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Longitudinal associations between specific types of emotional reactivity and psychological, physical health, and school adjustment

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Abstract

Using a multimethod, multiinformant longitudinal design, we examined associations between specific forms of positive and negative emotional reactivity at age 5, children's effortful control (EC), emotion regulation, and social skills at age 7, and adolescent functioning across psychological, academic, and physical health domains at ages 15/16 ($N = 383$). We examined how distinct components of childhood emotional reactivity directly and indirectly predict domain-specific forms of adolescent adjustment, thereby identifying developmental pathways between specific types of emotional reactivity and adjustment above and beyond the propensity to express other forms of emotional reactivity. Age 5 high-intensity positivity was associated with lower age 7 EC and more adolescent risk-taking; age 5 low-intensity positivity was associated with better age 7 EC and adolescent cardiovascular health, providing evidence for the heterogeneity of positive emotional reactivity. Indirect effects indicated that children's age 7 social skills partially explain several associations between age 5 fear and anger reactivity and adolescent adjustment. Moreover, age 5 anger reactivity, low-, and high-intensity positivity were associated with adolescent adjustment via age 7 EC. The findings from this interdisciplinary, long-term longitudinal study have significant implications for prevention and intervention work aiming to understand the role of emotional reactivity in the etiology of adjustment and psychopathology.

Keywords: emotional reactivity; physical health; psychopathology; risk-taking; school problems

There is little doubt that children's early experience and expression of emotions are associated with later well-being or maladjustment (e.g., Putnam, 2012; Rothbart & Bates, 2006). For example, early emotional expressions predict later mental (e.g., Chronis-Tuscano et al., 2009) and physical health (e.g., Anzman-Frasca et al., 2012), behavior problems (e.g., Gartstein et al., 2012), and social (e.g., Dougherty, 2006) and school functioning (e.g., Dollar et al., 2018). Although these direct links have been demonstrated, specific forms of positive and negative emotions are rarely considered; this is especially true when examined simultaneously, which is necessary to identify the most salient forms of emotional reactivity in predicting adjustment. Moreover, most studies do not examine outcomes across multiple domains which limits the impact on preventive interventions. Thus, a greater understanding of how distinct components of emotional reactivity predict later domain-specific adjustment above and beyond the propensity to express other forms of emotional reactivity is needed.

In addition, development is the result of a cascade-based acquisition of developmentally-salient skills that influence

subsequent adaptation to the challenges of the next developmental period (e.g., Masten & Cicchetti, 2010). Therefore, a developmentally informed theory of risk or well-being must move beyond direct effects and aim to understand the mechanisms that explain *how* and *why* these associations transpire. One area of interest to developmental scientists has been the associations between children's emotional reactivity and self-regulation in developmental trajectories toward optimal functioning. Behavioral and emotional self-regulatory skills are more difficult to acquire and employ for emotionally reactive children (Bridgett et al., 2009; Eisenberg et al., 2001; Eisenberg et al., 2010; Stifter & Spinrad, 2002); yet these self-regulatory skills are essential for subsequent adjustment (see Calkins & Perry, 2016; Stifter & Dollar, 2016 for reviews).

Social functioning (i.e., social skills) also may explain variation in adjustment trajectories because it is both predicted by early emotional reactivity and predictive of well-being in adolescence and beyond (e.g., Parker et al., 2006). Thus, the regulation of emotion and behavior, as well as the development of strong social skills, by middle childhood are important developmental mechanisms to consider when investigating the link between early emotional reactivity and subsequent outcomes. The current study examines the longitudinal associations among specific types of positive (i.e., low-intensity positivity, high-intensity positivity) and negative

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(i.e., anger, fear) emotional reactivity in early childhood, regulatory (effortful control [EC], emotion regulation [ER]) and social skills in middle childhood, and adolescent adjustment across multiple developmental domains (risk-taking, psychological and physical health, school problems). This work is essential to better understand the role of distinct components of early emotional reactivity in the etiology of individual differences underlying pathways toward domain-specific adolescent outcomes.

Childhood emotional reactivity and adjustment

Although positive and negative emotions are experienced and expressed by everyone, there are notable individual differences in the intensity and frequency of emotions. These individual differences are often discussed as reflecting, at least in part, a child's temperament, defined as early emerging, relatively stable individual differences in affect, activity level, attention, and self-regulation (Rothbart, 2011; Shiner et al., 2012). All emotions serve adaptive purposes (Saarni et al., 2006), but for some children the experience of intense and/or frequent forms of certain emotions may have maladaptive consequences (Stifter & Dollar, 2016).

Below, we provide a selective overview of empirical work that links anger, fear, and positive emotional reactivity to psychological, school, and physical health outcomes. In line with a growing literature that considers fine-grained aspects of temperament within one study (Buss et al., 2014; Dollar & Buss, 2014; Morales et al., 2021), we emphasize the importance of accounting for the propensity to experience other forms of emotional reactivity when investigating the associations between distinct types of emotional reactivity and adjustment. Moreover, we argue that it is necessary to consider how these associations are explained through intermediate skills in middle childhood in order to best inform intervention efforts targeting regulatory or social skills.

We focus on the adolescent outcomes of risk-taking, cardiovascular risk, emotional symptomatology, and school problems, each of which has been linked to negative and/or positive emotional reactivity. Given that the adolescent period is characterized by rapid biological changes, heightened stress, conflicting role demands, and increased impulsivity and sensation seeking (Steinberg, 2007), examining the social, emotional, and behavioral predictors of maladaptive adolescent psychological and physical health is of considerable importance and may have lifelong consequences (e.g., Haller et al., 2010; Hartiala et al., 2012; Monroe et al., 2014).

Emotional reactivity and psychopathology

Negative emotional reactivity
There is little dispute that early proclivities to express negative emotional reactivity is predictive of behavior problems and poorer mental health in the internalizing and externalizing realms (Bates et al., 1991; Bohlin & Hagekull, 2009; Eisenberg et al., 2001; McClowry et al., 1994). However, it is important to move beyond a general measure of negative emotional reactivity to consider specific negative emotions (i.e., anger, fear), given that each form of reactivity differentially predicts children's trajectories (e.g., Stifter & Dollar, 2016).

Anger reactivity, which is often a response to blocked goals (Saarni et al., 2006), is positively associated with childhood and adolescent behavior problems (Frick & Morris, 2004; Perry et al., 2017; Rydell et al., 2003). In a sample of children followed from toddlerhood through adolescence, high anger at age 5 was associated with a greater probability of a stable pattern of externalizing behaviors from age 2 to 15 (Perry et al., 2017). Furthermore, children with high anger reactivity sometimes develop cooccurring externalizing and internalizing symptoms (Wang et al., 2016).

Fear reactivity, defined as negative affect related to anticipated novelty, threat, distress, and/or pain (Rothbart & Bates, 2006), is most often linked with high internalizing problems (Biederman et al., 2001; Chronis-Tuscano et al., 2009; Rydell et al., 2003). For example, behaviorally inhibited children, a temperamental group of children characterized by fearful and avoidant responses to unfamiliar people, objects, and situations (Kagan, 2018), are at greater risk for anxiety, often specifically social anxiety (e.g., Chronis-Tuscano et al., 2009; Schwartz et al., 1999), in adolescence.

Positive emotional reactivity
Positive emotional reactivity is linked with both well-being and maladjustment (Putnam, 2012; Stifter & Dollar, 2016). Although positive emotional reactivity is often considered as one construct on a spectrum from low-intensity positivity to high-intensity positivity, the seemingly contradictory literature may be a function of its heterogeneous nature (Kochanska et al., 2007). That is, the mixed findings may be explained by whether researchers emphasize the high approach or low-intensity elements of positive affect in their measurement (Kochanska et al., 2007; Polak-Toste & Gunnar, 2006).

Low-intensity positivity, including pleasure (smiling, laughing) experienced in nonstimulating activities, may be an adaptive quality by suggesting the ability to experience pleasure in calm, low-risk situations. Indeed, childhood positive emotional reactivity is protective against developing internalizing difficulties, such that low childhood positive reactivity is linked with electroencephalogram (EEG) asymmetries that characterize depressed individuals, and a greater likelihood of having mothers with a history of depressive disorders (Durbin et al., 2005; Shankman et al., 2005). Further, low positive emotional reactivity at age 3 predicted depressive symptoms at age 10, after controlling for negative emotional reactivity and depressive behaviors (Dougherty et al., 2010).

In contrast, children who experience high levels of high-intensity positivity (i.e., excitement) may have difficulty controlling their behavior and finding pleasure in calm situations; in turn, these children may miss opportunities that support learning social, behavioral, and academic skills (Putnam, 2012; Stifter & Dollar, 2016). Increased positive emotional reactivity, for example, is linked with more externalizing behaviors (e.g., Rothbart et al., 1994), although this effect is sometimes moderated by regulatory skills (Rydell et al., 2003). Further, intense positive emotional reactivity is a defining characteristic of exuberance, a temperamental style that describes children who show positive affect, approach, activity level, and sometimes impulsivity (Degnan et al., 2011; Dollar et al., 2017, Putnam & Rothbart, 2006; Putnam & Stifter, 2005), which is linked to greater externalizing symptomology (Putnam & Stifter, 2005; Stifter et al., 2008). This work underscores the need to consider low- and high-intensity positivity in one study to identify if the heterogeneity in positive reactivity explains the mixed findings. If so, intervention efforts can be better informed as to the intensities of positivity that are protective or maladaptive for specific forms of adjustment.

Emotional reactivity and risk-taking behaviors

Negative emotional reactivity
An important aspect of adolescent maladjustment involves the propensity to engage in risk-taking (Steinberg, 2007), which is highly related to externalizing behaviors. Anger reactivity is often

an important predictor of risk-taking behaviors (e.g., Gambetti & Giusberti, 2009; Lerner & Keltner, 2001; Rothbart et al., 2000; Sigfusdottir et al., 2004). Indeed, anger is more strongly related to alcohol and drug use than other negative emotions in adolescence and adulthood (McCreary & Sadava, 2000; Pardini et al., 2004), suggesting that anger-prone individuals may engage in substance use to deal with their intense negative emotions and social difficulties. More complex associations have emerged for children high in fear reactivity, such that these associations depend on gender and related behaviors (Kerr et al., 1997; Williams et al., 2010). For example, high behavioral inhibition increased risk for substance-related problems for boys but protected against these problems among girls (Williams et al., 2010).

Positive emotional reactivity

Heightened positive emotional reactivity in adolescence also predicts risk-taking behaviors, including smoking (Romer & Jamieson, 2001), drug use (Romer & Hennessy, 2007), and lifetime marijuana use (Creemers et al., 2010). In childhood, research has focused on exuberant children. Lahat et al. (2012) found that children high in exuberance and low in attention-shifting had a high propensity for childhood risk-taking. This suggests that individuals who experience high-intensity positivity may be more likely to engage in impulsive, risky behaviors possibly because their initial assessment of the situation's risk is outweighed by a strong experience of positive affect. Moreover, childhood high-intensity positivity is likely to evolve into later extraversion, impulsivity, sensation-seeking, and lowered self-regulation (Putnam, 2012; Rothbart & Bates, 2006). Together, these motivations and tendencies could contribute to adolescents' increased engagement in risky behavior. Longitudinal developmental studies are needed to confirm this hypothesis.

Emotional reactivity and physical health

Negative emotional reactivity

Given that mental and physical health are intertwined, a growing number of studies have examined how emotional reactivity and physical health are linked. For example, heightened anger is linked to cardiovascular risk (CVR; e.g., Harburg et al., 2003), cancer (e.g., Thomas et al., 2000), and elevated blood pressure and heart rate (Hauber et al., 1998). Evidence of these associations begins as early as adolescence and continues throughout adulthood. However, no known work has examined if high levels of childhood anger is predictive of lowered later physical health. Moreover, increased stress responses that come with frequent fear could increase children's risk for CVR (Dhabhar, 2014; McEwen, 1998). This is particularly salient for intervention efforts because identification of children more prone to develop early CVR could significantly lower the public health burden associated with cardiovascular disease (CVD).

Positive emotional reactivity

Adults who experience more positive emotion are generally healthier (e.g., Cohen et al., 2006) and live longer (e.g., Cohen & Pressman, 2006). However, existing studies are difficult to synthesize because measures of positivity vary greatly by study and often examine general constructs (e.g., life satisfaction), as opposed to experienced or expressed positive emotion (Cohen & Pressman, 2006; Pressman & Cohen, 2005). Thus, the role of specific forms of childhood positive emotional reactivity as predictors of physical health needs to be identified using well-established measures.

Evidence that early low- and/or high-intensity positivity is associated with lowered CVR could inform multifocal prevention intervention efforts aimed at lowering CVD.

Emotional reactivity and school problems

Negative emotional reactivity

Children's emotional reactivity influences their reactions to the school environment, ability to adhere to classroom rules, and relationships with teachers and peers (Blair, 2002; Keogh, 2003; Valiente et al., 2008). In turn, these things influence their school engagement. Increased anger reactivity is associated with lowered school engagement (Valiente et al., 2012), more school problems (mediated by social skills; Dollar et al., 2018), and frequent anger may undermine the student-teacher interactions (Raver, 2002). High fear reactivity is associated with positive (Chen et al., 2009) and negative school adjustment (Weeks et al., 2009). Identification of which types of negative emotional reactivity most strongly predict school difficulties could significantly help to specify academic adjustment intervention efforts.

Positive emotional reactivity

Positive emotions impact school adjustment in various ways, including enhancing motivation, directing attention toward task performance, and facilitating information processing (Pekrun & Linnenbrink-Garcia, 2012), as well as helping children develop stronger teacher relationships (Denham, 1998). However, some studies fail to find this association (Diaz et al., 2017; Dollar et al., 2018; Herndon et al., 2013). Thus, consideration of specific forms of positive emotional reactivity may elucidate these pathways and inform academic intervention efforts.

Taken together, specific negative and positive emotional expressions are associated with subsequent adjustment across domains in unique ways. However, with the exception of a few studies that include children (i.e., Gartstein et al., 2012) or adolescents (i.e., Creemers et al., 2009, 2010), it is largely unknown how distinct aspects of emotional reactivity (i.e., low-intensity positivity and high-intensity positivity as opposed to "positive reactivity") might uniquely predict functioning. This question can only be assessed by simultaneously accounting for other forms of emotional reactivity. For example, is high anger reactivity in early childhood uniquely associated with adolescent outcomes, even after accounting for its shared variance with positive and fear reactivity, reflecting the child's general tendency to be emotionally reactive? The first aim of the current study was to elucidate answers to questions like this. Specifically, we tested whether specific types of positive and negative emotional reactivity in early childhood were associated with psychological, physical health, and school adjustment in adolescence.

EC, ER, and social skills as potential mechanisms

It is clear that numerous direct links exist between early emotional reactivity and adjustment. However, failure or success in key tasks in one developmental period significantly influences functioning in subsequent developmental periods (Masten & Cicchetti, 2010). Thus, successful skill acquisition in middle childhood is essential to consider when predicting adolescent functioning from early childhood traits. The transition to middle childhood involves entering a more formal school environment, becoming active members of peer groups, and establishing and maintaining complex social relationships. It is also a period of increased autonomy and school demands that require the

regulation of emotion and behavior. A core focus of the early childhood period is refinement of these necessary social and regulatory behaviors (Kopp, 1989). Thus, the extent to which children have mastered these skills by the beginning of middle childhood is likely to have lasting impacts on adjustment. Specifically, if children have not developed strong social and regulatory skills by middle childhood, they are at a higher risk of maladjustment in adolescence and beyond (e.g., Crockett et al., 2006; Shortt et al., 2003).

One important skill that is refined into middle childhood is EC. EC includes children's ability to regulate their attention and behavior and is predicted by positive and negative emotional reactivity. Children who expressed less anger (Tan et al., 2013) and high low-intensity positivity (Kochanska et al., 2007) had greater EC skills, whereas children with high-intensity positivity displayed lower EC (Kochanska et al., 2007). Given the known link between EC and adolescent adjustment (King et al., 2011, 2013; Martel et al., 2007; Wang et al., 2015), these findings could have important long-term implications. For instance, if children's high-intensity positivity negatively impacts their ability to develop EC by middle childhood, then they will likely engage in more adolescent impulsive, risk-taking behaviors because their intense experience of positive affect may overpower their ability to manage their behavior and assess the situation's risk.

ER skills, including processes that serve to maintain, inhibit, or enhance the intensity and valence of these emotional experiences to accomplish one's goals (Calkins & Hill, 2007; Fox & Calkins, 2003) are developed and refined into middle childhood (Cole, 2014). Children prone to experience intense emotions, including anger and fear reactivity, are less likely to develop adaptive ER skills (Bridgett et al., 2009; Eisenberg et al., 2001, 2010; Stifter & Spinrad, 2002), likely because it is harder to regulate emotions as they become more intense. However, it is unknown how proclivities toward experiencing low- and high-intensity positivity are associated with the development of ER skills. Hundreds of studies have confirmed that children's poor ER is associated with externalizing and internalizing behavior problems (see Calkins & Perry, 2016 for review; Eisenberg et al., 2010), poorer school functioning (Hinshaw, 1992; Miles & Stipek, 2006), increased substance use (Cougle et al., 2013; Kober, 2014), and poorer physical health (e.g., Kitayama et al., 2015; Shriver et al., 2019). It is necessary to understand how specific forms of negative and positive reactivity predict ER skills in order to identify children who need increased support in developing these necessary abilities.

Finally, the development of strong social skills (i.e., the ability to respond in an appropriate manner in social situations, sharing and cooperating; Gresham & Elliott, 1990; Rose-Krasnor & Denham, 2009) is important for adjustment given its association with lowered internalizing (Hymel et al., 1990), externalizing (Blandon et al., 2010) and school problems (Pianta & Stuhlman, 2004; Spilt et al., 2012). Moreover, high anger reactivity is predictive of children's inability to engage in appropriate social skills (Rydell et al., 2003; Rydell et al., 2007), whereas children with low anger reactivity have an easier time acquiring socially skilled behaviors (Rubin et al., 2006). In addition, children high in fear reactivity are less likely to develop strong social skills and often display reticent behaviors (Coplan et al., 2004), withdrawing from social interactions, and/or not initiating social interactions with peers (Coplan & Prakash, 2003; Coplan et al., 2004). Therefore, children's social skills development by middle childhood likely serves as a central mechanism by which early emotional reactivity is linked with adolescent adjustment.

Less is understood about the link between positive emotional reactivity and social skills. Although few studies have considered low- and high-intensity positivity specifically, studies examining general positivity and exuberance report mixed findings. Greater childhood positive emotional reactivity is associated with declines in social skills (Sallquist et al., 2009). However, other work suggests that positive emotional reactivity may facilitate the initiation and regulation of social exchanges (Denham et al., 1990; Dougherty, 2006), providing a greater opportunity to learn appropriate social behaviors. Similarly, some report that exuberant children exhibit poorer social functioning (Dollar & Stifter, 2012), whereas others suggest this association is dependent on left frontal EEG asymmetry (Degnan et al., 2011) or inhibitory control (Dollar et al., 2017).

Although some preliminary support establishes the links between early emotional reactivity, middle childhood skills, and adolescent outcomes, either through short-term longitudinal studies and/or by showing long-term direct links, more work is needed to elucidate the mechanisms that underlie variation in developmental pathways toward adolescent adjustment. Thus, the second aim was to examine whether EC, ER, and social skills by middle childhood serve as mechanisms through which emotional reactivity during early childhood was associated with psychological, academic, and physical health adjustment in adolescence.

A multimethod, multiinformant, longitudinal design was employed to understand how specific forms of emotional reactivity in early childhood are associated with subsequent risk or well-being. We hypothesized that high levels of anger, fear, and high-intensity positivity would be associated with maladaptive functioning in middle childhood and adolescence, whereas high levels of low-intensity positivity would be associated with positive adjustment. Second, we hypothesized that the developed skills *by middle childhood* would serve as mechanisms that explain, at least in part, why negative and positive emotional reactivity in early childhood were associated with adolescent adjustment. That is, we hypothesized that the extent to which these skills have developed *by age 7* is essential in explaining the associations between early emotional reactivity and adolescent adjustment. We chose to examine these skills at age 7 because regulatory and social processes are fairly well-developed in most children by this age (Friedman et al., 2016; Raffaelli et al., 2005) and children have transitioned to a more formal school environment. Thus, children who have not developed these necessary skills, especially those who are emotionally reactive, during this time that requires significant regulatory and social skills, are less likely to acquire them and are at a heightened risk of maladaptive outcomes.

Methods

Participants

This study utilized data from three cohorts of children who are part of an ongoing longitudinal study of social and emotional development. The goal for recruitment was to obtain a sample of children who were at risk for developing future externalizing behavior problems and who were representative of the surrounding community in terms of race and socioeconomic status (SES). All cohorts were recruited through child daycare centers, the County Health Department, and the local Women, Infants, and Children program. Potential participants for cohorts 1 and 2 were recruited at 2-years-old and screened using mother report of the Child Behavior Checklist (CBCL; Achenbach, 1992) to oversample for externalizing behavior problems. Efforts were made to obtain

approximately equal numbers of boys and girls. This recruitment effort resulted in a total of 307 families who agreed to participate. Cohort 3 was initially recruited when infants were 6-months-old for their level of frustration, based on laboratory observation and parent report, and were followed through the toddler period (see Calkins, Dedmon, Gill, Lomax, & Johnson, 2002 for more information). Children from cohort 3 whose mothers completed the CBCL at age 2 ($N = 140$) were then included in the larger study. Of the entire sample ($N = 447$), 37% of children were identified as being at risk for future externalizing problems at age 2. There were no significant demographic differences between cohorts regarding gender, $\chi^2(2, N = 447) = .63$, $p = .73$, race, $\chi^2(2, N = 447) = 1.13$, $p = .57$, or age 2 SES, $F(2, 444) = .53$, $p = .59$. Although this sample was initially oversampled for externalizing behaviors, by early childhood the sample as a whole was no longer high in clinically relevant levels of externalizing behavior problems.

Of the 447 originally selected participants, six were dropped because they did not participate in any data collection at age 2 after the screening process. Four participants were dropped from the original sample due to developmental delays. Three hundred and sixty-five families participated at age 5, 350 families participated at age 7, and 327 families participated at age 15. There were no significant differences between families who did and did not participate in terms of race, $\chi^2(1, N = 447) = .14$–3.96, $p = .71$, 27 or age 2 externalizing T score, $t(445) = .24$–1.39, $p = .81$, .17 at ages 5, 7, and 15. Families with lower age 2 SES, $t(432) = -2.61$, $p < .01$, were less likely to participate in the age 7 assessment. These differences were nonsignificant at ages 5 and 15, $t(432) = -.56$ to -1.93, $p = .58$, .17. Boys were less likely to participate in the age 15 assessment $\chi^2(1, N = 447) = 9.31$, $p = .002$. These gender differences were nonsignificant at ages 5 and 7, $\chi^2(1, N = 447) = .76$–2.12, $p = .38$, .15. There were no differences between cohorts in any of the study variables (p's $> .10$) except age 15 risk-taking behaviors, such that cohort 1 was more likely to engage in risk-taking than cohort 3, $F(2, 300) = 2.92$, $p = .03$. For information regarding this sample at the age 16 health visit please see Wideman et al. (2016) and Dollar et al. (2021).

The sample for the current study included 383 children (58% girls) who had available data at the age 5 or age 15/16 assessments and then Full Information Maximum Likelihood (FIML) was used to handle missing data within the sample. The sample was 66% European American, 29% African American, 3% biracial, and 2% identified as other. Families were economically diverse based on Hollingshead (1975) scores at the age 5 assessment, with a range from 14 to 66 ($M = 39.86$, $SD = 11.08$), thus representing families from each level of social strata.

Procedures

Children participated in a longitudinal study beginning at age 2. The current analyses include data collected when children were ages 5, 7, 15, and 16. Mothers reported on children's low- and high-intensity positivity, anger, and fear when the children were age 5. When the children were age 7, mothers reported on children's EC and ER, and teachers reported on children's social skills. At age 15, adolescents self-reported their engagement in risky behaviors, school problems, and emotional symptoms. At age 16, adolescents completed a blood draw, anthropometrics (waist circumference [WC]), and blood pressure measurements.

Measures

Low- and high-intensity positivity, anger, and fear

When children were 5 years old, mothers completed the Child Behavior Questionnaire-short form (CBQ-SF; Putnam & Rothbart, 2006) to report on children's low- and high-intensity positivity, anger, and fear. Mothers were asked to report their child's reaction to a variety of situations and decide to what extent each item is true, using a 7-point Likert scale (1 = *extremely untrue* to 7 = *extremely true*). Of interest in the current study were the low-intensity pleasure (8 items; $\alpha = .73$), high-intensity pleasure (6 items; $\alpha = .68$), anger (6 items; $\alpha = .82$), and fear (6 items; $\alpha = .68$) subscales. *Low-intensity pleasure* measures the amount of pleasure involved in situations with low stimulus intensity, rate, complexity, novelty, and incongruity (e.g., "Enjoys just being talked to"). *High-intensity pleasure* measures the amount of pleasure related to situations involving high stimulus intensity, rate, complexity, novelty, and incongruity (e.g., "Enjoys activities such as being chased, spun around by the arms, etc."). *Anger* measures the amount of negative affect related to interruption of ongoing tasks or goal blocking (e.g., "Has temper tantrums when s/he doesn't get what s/he wants."). *Fear* measures the amount of negative affect related to anticipated pain, distress, or situations that might be frightening (e.g., "Is afraid of loud noises.").

The impulsivity (6 items; $\alpha = .61$), approach (6 items; $\alpha = .60$), and activity level (7 items; $\alpha = .73$) subscales on the CBQ were used as covariates. *Impulsivity* measures the speed of response initiation (e.g., "Tends to say the first thing that comes to mind, without stopping to think about it"). *Approach* measures the amount of excitement and positive anticipation for expected pleasurable activities (e.g., "Gets so worked up before an exciting event that s/he has trouble sitting still"). *Activity level* measures the level of gross motor activity including rate and extent of locomotion (e.g., "Tends to run rather than walk from room to room").

EC

Mothers reported on their 7-year-old children's EC using the CBQ-SF (Putnam & Rothbart, 2006). The EC variable ($\alpha = .70$) was an average of the attentional focusing, perceptual sensitivity, and inhibitory control subscales. *Attentional focusing* measures the tendency to maintain focus on a particular task (6 items; $\alpha = .70$; e.g., "When building or putting something together, becomes very involved in what s/he is doing, and works for long periods". *Perceptual sensitivity* measures the extent to which slight, low-intensity stimuli from the external environment can be detected (7 items; $\alpha = .68$; e.g., "Seems to listen, even to quiet sounds". *Inhibitory control* measures the capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations (6 items; $\alpha = .68$; e.g., "Can easily stop an activity when s/he is told 'no'").

ER

Mothers completed the Emotion Regulation Checklist (Shields & Cicchetti, 1997) when children were 7 years old. This measure assesses mothers' perception of the child's ER through 24 items rated on a 4-point Likert scale indicating how frequently the behaviors occur (1 = *almost always* to 4 = *never*). The regulation subscale (8 items; $\alpha = .67$; e.g., "S/he displays appropriate negative affect in response to hostile, aggressive or intrusive play by peers") assesses appropriate ER, emotive expression, and comprehension of one's own emotions and empathy.

Social skills

Teachers completed the elementary version of the Social Skills Rating System (Gresham & Elliott, 1990) in first grade (age 7), which assesses teachers' perceptions of children's behavioral social skills based on how often certain behaviors occur (0 = *never* to 2 = *very often*). The social skills scale (40 items; α = .73), which is a mean composite of the assertion (10 items; α = .79; e.g., "Appropriately questions rules that may be unfair"), cooperation (10 items; α = .91; e.g., "Follows your directions"), and self-control (10 items; α = .77; e.g., "Controls temper in conflict situations with peers") subscales, was used.

Risk-taking

At age 15, adolescents reported their risky behavior on a measure adapted from multiple risk-taking self-report questionnaires (i.e., Conger & Elder, 1994; Halpern-Felsher et al., 2005; 27 items). Adolescents reported on how frequently they have engaged in minor risky behaviors (α = .79; e.g., "drunk a bottle or glass of beer or other alcohol") and major risky behaviors (α = .68; e.g., "purposely set a fire in a building or in any other place"; 0 = *not at all* to 2 = *more than twice*). A risk-taking score was created using a sum of the items (α = .84).

CVR

Metabolic syndrome (MetS), defined as systematic elevations of CVR including obesity, elevated lipids, altered glucose metabolism, and hypertension, was used as the CVR indicator. At age 16, blood was analyzed for metabolic and immune markers using a multiplex system. Commercially available assay kits were used to assess glucose (Cayman Chemical, Ann Arbor, MI, USA) and lipid profiles (Wako Chemical, Richmond, VA, USA). A continuous MetS score was created by summing the standardized measures of glucose, triglycerides, high-density lipoprotein inverse, WC, and mean arterial pressure (MAP). MAP was calculated as MAP = DBP + 1/3(SBP-DBP). Greater MetS values indicate greater CVR. Three percent of our sample met the criteria for clinical elevations of MetS and 19% had subclinical elevations of MetS (Eisenmann et al., 2010).

Emotional symptoms

At age 15, adolescents completed the Self-Report of Personality adolescent version (SRP-A) of the Behavior Assessment System for Children (BASC-2; Reynolds & Kamphaus, 2004). This 176-item questionnaire assesses how the adolescent perceives their behavior, emotions, and personality characteristics. There are true/false questions and scale questions (0 = *never* to 3 = *almost always*). The emotional symptoms composite includes six subscales (61 items; α = .86), including social stress (10 items; α = .88; e.g., worry or distress related to social situations sense of inadequacy), anxiety (13 items; α = .88; e.g., child's frequency and level of perfectionism, nervousness, and feelings of worry and fear), depression (12 items; α = .83; e.g., depressive symptoms such as crying easily, loneliness, feeling sad and pessimistic, and having the desire to harm or kill oneself), sense of inadequacy (10 items; α = .81; e.g., adolescent's perception that they are unsuccessful in school, unable to achieve goals, and generally inadequate), self-esteem (10 items; α = .83; e.g., feelings of self-esteem, self-respect, and self-acceptance), and self-reliance (8 items; α = .71; e.g., adolescent's confidence in his/her ability to solve problems and belief in his/her dependability and decisiveness). Normative t-scores that are representative of the US population were used.

School problems

At age 15, adolescents reported on their school problems using the SRP-A BASC-2 (Reynolds & Kamphaus, 2004). The school problems composite (25 items; α = .87) includes three subscales: attitude to school (7 items; α = .85; e.g., feelings of alienation, disaffection, and hostility toward school), attitude to teachers (9 items; α = .84; e.g., feelings of resentment and dislike of teachers as well as beliefs that teachers are unfair, uncaring or overly demanding), and sensation seeking (9 items; α = .76; e.g., tendency to take risks and seek excitement). Normative t-scores that are representative of the US population were used.

Sex

Child sex was coded as 1 = male and 2 = female.

Age 5 externalizing behaviors

The CBCLs (Achenbach, 1992) externalizing subscale, which includes items measuring aggressive, destructive, and oppositional behaviors, was used as an index of parent report of externalizing behavior problems at age 5 (33 items; α = .90; e.g., "Cruelty, bullying, or meanness to others"). The mother indicated how true the statement was of her child on a scale of 0 = *not true* to 2 = *often true*. Standardized t-scores of externalizing behaviors were used.

Results

Analytic plan

Mplus (Verson 8; Muthén & Muthén, 2017) was used to conduct a path analysis to examine the study aims. FIML was used to handle missing data. Model fit was assessed by examining the comparative fit index (CFI; Marsh & Hau, 2007), the standardized root mean square residual, and the root mean square error of approximation (RMSEA; Cole & Maxwell, 2003). A bias-corrected bootstrapping procedure (10,000 draws) was used to test the indirect effects. This approach has been shown to generate the most accurate confidence intervals for indirect effects, reducing Type 1 error rates, and increasing power (MacKinnon et al., 2004).

Model results

Descriptive statistics and correlations are presented in Table 1. Significant differences in age 5 low- and high-intensity positivity and age 7 EC and social skills were found by sex. Therefore, these variables were regressed onto sex. To account for the significant associations and conceptual overlap, age 5 approach, impulsivity, and activity level were regressed onto age 5 high-intensity positivity. Age 5 externalizing was regressed onto the age 5 emotional reactivity variables because this sample was originally oversampled for externalizing behaviors.

The hypothesized model was a good fit to the data, χ^2 (46, $N = 383$) = 103.20, $p = .001$, CFI = .96, RMSEA = .05 [CI = .04, .07] (see Figure 1). The first aim was to assess whether childhood expressions of positive and negative emotional reactivity at age 5 were associated with psychological and physical health and school adjustment at ages 15/16. High-intensity positivity was positively associated with adolescent-reported risk-taking ($\beta = .16$, $p < .01$). Early childhood low-intensity positivity was negatively associated with adolescent CVR ($\beta = -.28$, $p < .05$).

The second aim of the study was to examine whether EC, ER, and social skills at age 7 serve as mechanisms through which emotional reactivity at age 5 was associated with adjustment at ages 15/16. High-intensity positivity was negatively associated with

Table 1. Correlations and descriptive statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Sex	–												
2. 5yr externalizing (PR)	.05	–											
3. 5yr HIP (PR)	−.19***	.29***	–										
4. 5yr LIP (PR)	.23***	−.12*	.00	–									
5. 5yr anger (PR)	.02	.58***	.23***	−.13*	–								
6. 5yr fear (PR)	.06	.12*	−.09	.08	.22***	–							
7. 7yr effortful control (PR)	.30***	−.30***	−.15***	.46***	−.29***	−.02	–						
8. 7yr ER (PR)	.09	−.30***	−.12*	.24***	−.24***	.06	.40***	–					
9. 7yr social skills (TR)	.26***	−.29***	−.13*	.04	−.25***	.10	.22**	.19**	–				
10. 15yr risk taking (AR)	−.20	−.19***	.21***	−.18**	.15*	−.07	−.30***	−.13*	−.35***	–			
11. 15yr CVR (B)	.00	−.06	−.03	−.25**	.05	.02	−.19	.16	−.04	.09	–		
12. 15yr emotional symptoms (AR)	.08	.20***	.13*	−.04	.13*	−.03	−.25***	−.21***	−.28***	.32***	−.05	–	
13. 15yr school problems (AR)	−.05	.23***	.22***	−.08	.11	−.13*	−.32***	−.16**	−.27***	.52***	.02	.48***	–
Mean	NA	51.71	5.05	5.87	4.30	4.09	5.26	3.41	1.40	4.20	.00	46.32	48.76
Standard deviation	NA	10.30	0.95	0.65	1.19	1.10	0.58	0.34	0.32	3.66	2.48	10.00	11.22
Minimum	1.00	30.00	1.67	2.50	1.17	1.33	3.51	2.25	0.33	0.00	−4.33	30.00	25.00
Maximum	2.00	79.00	7.00	7.00	7.00	6.83	7.00	4.00	1.93	19.00	9.70	81.00	85.00

Note. AR = adolescent report; B = biological measure; CVR = cardiovascular risk; ER = emotion regulation; HIP = high-intensity positivity; LIP = low-intensity positivity; PR = parent report; TR = teacher report; Sex (1 = male, 2 = female). ***$p < .001$; **$p < .01$; *$p < .05$.
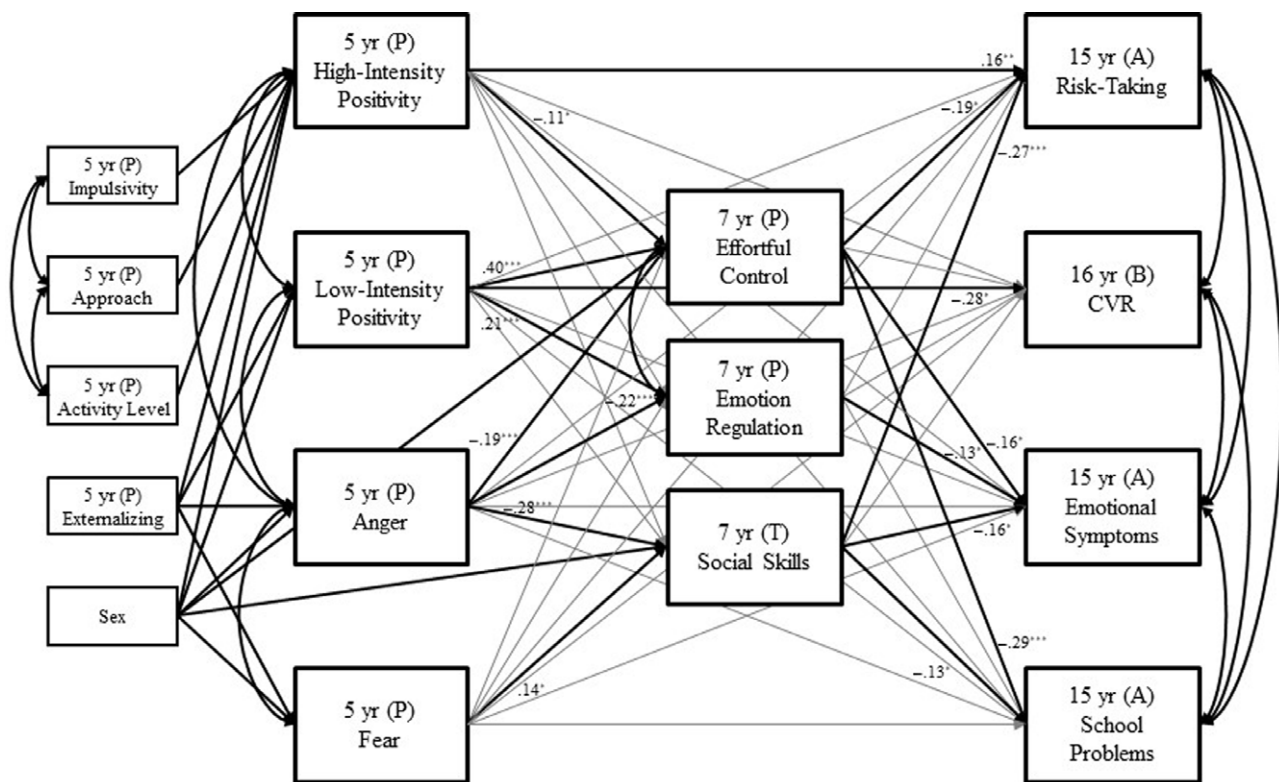

Figure 1. Standardized estimates and model fit. Model Fit: $\chi^2(46, N = 383) = 103.20, p = .001$, CFI = .96, RMSEA = .05 [CI = .04, .07]. All model paths shown; Significant paths bolded and include coefficients; A = adolescent report; B = biological measure; P = parent report; T = teacher report.

Table 2. Standardized estimates of significant indirect effects, standard errors, and 95% bias-corrected bootstrap confidence intervals

					Estimate	SE	Confidence intervals Lower	Upper
PR LIP(5yr)	→	PR EC(7yr)	→	AR risk taking(15yr)	−.07	.03	−.14	−.02
PR ANG(5yr)	→	PR EC(7yr)	→	AR risk taking(15yr)	.04	.02	.01	.08
PR ANG(5yr)	→	TR SS(7yr)	→	AR risk taking(15yr)	.08	.03	.03	.14
PR Fear(5yr)	→	TR SS(7yr)	→	AR risk taking(15yr)	−.04	.02	−.08	−.01
PR LIP(5yr)	→	PR EC(7yr)	→	AR emotional symptoms(15yr)	−.06	.03	−.14	−.01
PR ANG(5yr)	→	TR SS(7yr)	→	AR emotional symptoms(15yr)	.05	.02	.01	.10
PR ANG(5yr)	→	PR EC(7yr)	→	AR emotional symptoms(15yr)	.03	.02	.01	.07
PR HIP(5yr)	→	PR EC(7yr)	→	AR school problems(15yr)	.03	.02	.01	.07
PR LIP(5yr)	→	PR EC(7yr)	→	AR school problems(15yr)	−.12	.03	−.19	−.06
PR ANG(5yr)	→	PR EC(7yr)	→	AR school problems(15yr)	.05	.02	.02	.10

Note. ANG = anger; AR = adolescent report; B = biological measure; EC = effortful control; HIP = high-intensity positivity; LIP = low-intensity positivity; PR = parent report; SS = social skills; TR = teacher report. Only significant indirect effects reported.

EC ($\beta = -.11$, $p < .05$). Low-intensity positivity was associated positively with EC ($\beta = .40$, $p < .001$) and ER ($\beta = .21$, $p < .001$). Anger reactivity was negatively associated with EC ($\beta = -.19$, $p < .001$), ER ($\beta = -.22$, $p < .001$), and social skills ($\beta = -.28$, $p < .001$). Fear reactivity was positively associated with social skills ($\beta = .14$, $p < .05$). EC was negatively associated with adolescent-reported engagement in risk-taking ($\beta = -.19$, $p < .05$), emotional symptoms ($\beta = -.16$, $p < .05$), and school problems ($\beta = -.29$, $p < .001$). Social skills was negatively associated with adolescent-reported engagement in risk-taking ($\beta = -.27$, $p < .001$), emotional symptoms ($\beta = -.16$, $p < .05$), and school problems ($\beta = -.13$, $p < .05$). ER was negatively associated with adolescent-reported emotional symptoms ($\beta = -.13$, $p < .05$)

All significant indirect effects are provided in Table 2. Several mediational pathways were significant, indicating that EC and social skills play unique roles in the association between specific forms of childhood emotional reactivity and adolescent outcomes. Specifically, high anger reactivity was significantly associated with increased adolescent risk-taking and emotional symptoms via lower social skills. In addition, greater anger reactivity was significantly associated with increased risk-taking, adolescent emotional symptoms, and school problems via lower EC. High levels of childhood low-intensity positivity was associated with lower risk-taking and fewer adolescent emotional symptoms and school problems via stronger EC at age 7. High childhood high-intensity positivity was associated with more adolescent school problems through lower EC skills. Greater childhood fear reactivity was associated with lower adolescent risk-taking through stronger childhood social skills. The indirect effects from age 5 emotional reactivity to emotional symptoms through ER were not statistically significant.

Discussion

This study contributes to the current literature in three important ways. First, we considered multiple aspects of emotional reactivity in order to identify unique effects beyond the expression of other forms of emotional reactivity and to elucidate the heterogeneity within positive emotional reactivity. Second, we considered multiple aspects of adolescent adjustment simultaneously, which allows for a better understanding of which domains are most strongly associated with specific forms of emotional reactivity. Finally, this study is one of the first to investigate potential mechanisms that inform the role of cascading effects from early specific emotional proclivities to adolescent functioning more than a decade later.

Direct and indirect associations emerged between early childhood low- and high-intensity positivity and various forms of adolescent adjustment. In terms of direct effects, we found that children who displayed greater high-intensity positivity were more likely to engage in adolescent risky behavior, whereas those characterized by high low-intensity positivity were more likely to be physically healthy, with lower CVR. These findings support the heterogeneous nature of positive reactivity and align with the hypothesis that high-intensity positivity may be associated with some forms of maladjustment, while low-intensity positivity is more likely to be associated with well-being (Kochanska et al., 2007).

One reason for these discrepant associations may be the underlying motivations and behaviors that differing levels of intensity elicit (Polak-Toste & Gunnar, 2006; Putnam, 2012). High-intensity positivity activates approach motivation and may be specific to intense positive emotions such as joy and excitement. Moreover, childhood high-intensity positivity is likely to evolve into later extraversion, impulsivity, sensation-seeking, and, overall, lowered self-regulation (Putnam, 2012; Rothbart & Bates, 2006). Together, these motivations and tendencies could contribute to adolescents' increased likelihood of engaging in risky behavior. Importantly, our study expands previous work (e.g., Creemers et al., 2010; Kochanska et al., 2007) by being the first study to document these associations across a decade from childhood into adolescence.

Of note, we accounted for the shared variance between age 5 high-intensity positivity and age 5 impulsivity, approach, and activity level to provide a methodologically cleaner measure of high-intensity positivity rather than what is typically associated with the broader construct of surgency. By removing the variance in age 5 high-intensity positivity that is associated with impulsivity, approach, and activity level, our findings highlight that high-intensity positivity can put children at heightened risk of maladjustment and lends confidence to the importance of this construct in predicting later adjustment. This finding has significant implications for prevention work by suggesting that targeting high-intensity positivity early may offset risk prior to the development of later

occurring behaviors that may be more difficult to alter (i.e., high sensation seeking, high impulsivity). Although these findings are an important first step, additional work is needed. For instance, there is a need for studies to break down the exuberance profile (i.e., high-intensity positivity, approach, activity level) in order to identify which components are the strongest predictors of later outcomes (Stifter & Dollar, 2016).

Although little work has focused on the developmental role of childhood low-intensity positivity, including affiliation, contentment, and happiness in calm situations, a significant literature shows that adults who experience more positive emotion generally are healthier (e.g., Cohen et al., 2006) and live longer (e.g., Cohen & Pressman, 2006). Youth obesity has reached an all-time high, with more than one-third of U.S. adolescents meeting criteria for obesity (Ogden et al., 2014), and CVR is significantly increasing among adolescents (Gaydosh et al., 2018). This study provides the first known developmental work to extend the link between positive emotion and physical health to childhood and adolescence, which has significant implications for preventive intervention work. Although the mechanisms by which this association exists (i.e., biological, behavioral) are unknown, an important target for obesity/CVR intervention efforts may be to promote children's feelings of affiliation, contentment, and happiness in calm situations. Importantly, existing adult studies are difficult to synthesize because measures of positivity vary greatly by study and often examine general constructs (e.g., life satisfaction), as opposed to experienced or expressed positivity (Cohen & Pressman, 2006; Pressman & Cohen, 2005). This study uses a well-established measure of an individual's propensity to experience and express low- and high-intensity positivity, and highlights that low-intensity positivity, not high-intensity positivity, is associated with better physical health.

Indirect effects also emerged to suggest that skills developed by middle childhood explain at least, in part, the association between low- and high-intensity positivity and adolescent adjustment. As expected, children with greater high-intensity positivity had lower EC abilities at age 7, whereas children characterized by low-intensity positivity had greater EC skills at age 7. Moreover, children's EC skills at age 7 served as a significant mechanism by which low- and high-intensity positivity at age 5 were linked to school problems at age 15, although different pathways emerged by the type of positivity. Children showing greater high-intensity positivity were more likely to have adolescent school problems through lowered EC skills in middle childhood, whereas children high in low-intensity positivity reported having fewer adolescent school problems explained through stronger EC skills in middle childhood. These results provide important insight into mechanisms that explain divergent pathways for children who express different intensities of positive reactivity in childhood and builds upon the work of Kochanska et al. (2007), who first highlighted that low- and high-intensity positivity were differentially associated with the development of EC.

It is interesting that the regulatory and social skills in middle childhood did not explain more associations between low- and high-intensity positivity and adolescent adjustment. Although these are key abilities that lower developmental risk, the results suggest that there are additional processes to explain trajectories for children high in low- and high-intensity positivity that should be examined in future work. For instance, it is likely that other social processes, such as affiliation with deviant peers, should be considered to understand developmental pathways for children prone to experience high levels of high-intensity positivity. In addition, physiological processes (i.e., heart rate, inflammatory markers) may explain, at least in part, trajectories for children high in low-intensity positivity.

EC was also revealed as an important mechanism by which children high in low-intensity positivity were less likely to engage in risk-taking and develop emotional symptoms in adolescence. Specifically, children who find pleasure in low-intensity situations were less likely to report engaging in risk-taking behaviors and reported experiencing lower emotional symptoms through their ability to regulate their attention and behavior in middle childhood. Emotional symptoms in this study was a measure of adolescent social stress, anxiety, depression, sense of inadequacy, self-esteem, and self-reliance, and thus very similar to internalizing symptomatology. A growing literature has shown that childhood positive emotional reactivity is protective against developing later depression (Dougherty et al., 2010; Durbin et al., 2005; Shankman et al., 2005). These findings extend this literature by generalizing to a broader array of symptomatology, as well as highlighting EC as a mechanism by which this association exists.

It is logical that children high in low-intensity positivity would engage in fewer risky behaviors and that this association would be explained through EC. There is growing evidence that children who find pleasure in low-intensity situations often develop strong attentional and behavioral regulation skills (e.g., Kochanska et al., 2007), possibly because they are inherently calmer and thus acquire strong regulatory skills with greater ease. In turn, these regulatory skills prevent adolescents from engaging in risky behaviors (e.g., King et al., 2011, 2013). Importantly, these associations were found across a 10-year period, highlighting an important focus for preventive interventions by providing early target behaviors and entry points to offset maladaptive behavior early in development. Because high-intensity positivity is likely harder to regulate than low-intensity positivity, identifying youth who are prone to experience high-intensity positivity in early childhood and engaging with them in ways that bolster their regulatory skills when experiencing intense positive arousal may have profound implications for altering developmental trajectories toward maladjustment.

There were also a number of important pathways that emerged for children prone to experience anger and fear reactivity. Interestingly, there were no significant direct effects. These null effects, in conjunction with the number of significant indirect effects that emerged, point to the significance of middle childhood social and regulatory skills for children high in fear, and especially anger, reactivity. This builds on the premise that although children high in negative reactivity have greater difficulties developing social and regulatory skills, those who are able to acquire these skills are less likely to engage in or develop maladaptive behaviors by adolescence.

Specifically, consistent with existing research (for reviews see Calkins & Perry, 2016; Stifter & Dollar, 2016; Rubin et al., 2006) we found that childhood anger reactivity predicted lowered social skills, ER, and EC in middle childhood. Moreover, many indirect paths from childhood anger reactivity to adolescent outcomes via poorer social and behavioral skills emerged, suggesting that the tendency to experience intense/frequent anger may impede their development and lead to less optimal adolescent outcomes. For example, because anger-prone children are more likely to miss out on building social skills (Trentacosta & Shaw, 2009), they may be rejected by their peers, and, in response, spend time with deviant peers. In turn, affiliation with these peers likely enhances children's previous anger-prone tendencies and poor social skills (e.g., Cairns & Cairns, 1994). In addition, children who experience

intense anger have a more challenging task of developing strong ER and EC skills, albeit also more important, than children who have low to moderate experiences of anger. Cumulatively, this tendency to experience anger and difficulty developing important skills appears to contribute to a wide range of maladjustment, including risk-taking, school problems, and emotional symptoms, in adolescence.

For children high in anger reactivity, there were indirect paths toward all adolescent outcomes, other than CVR, via middle childhood low EC and social skills. For instance, EC and social skills served as mechanisms to explain why children who express intense anger are more likely to report high levels of emotional symptoms 10 years later. Thus, these findings suggest that anger-prone children who have difficulties controlling their behavior and developing social skills experience lowered self-esteem/self-reliance and greater anxiety and depressive symptoms in adolescence. Moreover, lowered social skills emerged as the most significant mechanism to explain why anger-prone children engage in more adolescent risk-taking. Many hypotheses have been posed to explain this link, including using substances to deal with intense emotions, being rejected by one's peers, and not developing important self-regulation skills to resist the impulse to engage in risk-taking. These results provide evidence for the important role of social skills above and beyond regulatory abilities.

Similar to children high in high-intensity positivity, anger-prone children were also more likely to report more adolescent school problems, which was at least partially explained through their lowered EC skills. Given that the school problems measure included sensation seeking as one of the subscales, these findings provide additional evidence that children who experience intense approach-based emotions, such as high-intensity positivity and anger, in early childhood need to develop strong behavioral regulation skills to appropriately cope with the impulse to take risks and seek excitement (Putnam, 2012; Polak-Toste & Gunnar, 2006). Although our measure of school problems is widely employed (Reynolds & Kamphaus, 2004), the aspects of school functioning assessed can differ across studies. In particular, the inclusion of sensation seeking in our school problems construct may differ from school-based measures in other studies, making it important for future work to confirm these findings when employing other measures.

Children who were high in fear reactivity were rated to have higher social skills than children low in fear reactivity. Moreover, there was a significant indirect effect by which children high in fear reactivity were less likely to engage in risk-taking behaviors through the development of strong social skills by age 7. These are significant for multiple reasons. First, a sizeable literature has shown that children high in fear reactivity/behavioral inhibition are more prone to have social difficulties, including lowered social competence and heightened social reticence (e.g., Coplan et al., 2004; Rubin et al., 2006). Our results, however, indicate that fear-prone children, as perceived by their mother, were rated by their teachers as showing strong social skills at age 7. This suggests that fearful children do not have social difficulties due to a lack of social skills; instead, other processes are at play, likely including how to modulate their social anxiety and feelings of being overwhelmed in social situations.

These findings are also notable when considering the well-established link between early fear reactivity/behavioral inhibition and later social anxiety (Chronis-Tuscano et al., 2009; Schwartz et al., 1999). Children prone to heightened fear may be inclined

to engage in substance use, especially in peer contexts, to cope with their social anxiety. Thus, although not tested directly by this study, these findings suggest that the development of social skills may be especially critical for fear-prone children in lowering the likelihood that they engage in substance use in order to dampen the effects of social anxiety. This should be considered by future work.

Finally, although there were significant direct effects between anger/low-intensity positivity and ER, and ER and adolescent emotional symptoms, there were no significant indirect effects where ER served as the mediator. This is surprising given the literature highlighting ER as a necessary developmental skill for children prone to experience intense emotional displays. However, most studies do not also consider other forms of self-regulation, as was done in the current study. Our results repeatedly revealed EC as a significant mechanism to explain the processes by which children high in anger or low in low-intensity positivity reported adolescent maladjustment (i.e., emotional symptoms). Thus, by middle childhood, EC skills may supersede the importance of ER as a significant mechanism to assuage risk. Across development distinct forms of self-regulation become intertwined and continuously build upon one another (Calkins et al., 2016); however, EC is a measure of children's behavioral and attentional regulation, whereas ER encompasses children's ability to regulate their emotional arousal. Thus, by age 7, the ability to regulate one's attention and behavior may be more essential for those who have heightened anger or low levels of low-intensity positivity. It is also important to consider that by middle childhood children increasingly internalize their emotional expressions and regulatory strategies making it more difficult for parents to accurately report. Thus, additional research on these links is warranted given that the lack of findings could be attributable to our methodology.

Limitations and future directions

Despite the many strengths of this study, it is not without limitations. First, only maternal reports of emotional reactivity, ER, and EC were considered. A strength of maternal reports is that mothers observe children's emotions/behavior across a range of contexts. However, maternal reports can be biased by mothers' personality or mental health (Kagan & Fox, 2006). Future studies should employ observed reactivity and regulation measures to confirm this study's findings. Moreover, although there were two years between measurements, mothers who view their children as more emotionally reactive at age 5 could also be viewing them as lower in EC at age 7. Importantly, however, social skills was assessed via teacher-report and was also predicted by children's emotional reactivity. Another point to consider is that although these cohorts were combined at age 2, recruitment procedures varied slightly and there are a few significant demographic differences among them in early ages.

In addition, we did not include measures of parental factors that likely influence developmental pathways. Recent research has shown that child effects on caregiving behaviors may be a mechanism by which children's later regulatory skills are, in part, undermined by children's anger reactivity (Bridgett et al., 2018). Thus, additional work is needed to build upon the current study's findings to include parental genetic and socialization factors. Moreover, parental monitoring becomes a significant predictor of risk (e.g., Eiden et al., 2016) and may impact these pathways. Future work considering these associations is needed. Additionally, we employed a measure of MetS that encompassed multiple aspects of CVR. However, given that some aspects of MetS may develop earlier than others, additional work

should examine discrete CVR risks to identify if there are specific pathways that could inform preventive interventions.

Finally, we did not include genetic measures that may explain the associations between emotional reactivity and adolescent adjustment. Children's early emotional reactivity has biological underpinnings (Rothbart & Bates, 2006), which could be similar to those underlying CVR, risky behaviors, or psychopathology (e.g., Kreek et al., 2005; Turcot et al., 2018). Work is needed to consider the role of genetic factors in these associations.

Conclusion

This study makes significant theoretical, empirical, and translational contributions. First, current theoretical models of biobehavioral risk rarely acknowledge that development is the result of a cascade-based acquisition of important skills that influence subsequent adaptation to the challenges of the next developmental period. Here we provided evidence for how early experiences of different emotions and early regulatory and social skill acquisition are important to consider in lowering biobehavioral risk in adolescence. From an empirical standpoint, this study makes an important contribution to the developmental literature by examining multiple forms of emotional reactivity concurrently to predict a wide range of psychological, physical health, social, and school adjustment outcomes across an 11-year time frame. Moreover, this is the first known study to highlight that specific forms of early childhood positive emotional reactivity are differentially associated with risk or well-being in adolescence, thus highlighting the necessity for future research to consider specific forms of emotional reactivity as predictors of developmental trajectories. Finally, this study makes a significant translational contribution given that it can inform multifocal health behavior interventions that target cooccurring risks and provide an early entry point and important target mechanisms for preventive interventions.

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