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Publication Date
2016-02-01

DOI
10.1016/j.jecp.2015.09.020

Peer reviewed

HHS Public Access
Author manuscript
J Exp Child Psychol. Author manuscript; available in PMC 2017 February 01.

Published in final edited form as:
J Exp Child Psychol. 2016 February ; 142: 344–358. doi:10.1016/j.jecp.2015.09.020.

The Effects of Distraction and Reappraisal On Children's Parasympathetic Regulation of Sadness and Fear

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Abstract

Children commonly experience negative emotions like sadness and fear, and much recent empirical attention has been devoted to understanding the factors supporting and predicting effective emotion regulation. Respiratory sinus arrhythmia (RSA), a cardiac index of parasympathetic function, has emerged as a key physiological correlate of children's self-regulation. But, little is known about how children's use of specific cognitive emotion regulation strategies corresponds to concurrent parasympathetic regulation (i.e., RSA reactivity while watching an emotion-eliciting video). The current study describes an experimental paradigm in which 101 5- to 6-year-olds were randomly assigned to one of three different emotion regulation conditions (Control, Distraction, Reappraisal). All children watched a sad and a scary film (order counterbalanced), and children in the Distraction and Reappraisal conditions received instructions to deploy the target strategy to manage sadness/fear while they watched. Consistent with predictions, children assigned to use either emotion regulation strategy showed greater RSA augmentation from baseline than children in the Control condition (all children showed an overall increase in RSA levels from baseline), suggesting enhanced parasympathetic calming when children used Distraction or Reappraisal to regulate sadness and fear. But, this pattern was found only among children who viewed the sad film before the scary film. Among children who viewed the scary film first, Reappraisal promoted marginally better parasympathetic regulation of fear (no condition differences emerged for parasympathetic regulation of sadness when the sad film was viewed second). Results are discussed in terms of their implications for our understanding of children's emotion regulation and affective physiology.

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Keywords

Emotion regulation strategies; parasympathetic regulation; RSA; Distraction; Reappraisal; childhood

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Children commonly experience negative emotions like sadness and fear, and much empirical attention has aimed to clarify the factors that support and predict effective regulation of these negative emotions. This interest is driven, in part, by research linking emotion regulation processes to a host of social, emotional, and cognitive outcomes with substantial consequences for children's daily lives (e.g., academic achievement, friendships, and psychopathology). Given the tight conceptual coupling between emotion and regulatory processes (Cole, Martin, & Dennis, 2004; Thompson, 2011), a key challenge for developmental scientists is to identify and employ methods that meaningfully distinguish these affective processes. At the same time, there is a need for improved clarity in our understanding of the psychobiological underpinnings and components of these emotion and regulatory processes. Respiratory sinus arrhythmia (RSA), a cardiac index of parasympathetic function, has emerged as a key psychophysiological correlate of children's self-regulation. But, no prior work has examined how children's use of specific emotion regulation strategies predicts parasympathetic regulation. This study experimentally manipulated the emotion regulation strategies that children used while viewing emotion-eliciting films. Our goal was to examine the effects of emotion regulation strategies on parasympathetic regulation of sadness and fear, to refine our understanding of emotion regulation in childhood.

Cognitive Emotion Regulation Strategies

A functional view of emotion holds that people experience emotions when they appraise events as relevant to their goals, values, or wellbeing. Although emotions provide useful status updates about goals, negative emotions must often be down regulated in the service of long-term goals like positive social relationships or academic achievement. Emotion regulation can be defined as any process that increases or decreases positive or negative emotions (Gross, 1998; Koole, 2009; Ochsner & Gross, 2005; Thompson, 2011). By adulthood, people have a wide range of emotion regulation strategies on which to draw when faced with emotionally challenging events (Li & Lambert, 2007; Ochsner & Gross, 2005, 2008; Sheppes & Meiran, 2007). Strategies to alter an emotional experience can be classified, broadly, as behavioral or cognitive. Behavioral strategies allow people to change external events so that the events conform to their goals, whereas cognitive strategies allow people to change their goals, thoughts, or appraisals of events. Use of behavioral strategies to manage emotion emerges early and remains relatively constant in frequency across the lifespan (Heckhausen, Wrosch, & Schulz, 2010). From infancy, children make use of behavioral emotion regulation strategies, as they shift attention away from a stranger who makes them feel wary or increase the intensity of their cries to elicit help from parents (Kopp, 1989; Thompson, 1994). In contrast, deliberate use of cognitive strategies to manage emotion requires an appreciation of the interrelation of goals, thoughts, and emotions, including awareness that changing goals and thoughts can lead to changes in emotional experience (Davis, Levine, Lench, & Quas, 2010).

When and how well children can use cognitive emotion regulation strategies is less clear. Evidence in support of regulatory sophistication comes from work demonstrating that children have a (tenuous) understanding of the link between thoughts and feelings from very early in development (Bell & Calkins, 2012). Toddlers and preschoolers talk about emotions and can correctly predict how another person will feel if they get (or do not get) something they want (Wellman & Banerjee, 1991; Wellman, Phillips, & Rodriguez, 2000). The appreciation that two people can react differently to the same event (demonstrating a rudimentary understanding of the link between emotions and beliefs) appears to emerge by age 4 or 5 (e.g., Harris, Johnson, Hutton, & Andrews, 1989), with considerable advancements in the understanding of emotion-cognition links documented across the elementary school ages (Bamford & Lagattuta, 2012; Lagattuta, 2008; Lagattuta & Wellman, 2001). These early indicators of the understanding that one's thoughts may influence one's feelings provide a conceptual foundation for cognitive emotion regulation in childhood.

Despite the acquisition of these developmental precursors to cognitive emotion regulation, other findings call into question whether children understand that feelings can be changed by thoughts alone before age 7 or 8 (e.g., Flavell, Flavell, & Green, 2001; Lagattuta, 2007; Pons, Harris, & de Rosnay, 2004). For instance, Bamford and Lagattuta (2012) examined the development of children's knowledge of cognitive reframing or reappraisal strategies for regulating negative emotions among 5- to 10-year-olds. Older children demonstrated more consistent understanding of how reframing an event could lead to changes in emotions, but all children considered cognitive reframing to be least effective in unambiguously negative (versus positive or ambiguous) contexts. Even an awareness of the fact that thoughts *can* change feelings, thus, does not necessarily mean that children view cognitive strategies as useful means of regulating or changing negative emotions.

Less sophisticated cognitive emotion regulation strategies may, however, be easier for young children to recognize as useful (and use in their own lives). A study of preschoolers' understanding of emotion regulation strategies by Dennis and Keleman (2009) used puppets to act out negative emotion situations and different ways to stop negative feelings. Young children rated distraction as more effective than rumination for managing negative feelings, suggesting that 3- and 4-year-olds recognize the relative utility of some cognitive regulatory strategies. Davis and colleagues (Davis et al., 2010) showed that five- and six-year-old children spontaneously generate a wide range of emotion regulation strategies (including cognitive ones like changing thoughts and changing goals) in response to being asked how a hypothetical protagonist could make herself feel better after experiencing an angry, sad, or scary event. When children recalled a time they had personally experienced these same negative emotions and described what they had done to make themselves feel better, cognitive emotion regulation strategies were frequently mentioned, particularly as a response to sad and scary events in children's lives. Given the studies reviewed above, we chose to focus on two cognitive emotion regulation strategies that 5- and 6-year-olds have been shown to generate and use, distraction and reappraisal. Distraction simply involves changing one's thoughts (i.e., thinking about something else), and reappraisal involves changing the way one thinks about a situation or event (i.e., thinking about how it's not that big a deal/not that important). Delineating the effects (or effectiveness) of these strategies across emotion contexts was a goal of this study. Cognitive change strategies to alleviate negative emotion may be relevant to children's experiences of sadness (a lost or failed goal) and fear (a threatened goal) in line with functionalist accounts, but no studies have directly compared how distraction and reappraisal strategies influence children's parasympathetic regulation of sadness and fear.

Parasympathetic Regulation of Heart Rate Variability

Respiratory sinus arrhythmia (RSA) is an index of parasympathetic regulation of the heart derived by measuring heart rate variability within the respiratory cycle (Calkins & Keane, 2004; Obradović, Stamperdahl, Bush, Adler, & Boyce, 2010). Parasympathetic regulation is mediated by the 10th cranial (vagus) nerve, which influences variability in heart rate--greater vagal influence leads to slower heart rate and dampening of the sympathetic nervous system's effect on the heart (Bell & Calkins, 2012). Contemporary perspectives on the psychophysiology of emotion highlight parasympathetic regulation of heart rate variability (RSA) as a useful marker of emotion regulation (Beauchaine, 2001; Porges, 2007) and as being implicated in physiological regulation of stress (Porges, 1995; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Resting RSA levels are thought to index the amount of regulatory resources available for a child to draw upon in times of challenge, so higher resting RSA typically has been linked to more adaptive outcomes (Calkins & Keane, 2004; Liew et al. 2011). Flexible parasympathetic regulation (e.g., the application or withdrawal of vagal influence over the heart in response to changing circumstances) underlies adaptive emotional and self-regulation. Decreases in RSA from resting levels (RSA suppression) under conditions of challenge enable greater sympathetic response and resource mobilization, reflecting a shift in focus from homeostatic demands to facilitation of sustained attention, behavioral self-regulation, and the generation of coping strategies to control affective or behavioral arousal (Porges, 1996; 2007).

Many studies have illustrated that children's RSA reactivity to lab challenges is associated with general measures of adaptive functioning, including less negative emotionality and risk for behavior problems, and better emotion regulation and sustained attention (Calkins & Dedmon, 2000; Calkins & Keane, 2004; El-Sheikh, 2001; Hastings et al., 2008; Porges, 1996; Suess, Porges, & Plude, 1994). For instance, Calkins and Keane (2004) examined how RSA reactivity (in this case, RSA suppression from initial levels) during challenge tasks related to children's adjustment and self-regulation in a longitudinal study of early childhood (age 2 to 4.5 years). Children who maintained pronounced patterns of RSA suppression during challenging tasks across these ages were rated by mothers as being better regulated and more socially skilled at age 4.5 than children who showed less pronounced RSA suppression at one or both time points. Although more research is needed to fully understand the relation between parasympathetic regulation and self-regulation, these results suggest that this aspect of physiology has important implications for the development of behavioral and cognitive regulatory abilities from early in childhood. Further supporting this idea, Hastings and colleagues (2008) studied how RSA reactivity related to socioemotional development in a sample of 2- to- 5-year-olds. Children who showed greater RSA reactivity to activities in a social group context had fewer internalizing symptoms and better behavioral self-regulation. Thus, parasympathetic regulation (measured by RSA reactivity) has been implicated in children's effective self-regulation, but no studies have yet examined how RSA reactivity is associated with children's use of emotion regulation strategies.

Other work has linked a lack of RSA suppression (or, RSA augmentation relative to baseline) with risk for internalizing and externalizing behaviors (Calkins & Dedmon, 2000, and these associations appear to be relatively robust--Graziano and Derefinko (2013) showed a small association between internalizing problems and less RSA suppression in a meta-analysis of RSA reactivity in childhood. Thus, patterns of RSA reactivity have implications for many domains of children's functioning beyond just emotion regulation. Of note, the studies described here have either focused on early childhood (e.g., longitudinal investigations of change from toddlerhood into preschool ages) or on middle childhood (e.g., investigations of psychophysiology among elementary-school aged children). Very little work on parasympathetic regulation has explicitly targeted kindergarten age children (5- to 6-year-olds), although this appears to be the age at which children first begin to demonstrate an understanding that thoughts can change feelings (Davis et al., 2010). Given the lack of extant knowledge about this particular age group, and our goal of understanding how parasympathetic regulation relates to emotion regulation, the current study focused on kindergarteners to document these emerging associations.

Although there is general consensus that RSA reactivity in the form of RSA suppression represents an adaptive parasympathetic response to cognitive, social, or emotional challenges children may experience, some studies have indicated that RSA augmentation (rather than suppression) correlates with adaptive outcomes (e.g., fewer internalizing and externalizing behaviors; Cipriano et al., 2011; Hastings et al., 2008; Obradovic et al., 2010). Because of the heterogeneity in research findings, recent investigations of children's parasympathetic regulation have noted the importance of considering the specifics of the context (e.g., discrete emotions, type of evocative or challenging task) in which RSA is measured when interpreting patterns (Hastings, Kahle, & Nuselovici, 2014; Morales, Beekman, Blandon, Stifter, & Buss, 2015). For example, Hastings and colleagues note that RSA reactivity patterns should be interpreted as physiological changes that may or may not be adaptive given the eliciting context (Hastings, Klimes-Dougan, Kendziora, Brand, & Zahn-Waxler, 2014; Hastings & Miller, 2014).

Despite the insights provided by research on children's parasympathetic regulation within challenging contexts, very little is known about how specific emotion regulation strategies (rather than a broad assessment of general emotion regulatory skill) influence children's physiology. Polyvagal theory (Porges, 2011) guides predictions about how emotion regulation strategies could influence RSA. When contexts are appraised as non-threatening, RSA augmentation prepares an individual for calm engagement with the environment. Enhanced parasympathetic influence over the heart would indicate an absence of concurrent affective challenge (e.g., sadness or fear). Thus, if cognitive emotion regulation strategies like distraction and reappraisal are effectively enabling children to alleviate negative emotions, the expected pattern would be RSA augmentation (relative to children reacting normally to emotion elicitation in a control group). In support of this reasoning, Butler, Wilhelm, and Gross (2006) examined the parasympathetic regulation of adult women who viewed an upsetting film and then discussed it together. Half the dyads had one partner instructed to either suppress or reappraise her emotional experience during the conversation. Women who used specific emotion regulation strategies showed greater RSA augmentation during the conversation. No studies have examined the patterns of parasympathetic regulation associated with cognitive emotion regulation strategies in childhood, so charting these associations was a goal of the current study.

The Present Study

The goal of this study was to provide new insight into the psychophysiological consequents of an experimental manipulation of cognitive emotion regulation strategies in childhood. Although previous research suggests that kindergarten-age children can describe and use cognitive emotion regulation strategies to manage their feelings of sadness and fear (Davis et al., 2010), little is known about the physiological effects of using specific strategies, especially in childhood. RSA is an index of physiology that corresponds to children's affective and regulatory functioning, but no previous studies with children have examined RSA changes in response to experimental instructions to use specific cognitive emotion regulation strategies. This study examined how children's RSA reactivity to sadness and fear changed as a function of the emotion regulation strategies children were instructed to use to mitigate their negative feelings. 101 5- to 6-year-olds were randomly assigned to one of three emotion regulation instruction conditions (Distraction, Reappraisal, or Control) and viewed two short emotion-eliciting movie clips (one designed to elicit sadness, and one designed to elicit fear). RSA reactivity was calculated as the change in RSA from a resting baseline to each of the age-appropriate film clips (i.e., a difference score). Positive values indicated RSA augmentation, whereas negative values indicated RSA suppression. We addressed the following research questions:

(1) The primary question was whether instructed cognitive emotion regulation strategies (i.e., Distraction, Reappraisal) would lead to differences in children's parasympathetic regulation (RSA reactivity) of sadness and fear. We predicted that use of either instructed emotion regulation strategy when regulating sadness or fear should lead to greater parasympathetic augmentation relative to baseline (i.e., an increase in RSA levels from baseline to task) than would be seen among children reacting naturally in the Control condition. We suggest that RSA augmentation can be thought of as evidence of an effective calming response (emotion regulation) in the context of this study, as children sit quietly, watch mildly sad and scary films, and deliberately deploy a coached emotion regulation strategy of Distraction or Reappraisal. Thus, differences in RSA reactivity to sadness and fear between the instructed emotion regulation strategy and Control groups would indicate that Distraction and Reappraisal assist children in effectively regulating parasympathetic reactivity and managing these negative emotions. A recent review of associations between emotion elicitation procedures and psychophysiology underscores the need for careful consideration of the specific methodology in use when interpreting patterns of parasympathetic regulation (Kreibig, 2010). Patterns of RSA suppression tend to be linked to experiencing fear and sadness, but RSA augmentation has been reported when sadness and fear are evoked via film clips (Hastings et al., 2014; Kreibig, 2010). Thus, we anticipated that the emotion-eliciting film clips would lead to RSA augmentation across all experimental groups, but augmentation would be stronger in the Distraction and Reappraisal conditions.

(2) Two exploratory questions concerned the relative effectiveness of Distraction and Reappraisal for regulating sadness and fear, and the potential impact of the order of the sad and scary film presentations on children's parasympathetic regulation. These questions were guided by our reasoning about how appraisal theories of emotion inform predictions about the utility of a given emotion regulation strategy in a particular emotional context. For instance, attempting to distract oneself from thinking about threatening/fear-eliciting information in an ambiguous context may not be an adaptive strategy, because attending to cues from the environment would help resolve the ambiguity (e.g., was that rustling noise in the bushes a bear or a squirrel?). We made no specific directional assumptions, but sought to explore how Distraction and Reappraisal may differ in their effectiveness for children too, as qualified by context-- the nature (or ordering) of the discrete emotion being regulated.

Method

Participants

This investigation makes use of data obtained from 101 5- to 6-year-old children (M_{age} = 5.818 years, SD_{age} = 4.076 months; 46 girls) who participated in a larger prospective longitudinal investigation of temperament and socio-emotional development. Children were recruited as toddlers from a rural area of the northeastern part of the United States. Children's race/ethnicity was reported by parents as predominantly non-Hispanic, European American (90.1%), 5% Asian/Asian American, 2% Multiracial, 1% American Indian, and 1% Hispanic and 1% African American. Most children resided in married two-parent households (95.4%). Family income ranged from <15,000 (1.3%) to >$60,000 (64.9%) with most families (88.3%) earning over $30,000. Mothers' education ranged from 12 to 20 years (*M* = 16.856, *SD* = 2.392) and fathers' from 10 to 20 years (*M* = 15.915, *SD* = 2.642).

Design

This study employed a 2 (emotion: sadness, fear; within-person) X 2 (order of films: sad-scary, scary-sad; between-person) X 3 (emotion regulation instructions: Distraction, Reappraisal, or Control; between-person) mixed experimental design. Children were randomly assigned to instruction condition and order of viewing the emotion-eliciting films with the constraint that an approximately equal number of boys and girls were assigned to each condition and emotion order.

Procedure

Children and a parent visited the lab. Parents consented for children's participation before the study began, and children provided verbal assent. Families received a small honorarium for their participation in the study session and children were thanked for their involvement with a small toy of their choosing. The campus' institutional review board approved this study before any research activities began. All procedures were recorded for offline coding and data processing.

Initial Assessments—After children acclimated to the lab environment and lead experimenter, they were trained to self-report negative and positive emotions using an age-appropriate measure, and they provided parasympathetic baseline information while quietly doing an activity of the child's choosing (e.g., coloring, reading).

Emotion self-report (training): Children were trained to self-report the intensity of their emotional reactions (sadness, fear, happiness) using simple, four-point cartoon face scales to rate each discrete emotion separately. Each scale depicted a neutral face ("not at all Sad/Scared/Happy") followed by three faces depicting increasingly exaggerated (*A Little, Pretty Much, Very*) target facial expressions for each emotion. The researcher read the scale anchors out loud when training children to interpret the points and ensured comprehension with two practice questions (e.g., "Which face would you point to if you felt *very* sad?" and, "Where would you point if you felt *not at all* scared?"). After successfully completing the training trials, the experimenter thanked the child and explained that s/he would be asked to tell the researcher about his/her feelings a few more times during the visit.

Psychophysiology baseline: Four minutes of seated baseline electrocardiograph (ECG) were recorded. Electrode placement was framed as a game--the experimenter and parent wore stickers chosen by the child. Once children were ready to begin, a second experimenter entered the room and explained that children were going to wear seven sticky sensors on their torsos so that the experimenters could listen to their hearts during the study. Stickers were secured to three disposable, pre-gelled electrodes that were then placed over the child's distal right collarbone, lower left rib, and lower right rib to acquire the ECG signal (the four additional electrodes placed on children's torsos were used to derive impedance data, which are not considered in this report). Ambulatory, wireless ECG recording continued for the rest of the visit with the ambulatory monitor secured in a child-sized backpack. Once electrodes were attached and children were given a few moments to acclimate to wearing the sensors, a resting parasympathetic baseline assessment was taken. During this baseline, children sat quietly at a table with the experimenter. An average of the four minutes of seated baseline acquisition phases was calculated for use as an index of children's resting parasympathetic regulation.

Discrete Emotions and Cognitive Emotion Regulation Strategies (DECERS) Task—Children viewed two brief, age-appropriate film clips: one designed to elicit mild sadness (*The Land Before Time*) and one to elicit mild fear (*The Secret of NIMH)*. The order of presentation of the sad and fear-eliciting clips was balanced across participants. The DECERS task was designed specifically for this study, but was modeled after a similar experimental paradigm used to examine children's emotion regulation strategies (Davis & Levine, 2013).

Emotion regulation instructions: Emotion regulation instructions were given to children by the lead experimenter twice--once before each of the emotion-eliciting film clips. Children received one of three sets of specific emotion regulation instructions: (1) to use *Distraction*, (2) to use *Reappraisal,* or (3) to pay attention to the clips (*Control)* with no reference to emotion or regulation made by the experimenter. The instruction frame for all conditions was:

> "I'm going to show you a short movie now. Pay close attention to the movie because we will ask you some questions about it later. [Insert condition-specific instructions] Can you try to do that? Ok, so what are you going to try to do while you watch the movie?"

Condition-specific Instructions:

> Control: "While you watch this movie, I want you to just try to pay attention to all the things that happen in the movie, ok?"
>
> Distraction: "While you watch this movie, if you start to feel bad or upset, I want you to think about something happy instead. You could think about a time you had fun playing, or eating ice cream, or think about a TV show you like to watch. Anything that you can think of that is happy is ok to think about instead, ok?"
>
> Reappraisal: "While you watch this movie, if you start to feel bad or upset, I want you to think about how everything that is happening in the movie is not really happening, so it's not a big deal. Think about how it's just a movie, and isn't real, ok?"

The follow-up questions after the instructions ensured that children understood what they were supposed to do (instructions were repeated for any child who expressed confusion about what to do, and no child expressed confusion after the repeat). Identical instructions were given before each of the emotion-eliciting films.

Cardiac physiology: Cardiac physiology was collected continuously (as described above) while children watched the sad and scary movie clips. Afterward, the sticky electrodes were gently removed and children participated in the remaining (unrelated) lab tasks.

Self-report of emotion: Before children received emotion regulation instructions or viewed any film clips, they were asked to use each of the emotion face scales to report how they were "really feeling, *right now.*" This self-report constitutes the baseline emotion assessment. Children additionally reported their sad, scared, and happy feelings again using this same format after the sad and scary movies.

Data Reduction/Coding

Processing and Coding of Cardiac Physiology (RSA)—ECG was continuously recorded during the Baseline and DECERS episodes, from which respiratory sinus arrhythmia (RSA) was derived. Cardiac data were collected via the Mindware Wi-Fi ACQ software, Version 1.0 (Mindware Technologies, LTD, Westerville, OH). The ECG signal was sampled at a rate of 500ms and band-pass filtered at 40 and 250 Hz. RSA was calculated from the ECG signal by detrending data using a first-order polynomial to remove the mean and any linear trends, cosine tapering, and submitting to Fast Fourier Transform. RSA was defined as the natural log integral of the high frequency 0.15 to 1.0 Hz power band based on the age of children in this study (Alkon, et al., 2003; Bar-Haim, Marshall, & Fox, 2000), and calculated in 30s epochs. Each 30s epoch of ECG data was visually inspected by trained research assistants for artifact identification using Mindware Heart Rate Variability (HRV) version 2.51. This program identifies inter-beat intervals (IBIs) and flags physiologically implausible intervals for manual inspection using an established algorithm (Berntson, Quigley, Jang, & Boysen, 1990). All data were reliably inspected and edited by three trained scorers. Interrater reliability was calculated on ~25% of the cases (750 total epochs for this phase of the larger study; 250 DECERS epochs) and was high (89% overall; 94% DECERS). Note that to be construed as a reliable match, final RSA values for any 30s epoch from two scorers had to fall within 0.1 of one another (Buss, Davis, & Kiel, 2011; Morales, Beekman, Blandon, Stifter, & Buss, 2015).

Calculation of Parasympathetic Regulation (RSA Reactivity) Scores—RSA was calculated over each 30s epoch for the baseline, sad movie, and scary movie. An average RSA value (averaging across the 30s epochs of each task) was calculated and used in analyses. RSA reactivity was calculated as the difference between baseline and average task values (e.g., average RSA during sad movie; task minus baseline), so positive values indicate RSA augmentation relative to baseline. Baseline RSA was included as a covariate in primary analyses to account for individual variation in initial level when characterizing the pattern of change within the experimental context.

Results

Results are organized in two sections. First, we report evidence that the emotional films elicited the target emotions (manipulation checks), as well as analyses to examine gender differences in RSA (a potential covariate), and to characterize the general pattern of parasympathetic regulation from baseline to the films. Second, we report the primary analyses of emotion regulation strategies and emotional context, and follow-up comparisons to pinpoint differences among the experimental conditions. Each reported analysis makes use of all participants with available data, so *ns* vary across analyses. 89 children had usable baseline RSA data, 83 of these also had usable RSA during the sad film, and 82 (of the 89 with baseline data) had usable RSA during the scary film (81 children had complete data on all measures). Cardiac data were missing primarily because of equipment malfunction, experimenter error, or participant refusal. Thus, children missing one of the RSA assessments (e.g., sad film clip) would be excluded from an omnibus repeated measures analysis but potentially included in follow-up comparisons. [1]

[1]Additional analyses with listwise deletion revealed an identical pattern of results.

Preliminary Analyses

Affect Manipulation Checks—To check that the emotion-eliciting videos induced the desired emotions, we compared children's self-report of the target emotion (i.e., sadness, fear) after watching the emotional videos to their baseline reports of the same emotion. Self-reports of sadness and fear were relatively low even after the emotion-eliciting films, but this was not surprising given the timing of children's emotion regulation instructions (i.e., given before each emotion-eliciting video was presented). Nevertheless, children reported significantly more fear after watching the scary film than at baseline, $t(97) = 4.047$, $p < .0001$; and also reported significantly more sadness after watching the sad film than at baseline, $t(97) = 3.863$, $p < .0001$. Descriptive statistics for emotion self-report and psychophysiology variables are given in Table 1.

Gender—We also examined whether gender differences in emotion self-report or cardiac physiology emerged. Boys and girls did not differ in their reports of sadness or fear at baseline, nor for the target emotions elicited by the sad and scary films (all *t*s (97) < 0.874, *p*s > .384). Likewise, there was no gender difference in baseline RSA or in reactivity to the scary film (*t*s < 1.432, *p*s >.159), but girls ($M = 0.516$, $SE = .106$) showed less RSA reactivity to the sad film than did boys ($M = 0.965$, $SE = .109$), $t(81) = 2.879$, $p = .005$. Thus, gender was included as a covariate in subsequent analyses.

Parasympathetic Regulation (RSA Reactivity)—Paired-samples *t*-tests between baseline RSA and average task RSA (RSA levels during the sad and scary films; see Table 1) showed that children's RSA levels increased relative to baseline levels, a pattern characteristic of augmentation or (in this context) adaptive parasympathetic regulation. RSA during the sad film was higher than during baseline, $t(82)= 9.566$, $p < .0001$. RSA during the scary film was also higher than baseline, $t(81) = 9.436$, $p < .0001$. Thus, the RSA reactivity scores used in our primary analyses are reflective of the general tendency among children in this study to show RSA augmentation while watching emotion-eliciting video clips. Table 2 shows bivariate correlations among the RSA variables.

Primary Analyses

The goal of this study was to assess the effects of emotion regulation instructions and order of film presentation (the between-persons factors) on children's parasympathetic regulation of sadness and fear (the within-person factor). We conducted a 3 (experimental condition: control, distraction, reappraisal) X 2 (film order: sad-scary, scary-sad) ANCOVA predicting parasympathetic regulation (RSA reactivity) in the two (within-person) emotion contexts (sadness and fear), covarying gender and baseline RSA.

Baseline RSA was a statistically significant covariate, $F(1, 73) = 4.541$, $p = .036$, $\eta^2 = .059$, as was gender, $F(1, 73) = 6.364$, $p = .014$, $\eta^2 = .080$. There was a marginal main effect of experimental condition, $F(2, 73) = 2.607$, $p = .081$, $\eta^2 = .067$, but this was qualified by a condition X order interaction, $F(2, 73) = 4.160$, $p = .019$, $\eta^2 = .102$. RSA reactivity did not vary across sadness and fearful emotion contexts within-subjects, $p = .505$, but a statistically significant interaction of experimental condition, film order, and emotion context was detected, $F(2, 73) = 3.619$, $p = .032$, $\eta^2 = .090$. This 3-way interaction is depicted in Figure 1 (Part A and Part B represent separate charts for the two film presentation orders).

To probe this 3-way interaction, we conducted additional ANOVA to examine the effects of experimental condition (between) and emotion context (within) on children's RSA reactivity for the two film presentation orders (Order A: scary-sad; Order B: sad-scary) separately.

Film Order A: Scary-Sad—An ANOVA predicting differences in RSA reactivity in sad and scary contexts based on emotion regulation conditions (covarying baseline RSA and gender) revealed a marginally significant interaction of experimental condition and emotion context, $F(2, 34) = 3.014$, $p = .062$, $\eta^2 = .151$. As can be seen in Figure 1 (Part A), children augmented RSA (marginally) more strongly during the first film they viewed (the scary one) when instructed to use Reappraisal ($M = 1.034$, $SE = .189$) relative to children in the Distraction ($M = .484$, $SE = .232$) and Control ($M = .607$, $SE = .195$) conditions, $t(37) = 1.924$, $p = .062$ (contrast t comparing Reappraisal to Distraction and Control weighted together). No differences in RSA reactivity across the conditions were detected for the second (sad) film, $ts < .382$, $ps > .705$. In addition, the hypothesis that instructed use of *either* Distraction or Reappraisal would lead to better parasympathetic regulation relative to the Control condition was not supported by a focused contrast weighting the experimental conditions together versus Control, $t(37) = .363$, $p = .72$. Thus, these results provide only partial support for our expectation that Reappraisal and Distraction would promote better parasympathetic regulation of sadness and fear—Reappraisal predicted a slight (marginal but meaningful) benefit to parasympathetic regulation of fear only.

Film Order B: Sad-Scary—A second ANOVA, identical to the one described above (but only for the subset of children who viewed the sad film before the scary film), showed no within-person effect of emotion context or interaction of emotion context and experimental condition ($Fs < .846$, $ps > .437$). The analysis did, however, reveal a main effect of experimental condition, $F(2, 37) = 6.311$, $p = .004$, $\eta^2 = .254$. Inspection of Figure 1 (Part B) suggests that children instructed to use Distraction ($M_{sad} = 1.256$, $SE_{sad} = .189$; $M_{fear} = 1.337$, $SE_{fear} = .194$) and Reappraisal ($M_{sad} = .864$, $SE_{sad} = .191$; $M_{fear} = .761$, $SE_{fear} = .196$) demonstrated better parasympathetic regulation of sadness and fear relative to children in the Control condition ($M_{sad} = .389$, $SE_{sad} = .168$; $M_{fear} = .481$, $SE_{fear} = .173$). Focused contrasts weighting Reappraisal and Distraction together versus Control showed that either emotion regulation strategy led to greater RSA augmentation for both Sadness, $t(40) = 3.072$, $p = .004$, and Fear, $t(39) = 2.646$, $p = .012$, consistent with predictions.

Discussion

The goal of this study was to examine the effects of distraction and reappraisal on children's parasympathetic regulation of sadness and fear. We gave children explicit instructions to regulate emotion (by distracting themselves, reappraising the importance of the event, or just reacting normally, in the control condition) before they watched film clips designed to evoke sadness and fear. Consistent with previous work that has documented a pattern of RSA augmentation while people actively use cognitive emotion regulation strategies (Butler, Wilhelm, & Gross, 2006), we hypothesized that both distraction and reappraisal would lead to better parasympathetic regulation (RSA augmentation) compared to children in the control condition. Given the context of this particular task (i.e., actively regulating emotion during an emotional challenge), RSA augmentation can be interpreted as evidence of an effective calming response attribute to children's use of cognitive emotion regulation strategies. Results largely (but not entirely) supported our hypotheses, and the findings from this study comprise a notable advance in our understanding of whether and how well young children can use cognitive emotion regulation strategies.

We predicted that children who used distraction or reappraisal when regulating sadness or fear would show greater physiological calming compared to children in the control condition. Across emotion regulation strategy conditions and discrete emotion contexts, we detected RSA augmentation. This was in line with our expectations—we hypothesized this pattern given similar RSA augmentation patterns in previous research that has used film clips to elicit negative emotions (Hastings et al., 2014; Kreibig, 2010). Previous research has found that sadness and fear typically elicit distinct physiological patterns (Kreibig, Wilhelm, Roth, & Gross, 2007; Kreibig, 2010), but this was not reflected in the within-persons emotion comparisons in our study. This study focused on a single indicator of affective psychophysiology, however, which may not fully capture the psychophysiological distinctions between sadness and fear. Future studies wishing to compare physiological regulation of sadness and fear in childhood could include multiple measures of stress responding to clarify these effects (e.g., Kreibig, 2010).

Children in all three conditions showed RSA augmentation while watching the emotion-eliciting video clips. This could be a methodological quirk of eliciting negative emotions using film clips, or it is possible that the RSA augmentation seen in the control group could be due to spontaneous regulatory attempts on the part of these children. Previous research has demonstrated that 5- and 6-year-olds are capable of generating and using cognitive emotion regulation strategies (Davis et al., 2010), so it is plausible that some children may have spontaneously recruited a strategy of their own to regulate any negative emotions that arose.

Of course, the key comparison in this experimental design was the difference in RSA augmentation between the emotion regulation instruction conditions and the control condition. Even if some children in the control condition spontaneously regulated negative emotion using cognitive strategies, children who received explicit instructions to use distraction or reappraisal augmented more strongly, suggesting an additional benefit to being encouraged to use these strategies. Very little prior research has examined the question of how instructed emotion regulation strategies affect peripheral psychophysiology, and to our knowledge this study is the first to do so with children. As has been shown with adults (Butler et al., 2006), instructed emotion regulation strategies lead to RSA augmentation, over and above any “deactivating” effect (causing RSA augmentation) of the film clip emotion elicitation methodology.

As expected, the general pattern of RSA reactivity was augmentation from baseline to task. A more complex set of findings emerged from our analysis delineating the effects of distraction and reappraisal on parasympathetic regulation of sadness and fear. If children watched the sad film clip first, distraction and reappraisal both resulted in greater RSA augmentation (relative to the control condition, as predicted), for both film clips. In contrast, if children watched the scary film clip first, reappraisal led to marginally greater parasympathetic regulation of fear relative to using distraction or doing nothing specific in the control group. There was no effect of experimental condition on these same children's parasympathetic regulation of sadness (i.e., the second film clip they viewed).

These findings provide partial support for our hypothesis that distraction and reappraisal can enable effective emotion regulation, and they raise interesting questions about how distraction and reappraisal may be differently effective for parasympathetic regulation of sadness and fear. For example, if we consider only the first film clip children viewed (half the children saw the sad clip first, half saw the scary clip first), the differences are clearer. Distraction and reappraisal both led to RSA augmentation (versus control) for children regulating sadness. But, only reappraisal led to RSA augmentation (and only marginally so) for children regulating fear. This suggests that children may have been less able to use distraction to regulate fear versus sadness.

Fear is elicited when someone perceives that a goal (e.g., of feeling safe) has been threatened, but the ultimate outcome is not yet clear. Because fear indicates a potential threat in the environment, disengaging attention could be a very costly strategy. Our finding that reappraisal promoted better parasympathetic regulation of fear than did distraction fits with this theoretical framing of the function of fear. Overall, the results from both groups suggest that emotion regulation instructions do benefit physiological regulation as evidenced by an increase in RSA. These results suggest that reappraisal might be more consistently beneficial for parasympathetic regulation than distraction (which may be effective in some, but not all, emotion contexts). Converging evidence from studies of adults shows that reappraisal is effective across discrete emotion contexts like sadness and fear. A recent meta-analysis (Webb, Miles, & Sheeran, 2012) of 306 effect sizes from the emotion regulation literature showed that both distraction and reappraisal have positive effects on emotional outcomes across emotions. When comparing the effectiveness of these strategies, reappraisal was shown to be more effective than other strategies, including distraction. Thus, our findings are consistent with the view that cognitive emotion regulation strategies are effective techniques for regulating negative emotions, but these may be more or less effective for children depending on the emotion context at hand.

The film presentation order effects are intriguing primarily because they document a distinct pattern of within-person parasympathetic regulation based on which negative emotion was elicited first. If children saw the sad film first, the pattern of RSA augmentation looks similar for each of the experimental conditions, and for both of the film clips. If children saw the scary film first, however, the RSA augmentation patterns varied by emotion regulation condition and across the scary and sad films. One interpretation for the consistent pattern of RSA for children who saw the sad film first is that the sad film resulted in emotional "spillover" effects. Because films were presented one after the other with no rest/ baseline phase in between, it is possible that the emotion generated from the first film might have been carried to the second film. Whether this spillover occurred because of theoretical differences between sadness and fear, or because of methodological limitations in the current study's design (e.g., perhaps the sad film clip was more evocative than the scary film clip) is not clear. This issue should be addressed in future research.

Limitations and Future Directions

The goal of the current study was to investigate the effects of cognitive emotion regulation strategies (distraction and reappraisal) on children's parasympathetic regulation (RSA augmentation) of sadness and fear. This is the first study to address this question in children. Findings represent a first step towards understanding how emotion regulation strategies relate to changes in children's psychophysiology. As with any research study, some limitations bear mention. First, this sample was not sociodemographically diverse, which limits the generalizability of our findings. A specific goal of this investigation was to examine whether kindergarten-age children (5- and 6-year-olds) could use distraction and reappraisal to effectively regulate sadness and fear. Although results from this study represent a meaningful first step, considering how little we know about emotion regulation as it relates to psychophysiology in this age range, the narrow range of ages limits what we can say about the developmental trajectory of emotion regulation abilities and other potential differences in the development of physiological self-regulation. A future direction for work in this area would be to prospectively examine the onset of the effectiveness of cognitive emotion regulation strategies across early childhood, ideally with a more diverse sample of participants.

Another constraint of this study concerns the timing and format of the baseline episode that was used to establish resting parasympathetic levels. The baseline required children to sit quietly for a few minutes while drawing or coloring with the experimenter, and this was the only baseline acquired for this study (i.e., there were no additional baselines in between tasks, including the two emotion-eliciting film clips). A more representative baseline for the emotion-eliciting film clips would have been a neutral film, viewed before the emotion-eliciting film clips were shown. Related to this, the lopsided spillover effect of emotion accumulation (sadness carries over into fear, but fear does not carry over into sadness) we found in children's parasympathetic regulation patterns by examining film presentation order is theoretically interesting in its own right, but was not anticipated. Including pre-emotion baselines before the sad and scary films could reduce some of these unintended accumulation/spillover effects. More research is needed to understand physiological regulatory processes as they relate to specific emotion regulation strategies and the implications for other aspects of development that these might have.

Conclusion

This study is the first to provide experimental evidence that cognitive emotion regulation strategies like distraction and reappraisal enhance children's parasympathetic regulation of sadness and fear. These findings suggest that, despite developmental limitations in their knowledge that changing what or how one thinks can repair negative emotions, young children can effectively make use of sophisticated cognitive emotion regulation strategies to manage negative emotions.

Acknowledgments

We gratefully acknowledge the support provided by the NIMH (R01-MH075750) and the Penn State Children, Youth and Family Consortium to Kristin A. Buss.

We extend our appreciation to the families that participated in this study and the staff and students in Dr. Buss' Emotion Development Lab.

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Highlights

- Children can use cognitive emotion regulation strategies to manage sadness and fear
- Distraction and reappraisal emotion regulation strategies promote better parasympathetic regulation
- Reappraisal was effective for regulating sadness and fear
- Distraction was effective for regulating sadness only

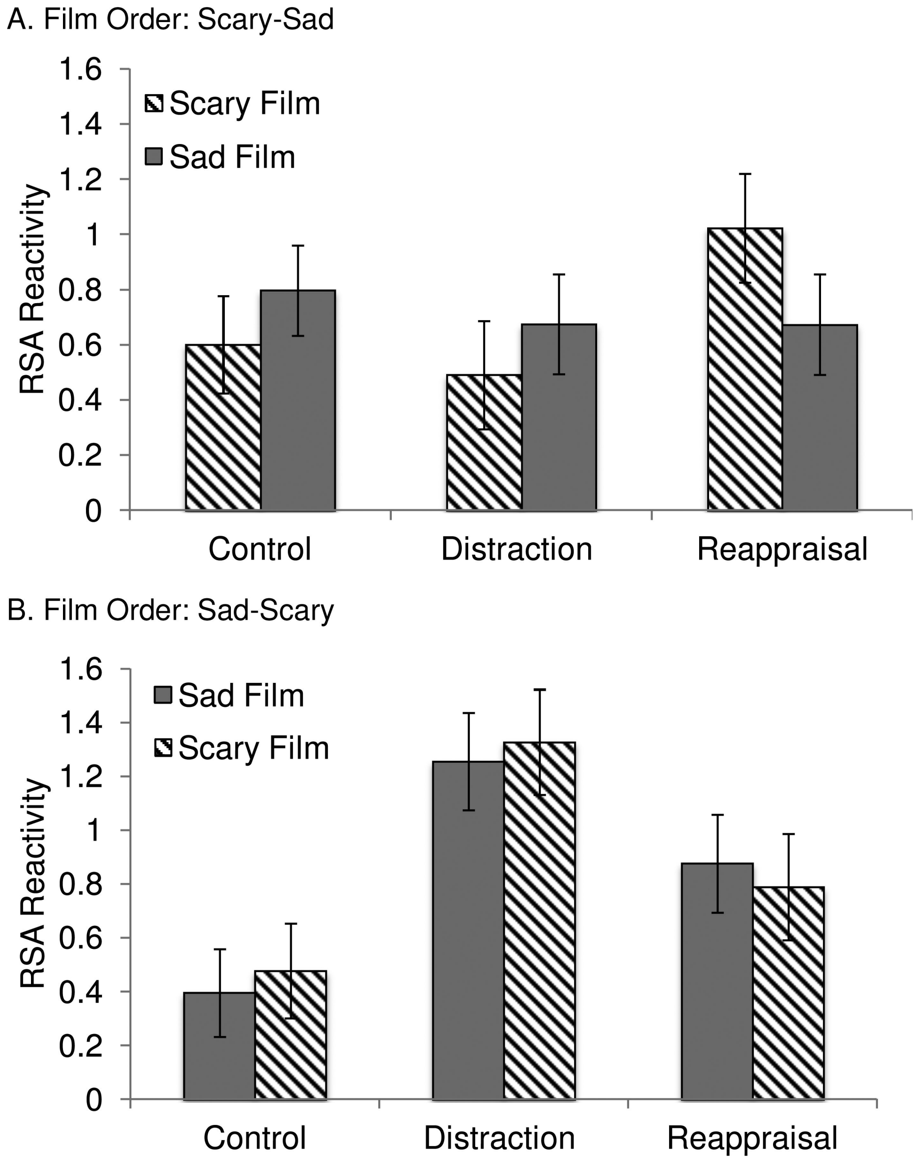

Figure 1.

RSA reactivity to sad and scary films by emotion regulation condition.

Note. Error bars represent standard error.

Table 1

Descriptive Statistics

	M	*SD*	Min	Max	LL 95% CI	UL 95% CI
Emotion Ratings						
Sadness at Baseline	1.19	0.51	1.00	4.00	1.08	1.30
Sadness after Sad film	1.51	0.75	1.00	4.00	1.34	1.67
Fear at Baseline	1.27	0.59	1.00	4.00	1.13	1.40
Fear after Scary film	1.67	0.98	1.00	4.00	1.45	1.89
RSA Assessments						
RSA (Baseline)	6.60	1.09	3.48	8.70	6.35	6.84
RSA Sad Film	7.35	1.16	3.92	9.84	7.09	7.61
RSA Scary Film	7.37	1.21	3.91	9.89	7.10	7.64
RSA Reactivity to Sad	0.75	0.73	−0.94	2.78	0.59	0.92
RSA Reactivity to Scary	0.78	0.76	−1.38	2.56	0.60	0.95

Table 2

Bivariate Correlations Among RSA Variables

	1	2	3	4
1. RSA at Baseline				
2. RSA Sad film	0.78**			
3. RSA Scary film	0.78**	0.88**		
4. RSA Reactivity to Sad film	−0.25*	0.40**	0.23*	
5. RSA Reactivity to Scary film	−0.18	0.28*	0.47**	0.70**

Note.

* $p < .05$

** $p < .01$

*** $p < .001$.