parental education	−.058	1.425	.958	.080	1.108	.942	−.349	1.117	.754	−.344	1.100	.754
Length fear utterance	1.112	.664	.874	−.000	.013	.999	.002	.013	.884	.004	.013	.749
Externalizing symptoms	5.420	3.817	.156	3.482	4.137	.842	3.743	4.154	.368	3.220	4.076	.429
Depressive symptoms	15.209*	3.251*	<.001*	15.234	3.361	<.001	15.824	3.386	<.001	15.644*	3.334*	<.001*
Age				.336	.657	.511	.160	.659	.808	−.092	.657	.888
Resting RSA				−1.453	.815	.075	−.953	.846	.261	−1.313	.846	.121
Fear strategy repertoire				−.873	−.060	.355	−.889	.959	.354	−1.664	1.021	.103
Age × Resting RSA							−.299	.607	.622	.323	.675	.633
Age × Fear strategy repertoire							−.173	.738	.815	−.458	.741	.536
Resting RSA × Fear strategy repertoire							−1.776	.841	.035	−1.334	.854	.118
Age × Resting RSA × Fear strategy repertoire										−1.559*	.783*	.047*

Note. RSA = Respiratory sinus arrhythmia. Model statistics were averaged across all 10 data sets.
* $p < .05$ in significant steps.

Corwyn, 2002). By including income in our model, we were better able to parcel out the effect of emotion regulation strategy repertoire on externalizing (and anxiety) symptoms. As expected, lower resting RSA was associated with externalizing and anxiety symptoms. This finding supports a growing consensus that poorer physiological regulation represents a particularly important marker of risk for the development and maintenance of psychopathology symptoms (Calkins & Dedmon, 2000; El-Sheikh & Hinnant, 2011; Schmitz, Krämer, Tuschen-Caffier, Heinrichs, & Blechert, 2011). We documented this established effect in a diverse sample of children, which is an important contribution to our understanding of how resting physiological functioning is implicated in child psychopathology. Of course, this effect was qualified by a higher order interaction for anxiety symptoms, underscoring the importance of considering physiology in conjunction with behavioral measures to fully characterize psychopathology. The fact that the main effect of RSA was still significant in the externalizing model is not entirely surprising, as other studies have previously highlighted the importance of context when understanding the role of RSA in development (El-Sheikh & Hinnant, 2011).

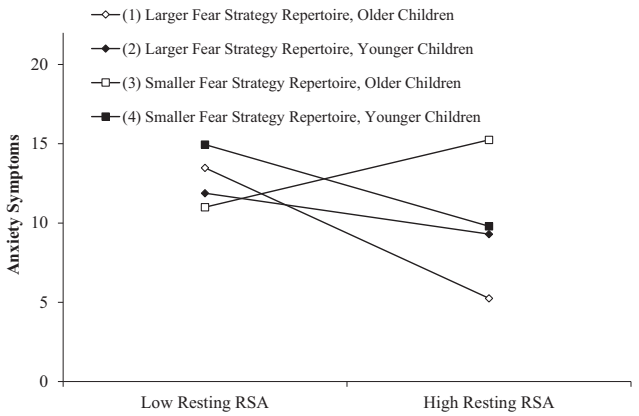

Figure 2. Three-way interaction of resting RSA, fear strategy repertoire, and age predicting anxiety symptoms. Younger children with smaller strategy repertoires: $b = -1.861$, $t = -.890$, $p = .376$. Older children with smaller strategy repertoires: $b = 1.903$, $t = 1.304$, $p = .196$. Younger children with larger strategy repertoires: $b = -1.411$, $t = -1.075$, $p = .285$. Older children with larger strategy repertoires: $b = -3.883$, $t = -3.402$, $p = .001$.

When we examined anxiety symptoms, emotion regulation strategy repertoire for fear and resting RSA interacted to predict symptoms, but this was qualified by age. A larger fear repertoire was associated with fewer anxiety symptoms for older children with higher resting RSA levels compared with older children with smaller repertoires, or younger children regardless of repertoire size. We hypothesized that the size of the repertoire would be particularly important for older children as they have had more time to develop a larger emotion regulation skill set that they could apply to any given emotional situation. Our findings, however, were more aligned with a protective effect, seen for older children with larger repertoires. Although we did not directly hypothesize this, the current findings still offer valuable information about the importance of strategy repertoires for anxiety. Given the protective effect of a larger repertoire of fear regulation strategies, a lack of access to diverse emotion regulation strategies in late childhood may still represent a meaningful deficit in emotion regulation. Our findings suggest that efforts to improve emotion regulation strategy repertoires in children at risk of anxiety might be more helpful for children with better physiological regulation. This suggestion should, of course, be taken with caution as our findings are preliminary and more studies are needed to confirm this. Additionally, longitudinal work is needed to confirm this intuition (and the directionality of the link between regulatory functioning and psychopathology it implies), but this is a novel finding and opens a new avenue of inquiry for future research.

Table 6
Regression Model Predicting Depressive Symptoms

Variable	Step 1			Step 2			Step 3			Step 4		
R^2	.513			.539			.562			.568		
ΔR^2	.513			.026			.023			.006		
ΔF	15.652			1.848			1.618			1.294		
	b	*SE b*	*p*	*B*	*SE b*	*p*	*b*	*SE b*	*p*	*b*	*SE b*	*p*
Constant	.326*	.031*	<.001*	.318	.031	<.001	.325	.031	<.001	.318	.031	<.001
Gender	−.065	.047	.164	−.046	.048	.335	−.056	.048	.243	−.041	.050	.406
Income	−.003	.009	.745	−.003	.008	.718	−.002	.009	.858	−.002	.009	.820
Parental education	−.003	.031	.919	.002	.031	.936	.000	.031	.997	.000	.000	.810
Length sad utterance	.000	.000	.609	−.000	.000	.997	−.000	.000	.825	−.000	.000	.810
Externalizing symptoms	.493*	.098*	<.001*	.537	.099	<.001	.526	.101	<.001	.540	.101	<.001
Anxiety symptoms	.012*	.003*	<.001*	.011	.003	<.001	.012	.003	<.001	.012	.003	<.001
Age				.039	.018	.031	.040	.018	.029	.041	.018	.024
Resting RSA				.022	.022	.325	.024	.023	.298	.029	.023	.220
Sad strategy repertoire				−.005	.026	.861	−.020	.019	.285	−.008	.027	.778
Age × Resting RSA							−.025	.018	.165	−.015	.020	.463
Age × Sad strategy repertoire							−.020	.019	.285	−.019	.019	.317
Resting RSA × Sad strategy repertoire							.030	.022	.181	.039	.024	.097
Age × Resting RSA × Sad strategy repertoire										−.021	.019	.279

Note. RSA = Respiratory sinus arrhythmia. Model statistics were averaged across all 10 data sets.
* $p < .05$ in significant steps.

The idea that higher resting RSA is an important protection against psychopathology is not new (Beauchaine et al., 2013), but our findings suggest that strategy repertoire size might also be an important protective factor against the development of psychopathology symptoms (especially for anxiety) in childhood. Emotion dysregulation is an integral part of many psychopathologies, and as such, interventions are already being used that focus on improving emotion regulation skills as an important avenue for overall improvement in symptoms (Berking et al., 2008; Fowler et al., 2016). This investigation serves as additional empirical support for the importance of focusing on emotion regulatory skill as a target for interventions in children.

Though little prior work has examined these specific regulatory processes, our study suggests that the coupling of physiological and emotion regulation patterns differs across psychopathologies. If so, strategy repertoire size might be a particularly meaningful facet of emotion regulation to consider when studying the maintenance and emergence of symptoms. Future studies should focus on clarifying these associations and further disentangling the effects of physiological regulation on adaptive and maladaptive outcomes. But, it is important to highlight that we found no associations between facets of emotion regulation and depressive symptoms. Neither children's strategy repertoire for sadness nor resting RSA related to depressive symptomatology in our sample. Nevertheless, these results should be interpreted with caution as the alpha for the depression scale was relatively low.

Additionally, our findings highlight the importance of considering the regulation of discrete emotions, and how emotion-specific dysregulation may relate to specific symptomatology. Following a functionalist view of emotions (Campos et al., 1994) we reasoned that examining discrete emotion contexts that were congruent with children's specific symptoms would offer greater precision in clarifying affective dysregulation processes in psychopathology. For externalizing symptoms, we found that smaller emotion regulation strategy repertoires for angering events were associated with concurrent symptomatology in bivariate correlations, providing preliminary evidence that emotion-specific dysregulation is an important correlate of children's psychopathology. Our findings offer new and important insights, and highlight the need for continued empirical efforts to delineate what exactly is "dysregulated" in psychopathologies. Our results have implications not only for our understanding of the development of psychopathology symptoms in childhood, but for the improvement of more targeted interventions that offer explicit training in emotion regulation strategies (e.g., De Witte, Sütterlin, Braet, & Mueller, 2017). Future studies should examine different forms of dysregulation and different combinations of psychopathological symptoms to fully characterize the role of emotion regulation strategy repertoires in early psychopathology.

Lastly, consistent with previous research, we found that boys were rated as having more mean-level externalizing symptoms than girls (Bongers, Koot, Van Der Ende, & Verhulst, 2004), but these gender differences were not found in the full models. Surprisingly, we also found that boys were rated as having more mean-level depressive symptoms than girls. Studies looking at gender differences in prepubescent children has often found a lack of gender differences in depressive symptoms (Nolen-Hoeksema, 1990), and it is not until adolescence that gender differences emerge with females usually showing higher symptoms (Nolen-Hoeksema & Girgus, 1994). The possibility of gender differences in discrete emotion regulation strategy use that relates to psychopathology, or gender differences in the extent to which repertoires mark risk for developing psychopathology is an open question.

Limitations and Future Directions

This study is one of the first to focus on how children's emotion regulation strategy repertoires are implicated in psychopathology symptoms, and provides novel insight about emotion dysregulation. Some limitations to this investigation should be noted, how-

ever. Although examining repertoire is an important step toward greater understanding of the relation between psychopathology and emotion regulation, this summative measure of emotion regulation tells us little about the effectiveness of specific emotion regulation strategies used by children with higher and lower levels of symptomatology. For example, children with more symptoms may be less able to effectively elicit social support, or may be less able to change the way they think about the negative situations (i.e., reappraise) or shift attention (i.e., distract). Moreover, it is not possible to know with certainty which strategies children actually implemented during those events; however, several studies with school-age children have demonstrated that children can reliably report on their own use of emotion regulation strategies (e.g., Gullone & Taffe, 2012; Suveg & Zeman, 2004; Walden, Harris, & Catron, 2003; Zeman, Shipman, & Suveg, 2002). We also acknowledge that some children might have received unsolicited help with some of the strategies they reported and that this is not reflected in our data. Asking children multiple times to provide strategies during the interview may have encouraged some children to overreport the number or variety of emotion regulation strategies they had used, but multiple prompts enable children to reveal the extent of their knowledge (Davis et al., 2010). This study's modest sample size and limited power preclude a full understanding of the complex patterns between RSA and strategy repertoire across psychopathologies. The novelty of the preliminary findings, however, suggests interesting new directions for research that will contribute to a greater understanding of the relation between emotion regulation and childhood psychopathology. The results of this innovative first study should be replicated and extended in future research.

There are also inherent limitations to using a cross-sectional design to study child psychopathology. The concurrent assessment of variables in this study means that we cannot say definitively whether children's limited regulatory repertoires are a precursor to or consequence of their symptoms. Prospective longitudinal designs would address this and other important temporal questions about these relations. We also acknowledge the limitations of only using parental report to assess children's symptomatology (instead of also including child report or a clinical interview). But, given the wide range of ages in our normative, healthy community sample, some children in our study would not have been able to accurately (and thoroughly) report on their symptoms, and most would not have met thresholds for clinical cutoffs. This restricted range of psychopathology symptoms, although typical for community samples like ours (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003) limits what we can say about clinical levels of symptoms and strategy repertoires. It is important to acknowledge that the level of symptomatology in our sample was low, thus questions still remain about how children with existing clinical levels of symptomatology regulate emotion, and about the role that their use of adaptive strategies plays in the maintenance or worsening of their symptoms. Our interest, however, was in examining how strategy repertoires related to psychopathology symptoms in a community sample of normatively developing children, to set the foundation for work assessing trajectories of emotion regulation that relate to the emergence, maintenance, or worsening of psychopathology symptoms in childhood. The pattern of results we obtained in a healthy sample therefore helps underscore the potential utility of examining emotion regulation strategy use to better understand the emergence of child psychopathology.

Conclusion

This study provides new insight about how and under what circumstances emotion regulation processes relate to psychopathology symptoms in childhood. Our findings advance knowledge about emotion regulation and psychopathology, and highlight previously unexplored associations between emotion regulation repertoires, physiological regulation, and psychopathology. Lastly, our results suggest new directions for developmental work by showing the importance of discrete emotion regulatory repertoires for characterizing children's psychopathology symptoms.

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Atlanta, GA: Sage.

Aldao, A., Sheppes, G., & Gross, J. J. (2015). Emotion regulation flexibility. *Cognitive Therapy and Research, 39,* 263–278. http://dx.doi.org/10.1007/s10608-014-9662-4

Bar-Haim, Y., Marshall, P. J., & Fox, N. A. (2000). Developmental changes in heart period and high-frequency heart period variability from 4 months to 4 years of age. *Developmental Psychobiology, 37,* 44–56.

Beauchaine, T. P., Gatzke-Kopp, L., Neuhaus, E., Chipman, J., Reid, M. J., & Webster-Stratton, C. (2013). Sympathetic- and parasympathetic-linked cardiac function and prediction of externalizing behavior, emotion regulation, and prosocial behavior among preschoolers treated for ADHD. *Journal of Consulting and Clinical Psychology, 81,* 481–493. http://dx.doi.org/10.1037/a0032302

Berking, M., Wupperman, P., Reichardt, A., Pejic, T., Dippel, A., & Znoj, H. (2008). Emotion-regulation skills as a treatment target in psychotherapy. *Behaviour Research and Therapy, 46,* 1230–1237. http://dx.doi.org/10.1016/j.brat.2008.08.005

Birmaher, B., Khetarpal, S., Brent, D., Cully, M., Balach, L., Kaufman, J., & Neer, S. M. (1997). The screen for child anxiety related emotional disorders (SCARED): Scale construction and psychometric characteristics. *Journal of the American Academy of Child & Adolescent Psychiatry, 36,* 545–553. http://dx.doi.org/10.1097/00004583-199704000-00018

Bonanno, G. A., & Burton, C. L. (2013). Regulatory flexibility: An individual differences perspective on coping and emotion regulation. *Perspectives on Psychological Science, 8,* 591–612. http://dx.doi.org/10.1177/1745691613504116

Bongers, I. L., Koot, H. M., van der Ende, J., & Verhulst, F. C. (2004). Developmental trajectories of externalizing behaviors in childhood and adolescence. *Child Development, 75,* 1523–1537. http://dx.doi.org/10.1111/j.1467-8624.2004.00755.x

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53,* 371–399. http://dx.doi.org/10.1146/annurev.psych.53.100901.135233

Braungart, J. M., & Stifter, C. A. (1991). Regulation of negative reactivity during the strange situation: Temperament and attachment in 12-month-old infants. *Infant Behavior & Development, 14,* 349–364. http://dx.doi.org/10.1016/0163-6383(91)90027-P

Calkins, S. D., & Dedmon, S. E. (2000). Physiological and behavioral regulation in two-year-old children with aggressive/destructive behavior problems. *Journal of Abnormal Child Psychology, 28,* 103–118. http://dx.doi.org/10.1023/A:1005112912906

Calkins, S. D., & Keane, S. P. (2004). Cardiac vagal regulation across the preschool period: Stability, continuity, and implications for childhood adjustment. *Developmental Psychobiology, 45,* 101–112. http://dx.doi.org/10.1002/dev.20020

Campos, J. J., Mumme, D. L., Kermoian, R., & Campos, R. G. (1994). A functionalist perspective on the nature of emotion. *Monographs of the*

Society for Research in Child Development, 59, 284–303. http://dx.doi.org/10.1111/j.1540-5834.1994.tb01289.x

Caspi, A., Moffitt, T. E., Newman, D. L., & Silva, P. A. (1996). Behavioral observations at age 3 years predict adult psychiatric disorders. Longitudinal evidence from a birth cohort. *Archives of General Psychiatry, 53,* 1033–1039. http://dx.doi.org/10.1001/archpsyc.1996.01830110071009

Cisler, J. M., Olatunji, B. O., Feldner, M. T., & Forsyth, J. P. (2010). Emotion regulation and the anxiety disorders: An integrative review. *Journal of Psychopathology and Behavioral Assessment, 32,* 68–82. http://dx.doi.org/10.1007/s10862-009-9161-1

Cole, C. E., Zapp, D. J., Fettig, N. B., & Pérez-Edgar, K. (2016). Impact of attention biases to threat and effortful control on individual variations in negative affect and social withdrawal in very young children. *Journal of Experimental Child Psychology, 141,* 210–221. http://dx.doi.org/10.1016/j.jecp.2015.09.012

Cole, P. M. (2014). Moving ahead in the study of the development of emotion regulation. *International Journal of Behavioral Development, 38,* 203–207. http://dx.doi.org/10.1177/0165025414522170

Cole, P. M., Martin, S. E., & Dennis, T. A. (2004). Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. *Child Development, 75,* 317–333. http://dx.doi.org/10.1111/j.1467-8624.2004.00673.x

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60,* 837–844. http://dx.doi.org/10.1001/archpsyc.60.8.837

Davis, E. L., Levine, L. J., Lench, H. C., & Quas, J. A. (2010). Metacognitive emotion regulation: Children's awareness that changing thoughts and goals can alleviate negative emotions. *Emotion, 10,* 498–510. http://dx.doi.org/10.1037/a0018428

Davis, E. L., Quiñones-Camacho, L. E., & Buss, K. A. (2016). The effects of distraction and reappraisal on children's parasympathetic regulation of sadness and fear. *Journal of Experimental Child Psychology, 142,* 344–358. http://dx.doi.org/10.1016/j.jecp.2015.09.020

De Witte, N. A., Sütterlin, S., Braet, C., & Mueller, S. C. (2017). Psychophysiological correlates of emotion regulation training in adolescent anxiety: Evidence from the novel PIER task. *Journal of Affective Disorders, 214,* 89–96. http://dx.doi.org/10.1016/j.jad.2017.03.012

Dodge, K. A., & Pettit, G. S. (2003). A biopsychosocial model of the development of chronic conduct problems in adolescence. *Developmental Psychology, 39,* 349–371. http://dx.doi.org/10.1037/0012-1649.39.2.349

Dunn, L. M., & Dunn, D. M. (2007). *PPVT-4: Peabody picture vocabulary test.* Boulder, CO: Pearson Assessments.

Dunn, L. M., & Dunn, D. M. (2013). *Peabody picture vocabulary test, Tech. Rep. No*. Boulder, CO: Pearson Assessments.

El-Sheikh, M., & Hinnant, J. B. (2011). Marital conflict, respiratory sinus arrhythmia, and allostatic load: Interrelations and associations with the development of children's externalizing behavior. *Development and Psychopathology, 23,* 815–829. http://dx.doi.org/10.1017/S0954579411000320

Essex, M. J., Boyce, W. T., Goldstein, L. H., Armstrong, J. M., Kraemer, H. C., & Kupfer, D. J., & the MacArthur Assessment Battery Working Group. (2002). The confluence of mental, physical, social, and academic difficulties in middle childhood. II: Developing the Macarthur health and Behavior Questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry, 41,* 588–603. http://dx.doi.org/10.1097/00004583-200205000-00017

Fowler, J. C., Clapp, J. D., Madan, A., Allen, J. G., Oldham, J. M., & Frueh, B. C. (2016). Emotion dysregulation as a cross-cutting target for inpatient psychiatric intervention. *Journal of Affective Disorders, 206,* 224–231. http://dx.doi.org/10.1016/j.jad.2016.07.043

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,* 156–163. http://dx.doi.org/10.1016/j.biopsycho.2009.07.002

Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry, 26,* 1–26. http://dx.doi.org/10.1080/1047840X.2014.940781

Gullone, E., & Taffe, J. (2012). The emotion regulation questionnaire for children and adolescents (ERQ–CA): A psychometric evaluation. *Psychological Assessment, 24,* 409–417. http://dx.doi.org/10.1037/a0025777

Helmsen, J., Koglin, U., & Petermann, F. (2012). Emotion regulation and aggressive behavior in preschoolers: The mediating role of social information processing. *Child Psychiatry and Human Development, 43,* 87–101. http://dx.doi.org/10.1007/s10578-011-0252-3

Hill, A. L., Degnan, K. A., Calkins, S. D., & Keane, S. P. (2006). Profiles of externalizing behavior problems for boys and girls across preschool: The roles of emotion regulation and inattention. *Developmental Psychology, 42,* 913–928. http://dx.doi.org/10.1037/0012-1649.42.5.913

Hinnant, J. B., & El-Sheikh, M. (2009). Children's externalizing and internalizing symptoms over time: The role of individual differences in patterns of RSA responding. *Journal of Abnormal Child Psychology, 37,* 1049–1061. http://dx.doi.org/10.1007/s10802-009-9341-1

Hinnant, J. B., & El-Sheikh, M. (2013). Codevelopment of externalizing and internalizing symptoms in middle to late childhood: Sex, baseline respiratory sinus arrhythmia, and respiratory sinus arrhythmia reactivity as predictors. *Development and Psychopathology, 25,* 419–436. http://dx.doi.org/10.1017/S0954579412001150

Hofstra, M. B., Van der Ende, J., & Verhulst, F. C. (2000). Continuity and change of psychopathology from childhood into adulthood: A 14-year follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry, 39,* 850–858. http://dx.doi.org/10.1097/00004583-200007000-00013

Hu, T., Zhang, D., Wang, J., Mistry, R., Ran, G., & Wang, X. (2014). Relation between emotion regulation and mental health: A meta-analysis review. *Psychological Reports, 114,* 341–362. http://dx.doi.org/10.2466/03.20.PR0.114k22w4

Johnson, M., Deardorff, J., Davis, E. L., Martinez, W., Eskenazi, B., & Alkon, A. (2017). The relationship between maternal responsivity, socioeconomic status, and resting autonomic nervous system functioning in Mexican American children. *International Journal of Psychophysiology, 116,* 45–52. http://dx.doi.org/10.1016/j.ijpsycho.2017.02.010

Lahey, B. B., Rathouz, P. J., Van Hulle, C., Urbano, R. C., Krueger, R. F., Applegate, B., . . . Waldman, I. D. (2008). Testing structural models of *DSM–IV* symptoms of common forms of child and adolescent psychopathology. *Journal of Abnormal Child Psychology, 36,* 187–206. http://dx.doi.org/10.1007/s10802-007-9169-5

Lemery-Chalfant, K., Schreiber, J. E., Schmidt, N. L., Van Hulle, C. A., Essex, M. J., & Goldsmith, H. H. (2007). Assessing internalizing, externalizing, and attention problems in young children: Validation of the MacArthur HBQ. *Journal of the American Academy of Child & Adolescent Psychiatry, 46,* 1315–1323. http://dx.doi.org/10.1097/chi.0b013e3180f616c6

Lougheed, J. P., & Hollenstein, T. (2012). A limited repertoire of emotion regulation strategies is associated with internalizing problems in adolescence. *Social Development, 21,* 704–721. http://dx.doi.org/10.1111/j.1467-9507.2012.00663.x

Mennin, D. S., Turk, C. L., Heimberg, R., & Carmin, C. (2004). Focusing on the regulation of emotion: A new direction for conceptualizing and treating generalized anxiety disorder. In M. A. Reinecke & D. A. Clark (Eds.), *Cognitive therapy over the lifespan evidence and practice* (pp. 60–89). New York, NY: Cambridge University Press.

Mesman, J., & Koot, H. M. (2001). Early preschool predictors of preadolescent internalizing and externalizing *DSM–IV* diagnoses. *Journal of the American Academy of Child & Adolescent Psychiatry, 40,* 1029–1036. http://dx.doi.org/10.1097/00004583-200109000-00011

Nigg, J. T. (2017). Annual research review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry, 58,* 361–383. http://dx.doi.org/10.1111/jcpp.12675

Nolen-Hoeksema, S. (1990). *Sex differences in depression*. Stanford, CA: Stanford University Press.

Nolen-Hoeksema, S., & Girgus, J. S. (1994). The emergence of gender differences in depression during adolescence. *Psychological Bulletin, 115,* 424–443. http://dx.doi.org/10.1037/0033-2909.115.3.424

Obradović, J., Bush, N. R., Stamperdahl, J., Adler, N. E., & Boyce, W. T. (2010). Biological sensitivity to context: The interactive effects of stress reactivity and family adversity on socioemotional behavior and school readiness. *Child Development, 81,* 270–289. http://dx.doi.org/10.1111/j.1467-8624.2009.01394.x

Pihlakoski, L., Sourander, A., Aromaa, M., Rautava, P., Helenius, H., & Sillanpää, M. (2006). The continuity of psychopathology from early childhood to preadolescence: A prospective cohort study of 3–12-year-old children. *European Child & Adolescent Psychiatry, 15,* 409–417. http://dx.doi.org/10.1007/s00787-006-0548-1

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. http://dx.doi.org/10.1007/978-1-4757-0360-3_7

Porges, S. W. (1991). Vagal tone: An autonomic mediator of affect. In J. Garber & K. A. Dodge (Eds.), *The development of emotional regulation and dysregulation* (pp. 111–128). Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511663963.007

Porges, S. W., Macellaio, M., Stanfill, S. D., McCue, K., Lewis, G. F., Harden, E. R., . . . Heilman, K. J. (2013). Respiratory sinus arrhythmia and auditory processing in autism: Modifiable deficits of an integrated social engagement system? *International Journal of Psychophysiology, 88,* 261–270. http://dx.doi.org/10.1016/j.ijpsycho.2012.11.009

Röll, J., Koglin, U., & Petermann, F. (2012). Emotion regulation and childhood aggression: Longitudinal associations. *Child Psychiatry and Human Development, 43,* 909–923. http://dx.doi.org/10.1007/s10578-012-0303-4

Royston, P. (2004). Multiple imputation of missing values. *The Stata Journal, 4,* 227–241.

Schmitz, J., Krämer, M., Tuschen-Caffier, B., Heinrichs, N., & Blechert, J. (2011). Restricted autonomic flexibility in children with social phobia. *Journal of Child Psychology and Psychiatry, 52,* 1203–1211. http://dx.doi.org/10.1111/j.1469-7610.2011.02417.x

Scott, B. G., & Weems, C. F. (2014). Resting vagal tone and vagal response to stress: Associations with anxiety, aggression, and perceived anxiety control among youths. *Psychophysiology, 51,* 718–727. http://dx.doi.org/10.1111/psyp.12218

Sheppes, G., & Levin, Z. (2013). Emotion regulation choice: Selecting between cognitive regulation strategies to control emotion. *Frontiers in Human Neuroscience, 7,* 179. http://dx.doi.org/10.3389/fnhum.2013.00179

Sheppes, G., Scheibe, S., Suri, G., & Gross, J. J. (2011). Emotion-regulation choice. *Psychological Science, 22,* 1391–1396. http://dx.doi.org/10.1177/0956797611418350

Sheppes, G., Scheibe, S., Suri, G., Radu, P., Blechert, J., & Gross, J. J. (2014). Emotion regulation choice: A conceptual framework and supporting evidence. *Journal of Experimental Psychology: General, 143,* 163–181. http://dx.doi.org/10.1037/a0030831

Shipman, K. L., Zeman, J., Nesin, A., & Fitzgerald, M. (2003). Children's strategies for displaying anger and sadness: What works with whom? *Merrill-Palmer Quarterly, 49,* 100–122. http://dx.doi.org/10.1353/mpq.2003.0006

Spence, S. H., Najman, J. M., Bor, W., O'Callaghan, M. J., & Williams, G. M. (2002). Maternal anxiety and depression, poverty and marital relationship factors during early childhood as predictors of anxiety and depressive symptoms in adolescence. *Journal of Child Psychology and Psychiatry, 43,* 457–469. http://dx.doi.org/10.1111/1469-7610.00037

Suveg, C., & Zeman, J. (2004). Emotion regulation in children with anxiety disorders. *Journal of Clinical Child and Adolescent Psychology, 33,* 750–759. http://dx.doi.org/10.1207/s15374424jccp3304_10

Thai, N., Taber-Thomas, B. C., & Pérez-Edgar, K. E. (2016). Neural correlates of attention biases, behavioral inhibition, and social anxiety in children: An ERP study. *Developmental Cognitive Neuroscience, 19,* 200–210. http://dx.doi.org/10.1016/j.dcn.2016.03.008

Walden, T. A., Harris, V. S., & Catron, T. F. (2003). How I feel: A self-report measure of emotional arousal and regulation for children. *Psychological Assessment, 15,* 399–412. http://dx.doi.org/10.1037/1040-3590.15.3.399

Waters, S. F., & Thompson, R. A. (2014). Children's perceptions of the effectiveness of strategies for regulating anger and sadness. *International Journal of Behavioral Development, 38,* 174–181. http://dx.doi.org/10.1177/0165025413515410

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin, 138,* 775–808. http://dx.doi.org/10.1037/a0027600

Wetter, E. K., & El-Sheikh, M. (2012). Trajectories of children's internalizing symptoms: The role of maternal internalizing symptoms, respiratory sinus arrhythmia and child sex. *Journal of Child Psychology and Psychiatry, 53,* 168–177. http://dx.doi.org/10.1111/j.1469-7610.2011.02470.x

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120,* 3–24. http://dx.doi.org/10.1037/0033-2909.120.1.3

Zeman, J., & Shipman, K. (1997). Social-contextual influences on expectancies for managing anger and sadness: The transition from middle childhood to adolescence. *Developmental Psychology, 33,* 917–924. http://dx.doi.org/10.1037/0012-1649.33.6.917

Zeman, J., Shipman, K., & Suveg, C. (2002). Anger and sadness regulation: Predictions to internalizing and externalizing symptoms in children. *Journal of Clinical Child and Adolescent Psychology, 31,* 393–398. http://dx.doi.org/10.1207/S15374424JCCP3103_11

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