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Attention regulates anger and fear to predict changes in adolescent risk-taking behaviors

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Abstract

Background—Regulation of negative affect is critical to healthy development in childhood and adolescence. We conducted a longitudinal study examining the moderating role of attention control in the effects of anger and fear on changes in risk-taking behaviors from early to middle adolescence.

Method—The sample involved participants from the Study of Early Child Care and Youth Development (SECCYD), assessed at 9, 11, and 15 years of age. Composite scores for anger, fear, and attention control were computed using indicators from multiple informants, and risk-taking behaviors were assessed based on adolescents' self-reports.

Results—Latent difference score analysis indicated significant moderating effects of attention control showing that increased anger between 9 and 11 years was related to increases in risk-taking behaviors between 11 and 15 years only for adolescents with low attention control but not for adolescents with high attention control. In contrast, significant moderating effects of attention control for the link between fear and risk-taking behaviors suggested increased fear between 9 and 11 years tended to be associated with decreases in risk-taking behaviors between 11 and 15 years only for adolescents with high attention control but not for adolescents with low attention control.

Conclusions—Attention control regulates the connections between negative affect such as anger and fear with changes in adolescent risk-taking behaviors. Our data suggest the protective role of strong attention control against the development of risk-taking behaviors in adolescence as it demotes the effects of anger and promotes the effects of fear.

Keywords

Anger; Fear; Attention; Control; Adolescent Risk-Taking; Latent Difference Score Analysis

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Supporting Information
Additional Supporting Information is provided along with the online version of this article.
Table S1. Informants and item contents of the z-score composites for anger, fear, and attention control
Table S2. Descriptive Statistics for Anger, Fear, Attention Control, and Risk-Taking Behaviors

Introduction

In the transition to adolescence, many of our nation's youth show growth in risk-taking behaviors. Indeed, the developmental period of adolescence is characterized by heightened vulnerability to risk-taking behaviors, including experimenting with drugs, alcohol, and severe delinquent behaviors. As such, substance use and risky behaviors among adolescents represent a pernicious—and potentially preventable—risk to mortality, health, and functioning (Steinberg, 2008). The current view of developmental psychopathology emphasizes a critical role of control of attention in the regulation of emotions (Posner & Rothbart, 2007). It has been theorized that high anger reactivity and low fear response make up two different temperamental pathways to behavioral problems, such as conduct disorder (Nigg, 2006). No empirical research, however, has examined the independent and interactive roles of anger, fear, and attention control in contributing to the development of risk-taking behaviors. In the current study, we used data from multiple informants to investigate the predictive links between changes in anger and fear and changes in risk-taking behaviors, as a function of attention control level.

Anger, Fear, and Risk-Taking Behaviors

While risk-taking behaviors increase in the transition to and throughout adolescence (Steinberg, 2008), there are some adolescents who are more likely to show notably increasing risk-taking behaviors. That is, although adolescents as a group may be considered risk-takers compared to children and adults, not all adolescents get into trouble with risky behaviors that result in serious negative outcomes. Prior research has demonstrated that individual differences in aggressive behaviors, for example, are moderately stable over childhood and adolescence (Dodge, Coie, & Laynam, 2006). However, systematic developmental changes (i.e., within-person changes) in these individual differences are expected, and much remains to be learned about the complex cognitive and affective processes that may explain individual differences in intraindividual variability in risk-taking behaviors. We propose that anger and fear are key aspects of affective reactivity that may contribute to systematic changes in risk-taking behaviors in adolescence. We further propose that attention control may play a critical role in the regulation of these emotions and their contributions to risk-taking behaviors (Nigg, 2006; Posner & Rothbart, 2007).

One key to understanding the etiology of risk-taking in adolescence is considering the role of emotion as a reactive system. According to Gray's (1987) reinforcement sensitivity theory (RST), two statistically independent emotional/motivational systems are involved in disinhibition. The behavioral approach system (BAS) is sensitive to conditioned reward stimuli and responds with appetitive motivation, whereas the behavioral inhibition systems (BIS) responds with aversive motivation to conditioned cues signaling punishment. From this theory, the link between negative affect and risk-taking behavior may reflect efforts to approach potential rewards in the environment as shown in anger (Blair, 2012), as well as to inhibition or withdrawal from potential punishments in the environment as shown in fear (Pickering & Gray, 2001).

In the case of BAS, anger can arise 'offensively' from anticipation, due to behavioral activation that motivates movement toward a potentially rewarding experience that is impeded or obstructed (Carver, 2004). Indeed, children with high levels of anger in early childhood are more prone to develop externalizing symptomatology in childhood and adolescence (Eisenberg et al., 2007; Frick & Morris, 2004). Furthermore, children showing higher behavioral activation behaviors (i.e., were oriented toward potential rewards in the environment) were more prone to anger, which in turn predicted overt aggressive behavior (Deater-Deckard et al., 2010). There is also evidence that BAS is positively associated with young adults' substance abuse and gambling (Braddock et al., 2011) as well as adolescents' experimental use of substances (van Leeuwen, Creemers, Verhulst, Ormel, & Huizink, 2011).

In the case of BIS, dispositional fear becomes important. Researchers have suggests that negative affect that underlies children's predisposition to experience behavioral inhibition may be a protective factor against conduct disorders, especially callous-unemotional forms (Kagan, 2005; Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009). Similarly, higher BIS is negatively associated with primary psychopathy which represents the core emotional deficit and interpersonal manipulation (see Bijttebier, Beck, Claes, & Vandereycken, 2009, for a review). Although empirical research on BIS or fear linking to risk-taking behaviors is rare, there is evidence from at least one study suggesting that high BIS is related to low probability of regular substance use among adolescents (van Leeuwen et al., 2011).

Attention Control as a Regulating Mechanism

Another key to understanding the etiology of individual differences in adolescent risk-taking is examining the role of cognitive control as a regulatory system. Dispositional anger or fear on their own may not be what matters in the prediction of growth in risk-taking behaviors. Cognitive control of attention has been theorized to be a key aspect of emotion regulation and its impact on psychological maladjustment (Gray, 2004; Posner & Rothbart, 2007). It may be that low control of attention exacerbate the contribution of the behavioral approach system (shown in anger) on risk-taking behaviors, whereas high attention control amplify the constraining effect of the behavioral inhibition system (shown in fear) on risk-taking behaviors. Indeed, a few available studies suggest interactive effects between anger and attention on changes in externalizing behaviors throughout childhood (Kim & Deater-Deckard, 2011) and interactive effects between anger and effortful control on externalizing behaviors, as well as between fear and effortful control on internalizing behaviors among children and early adolescents (Eisenberg et al., 2007; Oldehinkel, Hartman, Ferdinand, Verhulst, & Ormel, 2007).

In the field of substance abuse research, it has been theorized that deficits in executive functioning (often defined as a higher-order cognitive construct involved in planning, initiation, and regulation of goal-directed behavior; Luria, 1980) contribute to adolescent substance use problems as a result of poor cognitive regulation of behavior (Giancola & Mezzich, 2003). However, evidence for the direct association between executive functioning and adolescents' risk-taking behaviors in nonclinical populations is scant and effect sizes are modest (e.g., Romer et al., 2011). Therefore, based on theories (Gray, 2004; Posner & Rothbart, 2007) as well as empirical findings showing the lack of main effects of executive functioning, we propose that cognitive control variables (i.e., attention control) may not be independent, direct predictors, but rather serve as 'regulators' that moderate the link between negative affect and risk-taking behaviors. Based on the temperament literature (Posner & Rothbart, 2007), we view attention control being broadly indicative of a set of cognitive control mechanisms that serve self-regulation.

The Present Study

The purpose of this study was to investigate if attention control regulates reactivity of anger and fear jointly contributing to the development of risk-taking behaviors among adolescents. Risk taking in adolescence may be the product of the interaction between two developing neurobiological systems: a network sensitive to rewards and a network associated with control. The developmental gap between these two systems peaks in mid-adolescence (around age 15) resulting in heightened vulnerability to risk-taking behaviors (Casey & Jones, 2010). Accordingly, we focused on predicting changes in risk-taking behaviors between early and middle adolescence from anger, fear, and attention assessed in preadolescence—an important developmental period preceding increases in risk-taking behaviors and escalation of sensation seeking later in adolescence.

Using structural equation modeling, we examined the temporally lagged prediction of changes in risk-taking behaviors from prior levels of anger and fear, while evaluating how level of attention control may modulate the effects of anger and fear. To our knowledge, the current study would be the first to investigate the moderating role of attention control in the link between dispositional negative affect and risk-taking behaviors into and through the transition to adolescence. We addressed the following questions and hypotheses. First, we examined stabilities within anger, fear, attention control, and risk-taking behaviors as well as contemporaneous and longitudinal correlations between the predictors of negative affect and attention control and the outcomes of risk-taking behaviors. Second, we examined the cross-lagged effects of anger and fear (measured at 9 and 11 years) on changes in risk-taking behaviors (from 11 to 15 years) to test whether attention control plays a protective role against the development of risk-taking behaviors by regulating the effects of anger and fear, such that the detrimental effect of anger is stronger when attention control is low and the protective effect of fear is stronger when attention control is high.

Method

Participants

We analyzed the public datasets of the National Institute of Child Health and Development Study of Early Child Care and Youth Development or SECCYD (http://www.nichd.nih.gov/research/supported/seccyd/datasets.cfm). Data collection began in 1991 and included 1364 children (51.7% male) and their families when the children were one month of age. At the time of the child's birth, all mothers were at least 18 and not more than 46 years old (*M* = 28.11, *SD* = 5.63). The current analyses include temperament measures taken when the children were in 4^{th} and 6^{th} grades (approximately, 9 and 11 years of age), and risk-taking behavior assessed in 6^{th} grade and again at 15 years of age (mean = 15 years, SD = .64). The present sample included 822 adolescents who had temperament data at 9 and 11 years and risk-taking data at 11 and 15 years, with 51% males (n = 417) and 83% White (11% Black and 6% other). About 79% were from two-parent families, and the median of maternal education was 'some college'. Additional details about data collection procedures are documented in the study's Manuals of Operation (http://www.nichd.nih.gov/research/supported/seccyd/Pages/overview.aspx#instruments). The procedures of the current study were approved by the university's internal review board.

Measures

Anger, fear, and attention control were assessed at 9 and 11 years, and adolescent risk-taking behaviors were assessed at 11 and 15 years. We used mothers', fathers', and teachers' ratings on items pertaining to several key indicators of anger, fear, and attention control. The items were selected based on face validity from a variety of instruments (see online supplementary Table S1). We used adolescents' self-reports on risk-taking behaviors.

Adolescent Risk-Taking Behaviors—We used 19 items assessing a range of risk-taking behaviors committed over the past year—such as fighting, damaging property, experimenting with drugs, and carrying weapons—that were originally adopted from the Risky Behavior Questionnaire (Conger & Elder, 1994). Responses were rated on a 3-point scale (0 = not at all; 1 = once or twice; 2 = more than twice). An average score was used, with higher scores indicating more risk-taking behaviors (α = .68 at 11 years and α = .81 at 15 years). To better describe the prevalence of risk-taking behaviors reported in the current sample, we followed the SECCYD study protocol and calculated the frequency of adolescents having committed four major risky behaviors including threatening to beat up someone, skipping school without permission, smoking a cigarette or using tobacco, and drinking beer or other alcohol. We found 9% of the participants at age 11 and 35% of at age 15 reported at least one of these major risk-taking behaviors. The results illustrate that there is a good range of frequencies of major risk-taking behaviors reported in the current sample, showing a notable increase in risk-taking behaviors from age 11 to 15.

Anger—We used four mother- and father-rated items from the Social Skills Rating System (SSRS; Gresham & Elliott, 1990), six mother-, father-, and teacher-rated items from the Disruptive Behavior Disorders Rating Scale (DBD; Pelham, Gnagy, Greenslade, & Milich, 1992), two teacher-rated items from the Student-Teacher Relationship Scale (Pianta, 1992), four mother- and father-rated items from the Child-Parent Relationship Scale (adopted from the Student-Teacher Relationship Scale), two mother- and father-rated items from the Child Behavior Checklist (CBCL; Achenbach, 1991), and two teacher-rated items from the Teacher Report Form (TRF; Achenbach, 1991).

Fear—We used 12 mother- and father-rated items from the CBCL and three teacher-rated items from the TRF.

Attention Control—We used two mother- and father-rated items from the CBCL, three teacher-rated items from the TRF, two mother- and father-rated items from the SSRS, and three mother-, father-, and teacher-rated items from the DBD.

To develop composite scores for anger, fear, and attention control, we conducted principal components analyses (PCAs) estimating the first principal component separately for each construct and each time point (6 PCA models in total). Internal consistency was acceptable. For attention control, explained variance in the indicators ranged from 49% to 50% and loadings were from .39 to .86. For anger, explained variance ranged from 30% to 32%, with loadings from .32 to .71. For fear, internal consistency was slightly lower with explained variance of 25% at both 9 and 11 years and loadings ranging from .27 to .63. Items were reverse scored if necessary so that higher scores indicated higher levels of dispositional anger, fear, and attention control. The average of the cross-informant correlations was .31 (ranging from .21 to .41). Every indicator was standardized, averaged, and standardized again to yield composite z-scores within each of the two time points for anger (α = .89 and .88 at 9 and 11 years respectively), fear (α = .78 and .76 at 9 and 11 years respectively), and attention control (α = .89 for at both 9 and 11 years).

Statistical Analysis—We tested latent difference score (LDS) models (McArdle & Hamagami, 2001) using maximum likelihood estimation to predict changes in risk-taking behaviors between 11 and 15 years from anger and fear measured at 9 and 11 years. Compared to the use of a manifest difference score, the LDS model offers an advantage of modeling change in perfectly reliable scores over a time series (by partitioning true scores from measurement errors), thus reducing the likelihood of bias in the estimates of parameters describing the change and enhancing power. The hypothesized LDS model included the time-varying predictor of anger or fear to examine the prospective effects of anger or fear on developmental changes in risk-taking behaviors. Because anger and fear scores were standardized z-scores compositing different scales reported by multiple informants, its time series data were constructed as a Markov simplex model based on manifest variables instead of an LDS model.

Results

Table 1 presents descriptive statistics as well as zero-order correlations among anger, fear, attention control, and risk-taking behaviors over time. For our first question, we found that the effect sizes for anger, fear, and attention control stability were substantial, ranging from .59 to .72. We also found moderate concurrent and longitudinal correlations between higher anger and higher risk-taking behaviors (r = .14 to .23) and between lower attention control and higher risk-taking behaviors (r = −.19 to −.27). Fear was not significantly correlated with risk-taking behaviors (r = .00 to .02).

Two-group structural equation models were used to test our second question regarding the moderating effects of attention control in the link between negative affect and risk-taking behaviors. We formed low attention (below median of the attention control scores, n = 411) versus high attention (above median of the attention control scores, n = 411) groups based on each individual's within-person mean of the attention control composites between 9 and 11 years. Using an average attention control score is justified, based on literature indicating substantial stability of individual differences in attention control (e.g., conflict monitoring) by late middle childhood (Deater-Deckard & Wang, 2012; Rueda et al., 2004). The low/high attention control groups were formed for testing moderating effects of *quantitative* differences in attention control using a multiple group structural equation model; they may not represent clinically meaningful or *qualitatively* different sub-groups. The low attention control group showed significantly higher levels of anger, fear, and risk-taking behaviors compared to the high attention control group (see online supplementary Table S2). We first fit a Configural Invariance model in which all parameters were freely estimated across the two groups. In subsequent models, we imposed equality constraints hierarchically to test numeric invariance between the low and high attention control groups with respect to the effects of age 9 anger/fear on the latent difference score of risk-taking behaviors (the Equal Initial Level Effect model) and the effects of age 11 anger/fear on the latent difference score of risk-taking behaviors (the Equal Change Effect model).

In Table 2, the chi-square difference tests comparing nested model fits indicated that the Equal Initial Level Effect model provided the best fit for the moderation effects of attention control in the link between anger and risk-taking behaviors. That is, the low and high attention control groups showed significantly different magnitude for the effects of changes in anger on changes in risk-taking behaviors. In particular, as shown in Figure 1, the low attention control group showed significant effects of anger at 11 years on the latent difference score factor of risk-taking behaviors ($b^* = .20$, $p = .004$), indicating that higher anger at 11 years, after controlling for variance in anger at 9 years, was predictive of larger increases in risk-taking behaviors from 11 to 15 years. However, anger at 11 years was not significantly predictive of changes in risk-taking behaviors in the high attention control group ($b^* = -.04$, $p = .59$). There was no attention control group difference with respect to the effects of the initial levels of anger at 9 years, showing that anger was not related to changes in risk-taking behaviors between 11 and 15 years ($b^* = -.07$ for the low attention control group and $b^* = -.05$ for the high attention control group with $p = .26$ for both groups).

Similar to the analysis for anger, nested model comparisons indicated that the Equal Initial Effect model provided the best fit for the moderation effects of attention control in the link between fear and risk-taking behaviors (see Table 2). Thus, the result indicated that the effects of age 11 fear on the latent difference score factor of risk-taking behaviors differed between the high and the low attention control groups. As shown in Figure 2, for adolescents in the high attention control group, there was a tendency that higher fear at 11 years, after controlling for variance in fear at 9 years, was predictive of larger decreases (or smaller increases) in risk-taking behaviors from 11 to 15 years ($b^* = -.10$, $p = .10$—a marginally significant effect size). In contrast, for the low attention control group, fear at 11 years did not predict changes in risk-taking behaviors ($b^* = .06$, $p = .36$). The two groups did not differ regarding the effects of the initial levels of fear at 9 years, showing that fear was not related to changes in risk-taking behaviors between 11 and 15 years ($b^* = -.04$ for the low attention control group and $b^* = -.03$ for the high attention control group, with $p = .44$ for both groups).

While low and high attention control groups significantly differed regarding the effects of age 11 fear on changes in risk-taking behaviors, age 11 fear was not a statistically significant predictor in either group. Therefore, we probed the differential moderation effects of attention control by comparing two extreme groups (McClelland & Judd, 1993)—those who were lower 25% of attention control and lower 25% of fear (‘low attention control with low fear group’; n = 36) versus those who were upper 25% of attention control and upper 25% of fear (‘high attention control with high fear group’; n = 33). Results revealed that higher fear at 11 years was significantly related to larger decreases (or smaller increases) in risk-taking behaviors between 11 and 15 years for the high attention control with high fear group (b = −.06, SE = .02, b^* = −.72, p = .01), but not for the low attention control with low fear group (b = −.45, SE = .30, b^* = −.32, p = .14).

Discussion

Little is known about the link between negative affect and risk-taking behaviors over the course of middle childhood and adolescence, and much of the prior research on negative affect and adjustment outcomes has been cross-sectional and relied on data from a single informant. We investigated longitudinal contributions of dispositional anger and fear to adolescent risk-taking behaviors based on multiple informant data, in an effort to better understand the protective role of the self-regulation mechanisms involving attention. This investigation represents the first study to examine whether the cross-lagged associations between earlier negative affect of anger and fear and later risk-taking behaviors may be moderated by the level of attention control spanning preadolescence through middle adolescence.

Consistent with prior research on the stability of temperament constructs (Posner & Rothbart, 2007), we found substantial stability of individual differences in anger, fear, and attention control from 9 to 11 years with stability coefficients ranging from .6 to .7. In contrast, the stability of risk-taking behaviors from 11 to 15 years was relatively lower with the stability coefficient of .4. It is possible that the relatively low stability of risk-taking was in part due to the relatively low base rates of more serious types of risk-taking behaviors (e.g., substance use) at age 11. Research indicates that rates of serious risk-taking behaviors remain relatively low until age 15 (e.g., Dahlberg, 1998). Although prior research based on a large national sample reported a statistically significant association between risk-taking at age 18 and alcohol use at age 22, the effect size was notably low (b^* = .05; Merline, Jager, & Schulenberg, 2008). The current investigation presents important information that fills the gap in the literature by finding moderate stability in adolescent risk-taking behaviors from early to middle adolescence. Taken together, these findings suggest the existence of considerable intraindividual variability and developmental plasticity in adolescent risk-taking behaviors.

Turning to analysis of anger related to subsequent changes in risk-taking behaviors, increased anger was related to elevated levels of risk-taking behaviors. This finding is consistent with prior research showing a positive association between anger and externalizing symptomatology among school-aged children and adolescents (Oldehinkel et al., 2007; Rydell, Berlin, & Bohlin, 2003; Sentse, Veenstra, Lindenberg, Verhulst, & Ormel, 2009). Furthermore, we found that attention control moderated the link between anger and risk-taking behaviors such that increases in anger predicted larger increases (or smaller decreases) in risk-taking behaviors from early to middle adolescence when attention control was low. In contrast, when attention control was high, these lagged predictive effects were not significant. The pattern of the anger by attention control interaction follows the protective-stabilizing model (Luthar, Cicchetti, & Becker, 2000) showing that the presence of strong attention control confers stability in good functioning despite increasing risk (i.e., high anger). Thus, the current findings lend support to theory and research emphasizing a modulation of self-regulation (Posner & Rothbart, 2007) and extends prior research showing a moderating effect of effortful control on healthy social-emotional development among children and early adolescents (Eisenberg et al., 2007; Oldehinkel et al., 2007).

To our knowledge, no study has examined the role of fear specifically in the development of adolescent risk-taking behaviors. Sentse and colleagues (2009) reported a very small but significant longitudinal association between greater fearfulness and lower externalizing symptomatology in early adolescence ($b^* = -.05$). More recently, Finy and colleagues (2014) reported that higher negative emotionality (worry and punishment sensitivity) was significantly related to lower impulsivity ($b^* = -.42$, a medium effect size). These findings suggest that fearful and anxious negativity may promote cautious behavior and protect against impulsive risk-taking behavior. Our findings provide the first evidence of the regulating role of attention control for a link between avoidance reactivity or fear and adolescent risk-taking.

Specifically, we found that fear appeared to be a statistical predictor of latent change scores with increased fear being associated with larger decreases (or smaller increases) in risk-taking behaviors from early to middle adolescence in the presence of high levels of attention control. In contrast, fear was not related to changes in risk-taking behaviors in the presence of low levels of attention control. Given that the fear by attention control interaction was relatively weak and only detectable at the extremes, this finding should be interpreted with great caution. Nevertheless, our finding presents preliminary evidence that emotional reactivity in behavioral inhibition may be a protective factor for externalizing problems (Kagan, 2005). In particular, our finding underscores the protective role of fear in the development of risk-taking behaviors and further illustrates when such protective effects are effective. The pattern of the fear by attention control interaction follows the protective-reactive model (Luthar et al., 2000), showing that the presence of strong attention control confers advantages but less so with increasing risk (i.e., low fear).

Furthermore, our results provide a potential account for the weak relationship previously found between executive functioning (a higher-order cognitive construct that involves attention) and risk-taking in studies focused on main effects. For example, in a large sample of high-risk adolescents from families with alcohol use disorder, the effects of executive functioning on alcoholism and other substance use disorders explained only 1% of the variance (Nigg et al., 2006). In addition, among typically developing adolescents, executive functioning was not directly predictive of performance on risky decision-making tasks, such as the Iowa Gambling Task (Hooper, Luciana, Conklin, & Yarger, 2004), or risky behaviors such as gambling and alcohol and cigarette use (Romer et al., 2011). Moving beyond these prior studies examining main effects, the current findings elucidate the moderating role of attention control by suggesting that high attention control may promote the protective effect of fear, whereas it may demote the detrimental effect of anger on the development of risk-taking behaviors among adolescents.

The observed interaction between negative affect and attention control may be, in part, explained by the interplay between brain regions that are responsible for reactivity versus regulation. Human and animal neuroscience research indicates that there are distinct neural mechanisms involved in the focusing and control of attention (e.g., prefrontal cortex) and the elicitation and expression of affect (e.g., limbic system). Though these systems are clearly separate from each other and show differential developmental trajectories (Steinberg, 2008), the activity in these brain regions is integrated in ways that serve to regulate thought, emotion, and behavior (Gray, 2004; Posner & Rothbart, 2007). In particular, our findings of the interaction between anger/fear and attention control can be viewed to reflect neural regulation of motivational response systems by control systems (e.g., Nigg, 2006). Specifically, high anger reactivity can be related to increases in risk-taking especially when a frontal-limbic approach system is poorly regulated, whereas high fear reactivity can be related to decreases in risk-taking especially when a frontal-limbic withdrawal system is well regulated.

This investigation addressed several methodological shortcomings present within the literature on temperament and psychopathology. We examined a large national sample that was assessed for an extended period of time and used composite scores based on multiple informants and measures. This approach maximizes power and the predictive validity of constructs by reducing random error, while it minimizes the study-wide type-I error rate by vastly reducing the number of statistical tests conducted. In addition, we examined longitudinal change in adolescent risk-taking behaviors using optimally reliable latent change scores via LDS models that permitted more precise estimation of the change.

Despite the strengths, the findings of the current study should be interpreted in the context of study limitations. First, by examining items and scales from various informants across different instruments at any given point in time, we had to standardize the indicators of anger, fear, and attention control to create meaningful and interpretable composite z-scores. As a result, we were not able to examine sample-wide mean-level changes over time for anger, fear, and attention control. A second limitation is that our secondary data analysis for constructing anger, fear, and attention control composites was limited by there being only questionnaire-based items. We also acknowledge that the majority of items used for the attention control construct assessed *problems* with sustained attention. Though it may not be ideal, we believe that those items measuring difficulty in maintaining attention reflect individual differences in attention control—the degree of well sustained, well maintained attention. In addition, although also having task-based laboratory measurements of attention would have been ideal, that may not be required to operationalizing attention control at the level of observable behaviors. Individual differences in questionnaire-based measures of attention control like those utilized in the current study have been shown to be correlated with task-based measures of executive attention in children (for reviews see Rothbart, 2007). However, one caveat is that broad measurement of attention control based solely on questionnaire in the present study provides a global ‘snapshot’ of overall attention control. We recommend future researchers to integrate multiple levels of assessment (e.g., behavior in laboratory paradigms, behavior in naturalistic contexts, and informant and self-reports).

Third, we primarily focused on examining how earlier interactions between reactivity (anger and fear) and regulation (attention control) measured in preadolescence contribute to changes in risk-taking from early to middle adolescence. We acknowledge that there are other important biological and environmental-social relationship factors (e.g., genetic, parenting, and peer influences) that contribute to the development of risk-taking in adolescence. Finally, although the ranges of risk-taking behaviors were not restricted, the mean levels of risk-taking behaviors were relatively low in our sample—though typical of what is seen in large community samples, certainly lower than one finds in referred or clinical samples. Replications using higher risk samples of adolescents will be helpful to evaluate the generalizability of the current findings to adolescents with differing levels of risks and risk-taking behaviors and cognitions.

Conclusion

Based on theoretical models regarding temperamentally-based behaviors (e.g., Posner & Rothbart, 2007), we considered cognitive control (i.e., attention control) as a regulatory system that can modulate both approach and avoidance reactive tendencies (i.e., anger and fear, respectively). Our results suggest that individual differences in adolescent risk-taking behaviors reflect, in part, variation in dispositional anger and fear. Furthermore, the current findings present the first evidence of the moderating role of cognitive control on the contributions of negative affect to the development of adolescent risk-taking behaviors. If enough cognitive control capacity is available, the impulsive reaction that arises from dispositional anger can be reduced and the inhibitory reaction that arises from dispositional fear can be enhanced, resulting in diminished risk-taking behaviors. From an intervention perspective, the reported interaction suggests changes in attention control may be targeted for preventive intervention strategies for risk-taking behaviors to be most impactful among adolescents with high propensity for anger and fear.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Achenbach, TM. Manual for the Child Behavior Checklist/4–18 and 1991 Profile. urlington, VT: University of Vermont Department of Psychiatry; 1991.

Achenbach, TM. Manual for the Teacher's Report Form and 1991 Profile. Burlington, VT: University of Vermont, Department of Psychiatry; 1991.

Bijttebier P, Beck I, Claes L, Vandereycken W. Gray's Reinforcement Sensitivity Theory as a framework for research on personality-psychopathology associations. Clinical Psychology Review. 2009; 29:421–430. [PubMed: 19403216]

Blair RJR. Considering anger from a neuroscience perspective. Wiley Interdisciplinary Reviews: Cognitive Science. 2012; 3:65–74. [PubMed: 22267973]

Braddock KH, Dillard JP, Voigt DC, Stephenson MT, Sopory P, Anderson JW. Impulsivity partially mediates the relationship between BIS/BAS and risky health behaviors. Journal of Personality. 2011; 79:793–810. [PubMed: 21682726]

Casey BJ, Jones RM. Neurobiology of the adolescent brain and behavior: Implications for substance use disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 2010; 49:1189–1201. [PubMed: 21093769]

Carver CS. Negative affects deriving from the behavioral approach system. Emotion. 2004; 4:3–22. [PubMed: 15053723]

Conger, RD.; Elder, GH. Families in troubled times: Adapting to change in rural America. New York: Aldine de Gruyter; 1994.

Dahlberg LL. Youth violence in the United States: Major trends, risk factors, and prevention approaches. American Journal of Preventive Medicine. 1998; 14:259–272. [PubMed: 9635070]

Deater-Deckard K, Beekman C, Wang Z, Kim J, Petrill SA, Thompson LA, DeThorne LS. Approach/positive anticipation, frustration/anger, and overt aggression in childhood. Journal of Personality. 2010; 78:991–1010. [PubMed: 20573133]

Deater-Deckard, K.; Wang, Z. Development of temperament and attention: Behavioral genetic approaches. In: Posner, M., editor. Cognitive neuroscience of attention. 2nd edition. Vol. 331. New York: Guilford; 2012. p. 342

Dodge, KA.; Coie, JD.; Lynam, D. Aggression and antisocial behavior in youth. In: Damon, W.; Eisenberg, N., editors. Handbook of child psychology, : Social, emotional, and personality development. 6th edition. Vol. 3. New York: Wiley; 2006. p. 719-788.

Eisenberg N, Ma Y, Chang L, Zhou Q, West SG, Aiken L. Relations among effortful control, reactive undercontrol, and anger to Chinese children’s adjustment. Development and Psychopathology. 2007; 19:385–409. [PubMed: 17459176]

Finy MS, Bresin K, Korol DL, Verona E. Impulsivity, risk taking, and cortisol reactivity as a function of psychosocial stress and personality in adolescents. Development and Psychopathology. 2014; 8:1–19.

Frick PJ, Morris AS. Temperament and developmental pathways to conduct problems. Journal of Clinical Child and Adolescent Psychology. 2004; 33:54–68. [PubMed: 15028541]

Giancola PR, Mezzich AC. Executive functioning, temperament, and drug use involvement in adolescent females with a substance use disorder. Journal of Child Psychology and Psychiatry. 2003; 44:857–866. [PubMed: 12959494]

Gray, JA. The psychology of fear and stress. London: Cambridge University Press; 1987.

Gray JR. Integration of emotion and cognitive control. Current Directions in Psychological Science. 2004; 13:46–48.

Gresham, FM.; Elliott, SN. The social skills rating system. Circle Pines, MN: American Guidance Service; 1990.

Hooper CJ, Luciana M, Conklin HM, Yarger RS. Adolescents’ performance on the Iowa Gambling Task: Implications for the development of decision of decision making and ventromedial prefrontal cortex. Developmental Psychology. 2004; 40:1148–1158. [PubMed: 15535763]

Kagan, J. Human morality and temperament. In: Carlo, G.; Pope Edwards, C., editors. Moral motivation through the life span (Vol.51 of the Nebraska Symposium on Motivation. Lincoln, NE: University of Nebraska Press; 2005. p. 1-32.

Kim J, Deater-Deckard K. Dynamic changes in anger, externalizing and internalizing problems: Attention and regulation. Journal of child psychology and psychiatry. 2011; 52:156–166. [PubMed: 20825522]

Luthar SS, Cicchetti D, Becker B. The construct of resilience: A critical evaluation and guidelines for future work. Child Development. 2000; 71:543–562. [PubMed: 10953923]

Luria, AR. Higher cortical functions in man. New York: Basic Books; 1980.

McArdle, JJ.; Hamagami, F. Latent difference score structural models for linear dynamic analyses with incomplete longitudinal data. In: Collins, LM.; Sayer, AG., editors. New methods for the analysis of change. Washington, DC: American Psychological Association; 2001. p. 139-175.

McClelland GH, Judd CM. Statistical difficulties of detecting interactions and moderator effects. Psychological Bulletin. 1993; 114:376–390. [PubMed: 8416037]

Merline A, Jager J, Schulenberg JE. Adolescent risk factors for adult alcohol use and abuse: stability and change of predictive value across early and middle adulthood. Addiction. 2008; 103:84–99. [PubMed: 18426542]

Nigg JT. Temperament and developmental psychopathology. Journal of Child Psychology and Psychiatry. 2006; 47:395–422. [PubMed: 16492265]

Nigg JT, Wong MM, Martel MM, Jester JM, Puttler LI, Glass JM, Zucker RA. Poor response inhibition as a predictor of problem drinking and illicit drug use in adolescents at risk for alcoholism and other substance use disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 2006; 45(4):468–475. [PubMed: 16601652]

Oldehinkel AJ, Hartman CA, Ferdinand RF, Verhulst FC, Ormel J. Effortful control as modifier of the association between negative emotionality and adolescents' mental health problems. Development and Psychopathology. 2007; 19:523–539. [PubMed: 17459182]

Pelham WE, Gnagy E, Greensdale KE, Milich R. Teacher ratings of DSM-III-R symptoms for the disruptive behavior disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 1992; 31:210–218. [PubMed: 1564021]

Pianta, R. Student-Teacher Relationship Scale. Charlottesville, VA: University of Virginia; 1992.

Pickering, AD.; Gray, JA. The neuroscience of personality. In: Pervin, LA.; John, OP., editors. Handbook of personality. 2nd ed.. New York: Guilford; 2001. p. 277-299.

Posner, MI.; Rothbart, MK. Educating the human brain. Washington DC: American Psychological Association; 2007.

Romer D, Betancourt LM, Brodsky NL, Giannetta JM, Yang W, Hurt H. Does adolescent risk taking imply weak executive function? A prospective study of relations between working memory performance, impulsivity, and risk taking in early adolescence. Developmental Science. 2011; 14:1119–1133. [PubMed: 21884327]

Rydell A, Berlin L, Bohlin G. Emotionality, emotion regulation, and adaptation among 5- to 8-year-old children. Emotion. 2003; 3:30–47. [PubMed: 12899315]

Sentse M, Veenstra RL, Siegwart, Verhulst FC, Ormel J. Buffers and risks in temperament and family for early adolescent psychopathology: Generic, conditional, or domain-specific effects? The TRAILS study. Developmental Psychology. 2009; 45:419–430. [PubMed: 19271828]

Steinberg L. A social neuroscience perspective on adolescent risk-taking. Developmental Review. 2008; 28:78–106. [PubMed: 18509515]

van Leeuwen AP, Creemers HE, Greaves-Lord K, Verhulst FC, Ormel J, Huizink AC. Hypothalamic–pituitary–adrenal axis reactivity to social stress and adolescent cannabis use: The TRAILS study. Addiction. 2011; 106:1484–1492. [PubMed: 21631618]

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Key points

- Regulation of negative affect such as anger and fear is critical to healthy development in childhood and adolescence.
- Our results from latent difference score analyses suggest that individual differences in adolescent risk-taking behaviors reflect, in part, variation in dispositional anger and fear, and attention control moderates the contributions of anger and fear to the development of adolescent risk-taking behaviors.
- Strong attention control promotes the protective effect of fear, whereas it demotes the detrimental effect of anger on the development of risk-taking behaviors among adolescents.
- The reported interaction suggests changes in attention control may be targeted for preventive intervention strategies for risk-taking behaviors to be most impactful among adolescents with high propensity for anger and fear.

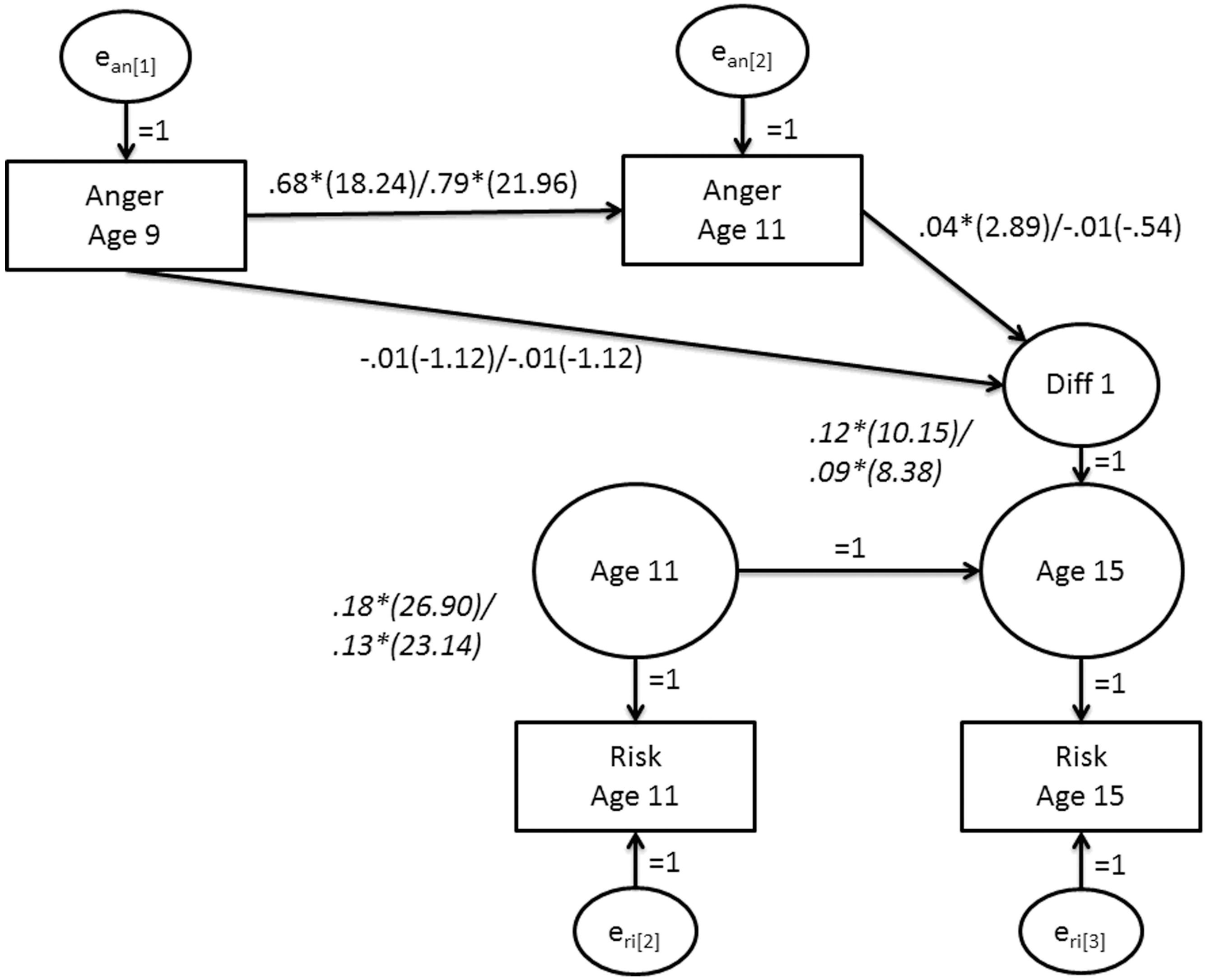

Figure 1.

Latent difference score model of the moderation of attention control between anger and risk-taking behaviors. Risk = risk-taking behaviors; Diff = latent difference score factor; and e = measurement error. Values given are unstandardized coefficients with critical ratio (CR) in parentheses. CR that exceeds greater than 1.96 is significant using a significance level of .05. For each path, the coefficients (CR) are listed for low attention/high attention control groups. For the intercept (Age 11) and the latent difference score (Diff) factor of risk-taking behaviors, estimated means (CR) are presented in italics.

* $p < .05$

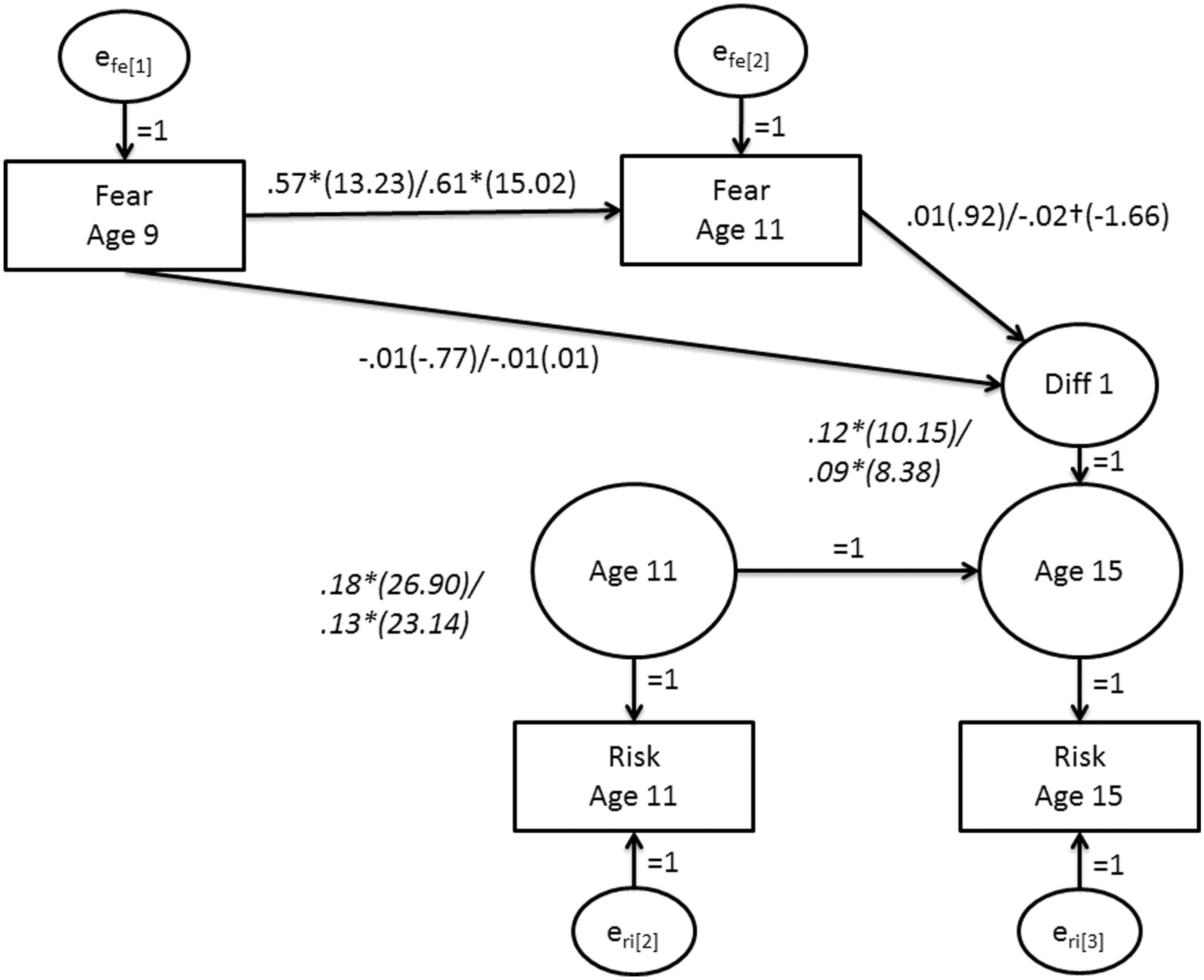

Figure 2.

Latent difference score model of the moderation of attention control between fear and risk-taking behaviors. Risk = risk-taking behaviors; Diff = latent difference score factor; and e = measurement error. Values given are unstandardized coefficients with critical ratio (CR) in parentheses. CR that exceeds greater than 1.96 is significant using a significance level of .05. For each path, the coefficients (CR) are listed for low attention/high attention control groups. For the intercept (Age 11) and the latent difference score (Diff) factor of risk-taking behaviors, estimated means (CR) are presented in italics.

* $p < .05$; † $p < .10$.

Table 1

Descriptive Statistics and Bivariate Correlations among Anger, Fear, Attention Control, and Risk-Taking Behaviors

	1	2	3	4	5	6	7	*M*	*SD*
1. Anger (Age 9)	–							−.02	.99
2. Anger (Age 11)	.70**	–						−.01	.99
3. Fear (Age 9)	.29**	.24**	–					−.01	.97
4. Fear (Age 11)	.24**	.32**	.59**	–				−.02	.98
5. Attention Control (Age 9)	−.44**	−.35**	−.22**	−.16**	–			.06	.95
6. Attention Control (Age 11)	−.38**	−.46**	−.17**	−.22**	.72**	–		.03	.97
7. Risk-Taking (Age 11)	.23**	.21**	.02	−.01	−.22**	−.27**	–	.15	.13
8. Risk-Taking (Age 15)	.14**	.16**	.00	.00	−.19**	−.24**	.40**	.27	.23

Note. Bivariate N = 740 to 822.

** $p < .01$.

Table 2

Comparisons of Latent Difference Score Models for Negative Affect and Risk-Taking Behaviors Moderated by Attention Control

Model Label	χ^2	*df*	CFI	RMSEA	Comparison	$\Delta\chi^2$	Δ*df*	*p*(d)
Anger								
a. Configural Invariance	41.06	6	.94	.08				
b. Equal Initial Level Effects	**41.30**	**7**	**.94**	**.08**	**a vs. b**	**.24**	**1**	**.62**
c. Equal Change Effects	48.76	8	.93	.08	a vs. c	7.46	1	.01
Fear								
a. Configural Invariance	13.66	6	.98	.04				
b. Equal Initial Level Effects	**13.87**	**7**	**.98**	**.04**	**a vs. b**	**.21**	**1**	**.65**
c. Equal Change Effects	18.09	8	.98	.04	a vs. c	4.22	1	.04

Note. CFI = comparative-fit index; RMSEA = root mean square error of approximation; $\Delta\chi^2$ = difference in likelihood ratio tests; Δ*df* = difference in *df; p*(d) = probability of the difference tests. Best-fitting models are in bold face.