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Interactive Contributions of Cumulative Peer Stress and Executive Function Deficits to Depression in Early Adolescence

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Abstract

Exposure to peer stress contributes to adolescent depression, yet not all youth experience these effects. Thus, it is important to identify individual differences that shape the consequences of peer stress. This research investigated the interactive contribution of cumulative peer stress during childhood (second-fifth grades) and executive function (EF) deficits to depression during early adolescence (sixth grade). Youth (267 girls, 227 boys; $\bar{X}_{age}$ at Wave 1 = 7.95, SD = .37) completed questionnaires and semi-structured interviews to assess peer stress and depression, respectively; teachers completed the Behavior Rating Scale of Executive Function to assess everyday performance in several EF domains. As anticipated, exposure to peer stress in childhood predicted heightened sixth-grade depression in girls but not boys with higher levels of EF deficits. This study extends theory and research on individual differences in vulnerability to adolescent depression, in turn elucidating potential intervention targets.

Keywords

peer stress; executive functioning; depression; sex differences

Theory and research implicate the cumulative effects of peer stress as a risk factor for the development of depression in early adolescence (Aseltine, Gore, & Colten, 1994; Rudolph, 2002, 2009). However, individual differences in youth may determine their level of vulnerability to the effects of such stress. This study examined the proposal that deficits in executive function (EF) accentuate the adverse effect of cumulative peer stress on depression over time. In light of the dramatic rise in depression during early adolescence (Rudolph & Flynn, 2014), we examined the interactive contribution of peer stress exposure during childhood (second-fifth grades) and EF deficits to depression during early adolescence (sixth grade), a developmental period during which the peer context becomes particularly salient (Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006) and peer stress may play an increasing role in the emergence of depression (Rudolph, 2009). Identifying the role of EF deficits in the development of early adolescent depression may help elucidate potential

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We dedicate this manuscript to the memory of Dr. Phil Rodkin.

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points of intervention for preventing future depression and help youth maintain a positive trajectory after experiencing stressful peer events.

Peer Stress From a Stressful Life Events Perspective

Peer stress has been emphasized as a key risk factor for adolescent depression (Rudolph, 2002). Stress within the peer domain can refer to individual events (e.g., a fight with a friend, a friend moving away, or not being invited to a party) as well as to the cumulative effect of exposure to different types of stressful events (e.g., multiple interpersonal conflicts, loss of friendships) over a period of time. Considering that peer relationships play a significant role in youths' adjustment during the period from middle childhood to early adolescence (Parker et al., 2006), cumulative exposure to peer stress during this time may predispose youth to subsequent depression. Exposure to stressful peer events may cause youth to focus excessively on their difficulties and negative emotions and to feel socially ineffective, leading to social withdrawal, low self-worth, sadness, and other symptoms of depression. Indeed, stressful peer events are associated with concurrent (Rudolph, 2002) and prospective (Aseltine et al., 1994; Hankin, Mermelstein, & Roesch, 2007) depressive symptoms during adolescence. However, not all youth exposed to peer stress develop depression, suggesting that individual differences may exacerbate or attenuate these effects.

Executive Function Deficits as a Moderator of the Effects of Peer Stress

EF deficits may serve as one factor contributing to individual differences in vulnerability to depression in the face of peer stress. EF involves a set of cognitive processes that regulate thoughts, feelings, and actions (Barkley, 1997). Based on prior theory and research, we focused on several domains of EF that may be especially relevant to the development of depression: working memory, planning/organization, inhibition, and shifting. Working memory involves the ability to hold information in mind for the purpose of manipulating it or following through with tasks (Miyake et al., 2000). It is essential for completing tasks that involve multiple steps, remembering the rules of an activity, and following a set of instructions or plans. Planning/organization involves the ability to manage demands of current or future tasks, plan and organize actions over time, and regulate behavior to follow through with plans (Gioia, Isquith, Guy, & Kenworthy, 2000b). Inhibition involves the ability to inhibit behavior and impulses, stop behaviors at the appropriate time, and generally control one's behavior (Barkley, 1997; Miyake et al., 2000; Nigg, 2000). Although the construct of inhibition is multi-dimensional (Nigg, 2000), this study focused specifically on inhibition of behavior. Finally, shifting involves the ability to control attention and switch focus to new topics or between situations, tasks, and activities (Miyake et al., 2000).

Deficits in EF may prevent youth from demonstrating effective and socially appropriate responses to peer stress, leading to unresolved or worsening stress and consequent depressive symptoms. Working memory deficits may lead youth to experience limited processing resources and reduced capacity to think about topics other than their negative emotions, preventing them from dealing effectively with peer stress. Planning/organization deficits may create difficulty thinking step-by-step through the best course of action to minimize the impact of stress, managing emotions, or coming to resolutions when facing

problems or frustrations with peers. Inhibition deficits may foster difficulty controlling the manifestation of internal experiences when faced with stress, leading them to behave in ways that alienate others (e.g., excessively seeking reassurance; Prinstein, Borelli, Cheah, Simon, & Aikins, 2005). Finally, shifting deficits may cause youth to become stuck in a negative mind-set when faced with stress, dwelling on unpleasant thoughts and events (Raver, Blackburn, Bancroft, & Torp, 1999). In turn, failure to deal effectively with stress or accompanying emotions (Flynn & Rudolph, 2011; Sontag, Graber, Brooks-Gunn, & Warren, 2008; Troop-Gordon, Rudolph, Sugimura, & Little, 2015), maladaptive social behavior (Prinstein et al., 2005), and rumination (Nolen-Hoeksema, Stice, Wade, & Bohon, 2007) can exacerbate stress and heighten risk for the development of depression in youth. In contrast, strong EF abilities may allow youth to cope effectively with stressors and accompanying emotions, thereby attenuating the effects of peer stress on depression.

Research links various EF deficits, including poor working memory (in adults; Joormann & Gotlib, 2008; Joormann, Levens, & Gotlib, 2011), difficulties with goal-setting and strategic problem solving (in youth; Brody & Ge, 2001), compromised inhibition or related problems such as poor effortful/inhibitory control (in youth; Lengua, 2006; Rudolph, Troop-Gordon, & Llewellyn, 2013), and cognitive inflexibility (in youth; for example, rumination; Nolen-Hoeksema et al., 2007; Roelofs et al., 2009) with depression concurrently and, to a lesser extent, over time. Only a small amount of research has investigated the idea that EF deficits moderate the effects of stress on depression. Social problem-solving abilities (part of the planning/organization dimension; Normandeau & Guay, 1998) moderate the concurrent (Goodman, Gravitt, & Kaslow, 1995) and prospective (Nezu & Ronan, 1988) link between stressful life events and depressive symptoms in youth and young adults. Moreover, poor self-regulation (a composite of attention regulation, inhibition, and impulsivity) moderates the concurrent association between stressful life events and internalizing symptoms in youth (Lengua, 2002; Lengua & Long, 2002). Drawing from theoretical perspectives on EF and this limited research base, we anticipated that exposure to peer stress would more strongly predict heightened subsequent depression in youth with poor EF. This study adds to prior research by examining the role of EF as a moderator of the longitudinal association between cumulative peer stress across several years and subsequent depressive symptoms in early adolescence.

Sex Differences

We also anticipated sex differences in the interactive contribution of peer stress and EF deficits to depression. In light of girls' stronger need for interpersonal connectedness and affiliation compared with that of boys (Rose & Rudolph, 2006), exposure to peer stress may threaten girls' sense of self-worth, leading to more negative self-evaluation, sad affect, hopelessness, and consequent depression in girls than in boys (Rudolph, 2009). Moreover, girls with EF deficits may have particular difficulty managing their emotions and be particularly prone to engaging in maladaptive cognitive (e.g., rumination; Roelofs et al., 2009) and behavioral (e.g., co-rumination; Rose, 2002) reactions to peer stress, thereby heightening their vulnerability to depression. Finally, maladaptive cognitive and behavioral responses to stress that may arise from poor EF predict depression more strongly in girls than in boys (Agoston & Rudolph, 2011; Hilt, McLaughlin, & Nolen-Hoeksema, 2010;

Prinstein et al., 2005). We therefore predicted that peer stress, as well as the interaction between peer stress and EF deficits, would predict subsequent depression more strongly in girls than in boys.

Study Overview

Addressing significant gaps in our understanding of how EF deficits contribute to early adolescents' reactions to peer stress, this study used a prospective design to test the hypothesis that cumulative exposure to peer stress across childhood (second-fifth grades) would interact with EF deficits to predict depression in early adolescence (sixth grade). Effects were investigated over a critical developmental period during which the peer context begins to assume an increasingly salient role in children's lives (Parker et al., 2006) and individual differences in EF have already emerged (Best, Miller, & Jones, 2009). We hypothesized that peer stress would predict subsequent depression more strongly in youth, particularly girls, with more EF deficits than in youth with fewer EF deficits.

To assess depression, we used a semi-structured diagnostic interview tapping symptoms of major depression disorder and dysthymia. To assess EF deficits, we used teacher ratings on the Behavior Rating Scale of Executive Function (BRIEF), which taps typical performance in several domains of EF and is sensitive to EF difficulties encountered in everyday life (Denckla, 2002). This measure differs from performance-based tasks, which are thought to measure maximal or optimal EF performance, typically assessed under highly standardized, "cold" conditions (Toplak, West, & Stanovich, 2013). Of note, difficulties in everyday use of EF skills may exert a stronger impact on emotional adjustment than those demonstrated during objective, time-limited, performance-based tasks, particularly when youth are exposed to ongoing peer stress.

We also considered several possible confounding variables. Research documents associations among low socioeconomic status (SES), stressful life events (Bradley & Corwyn, 2002), and internalizing symptoms (Keiley, Lofthouse, Bates, Dodge, & Petit, 2003) as well as between cognitive ability and EF (Friedman et al., 2008). To ensure that our findings were not better accounted for by SES or cognitive capacity, our analyses adjusted for SES as well as teacher ratings of academic performance, a proxy for cognitive ability. Moreover, because some items on the BRIEF mapped onto the temperamental construct of negative emotionality (e.g., "Acts upset by a change of plans." "Becomes upset with new situations."), which also is associated with depression (Sugimura & Rudolph, 2012), our analyses adjusted for levels of youths' negative emotionality.

In sum, we used a rigorous longitudinal design, adjusting for potential confounding factors, which provided the opportunity to contribute novel information about the interactive influence of cumulative peer stress and EF deficits to depression during early adolescence. Thus, this study built on prior research examining the concurrent links between EF deficits and depression and the small body of research examining moderators of the association between peer stress and depression. This research also addressed the key question of whether girls are particularly susceptible to the amplifying effects of EF deficits on the peer

stress-depression link, with the potential to help explain rising rates of depression during adolescence in girls.

Method

Participants and Procedures

Participants included 494 youth (267 girls, 227 boys; $\bar{X}_{age}$ in second grade = 7.95, *SD* = .37) and their teachers. Youth were from various ethnic groups (66.4% White, 33.6% minority) and were diverse in socioeconomic class (37.8% received a subsidized school lunch). Consent forms were distributed to families of 724 second graders across schools in several Midwestern towns. Of the original families, 80% (576) consented to participate, and an additional 60 third graders were added the following year for a total of 636 participants. Parents provided written consent for youth and teachers to participate, and youth provided verbal assent. Of the 636 families, 494 (78%) participated in a diagnostic interview in sixth grade. Participants and nonparticipants in the interview did not differ in sex, $\chi^2(1) = .73$, *ns*, or ethnicity, $\chi^2(1) = .07$, *ns*. Compared with participants, nonparticipants were slightly older ($\bar{X} = 12.02$, *SD* = .38 vs. $\bar{X} = 11.94$, *SD* = .40), $t(634) = 2.30$, $p < .05$, and less likely to have subsidized lunch, $\chi^2(1) = 7.19$, $p < .01$, but the subsample still included a socioeconomically diverse sample representative of the geographical area.

The study involved five annual assessments from the second (Wave 1 [W_1]) through sixth (Wave 5 [W_5]) grade. Of the 494 participants with diagnostic interviews at W_5, 446 had child reports of depressive symptoms at W_1; 486 had child reports of stressful peer events at W_1, W_2, W_3, or W_4; and 483 had teacher reports of EF at W_5. Youth with complete data on all measures ($n = 417$) did not significantly differ from those missing data on any measure at any wave in sex, $\chi^2(1) = .02$, *ns*; ethnicity, $\chi^2(1) = .67$, *ns*; subsidized lunch, $\chi^2(1) = 3.54$, *ns*; stress at W_1, $t(444) = .48$, *ns*; W_2, $t(481) = .95$, *ns*; W_3, $t(474) = 1.91$, *ns*; or W_4, $t(484) = .47$, *ns*; EF deficits, $t(481) = .53$, *ns*; W_1 depression, $t(444) = .81$, *ns*; or W_5 depression, $t(492) = -.11$, *ns*. Compared with youth with complete data, youth with missing data were slightly older at W_5 ($\bar{X} = 12.08$, *SD* = .54 vs. $\bar{X} = 11.91$, *SD* = .36), $t(492) = 3.37$, $p < .01$. Data imputation was conducted using a linear regression approach within the Missing Value Analysis module in *SPSS Statistics Version 20* to estimate missing values for all variables.

In the winter of the second to fifth grades, graduate/undergraduate students and trained project staff administered questionnaires assessing peer stress to groups of three to four students as youth recorded responses. Questionnaires were mailed to youth who moved from the area and were usually completed at school with teacher supervision. In sixth grade, teachers completed surveys of academic performance and EF, and youth completed in-person or telephone interviews of depression. Youth received small gifts for questionnaire completion and gift cards for completion of the diagnostic interview. Teachers received monetary reimbursements for completed surveys and honorariums for participating classrooms.

Measures

Table 1 displays descriptive statistics, psychometrics, and intercorrelations for the measures.

Stressful peer events—In second to fifth grade (W_1–W_4), youth completed a measure of their cumulative exposure to negative events within the peer domain. Three items (e.g., "A friend died.") and a rating scale for appraisal of events were adapted from a prior life events inventory (Robinson, Garber, & Hilsman, 1995). Four items (e.g., "You had a physical fight with another kid.") were taken from another life events inventory (Rudolph, Lambert, Clark, & Kurlakowsky, 2001) that modified several questions from the original measure (Robinson et al., 1995) to be relevant to peers. Several new items were created to tap additional stressful peer events (e.g., "You were not invited to a party that you wanted to go to."). The final measure included 13 items assessing exposure to stressful peer events since the beginning of the school year. Youth circled *Yes* or *No* to indicate whether the event happened to them and, if so, checked a box indicating "How bad was it for you?" (1 = *not bad at all* to 5 = *horrible*). To reduce response bias and obtain an estimate of objective stress levels, scores were computed by multiplying each event endorsed by the average severity rating for all participants experiencing the event. The sum of endorsed events, weighted by their average severity, was totaled across second to fifth grades such that higher scores represented more cumulative peer stress exposure in elementary school. Life events checklists are reliable (e.g., Johnson & McCutcheon, 1980), and validity has been demonstrated for life event inventories forming the basis of this measure (e.g., Rudolph et al., 2001) and for life event checklists in the peer domain (Aseltine et al., 1994; Sontag et al., 2008).

Executive function—In sixth grade (W_5), teachers completed four subscales of the BRIEF (Gioia et al., 2000b) to assess behavioral manifestations of EF. The original measure includes 86 items separated into eight clinical and two validity scales. Four subscales were selected for this study based on hypotheses about relevant aspects of EF: Working Memory (10 items; for example, "Forgets what he/she is doing."); Plan/Organize (12 items; for example, "Does not plan ahead for school assignments."); Inhibit (10 items; for example, "Has trouble putting the brakes on his/her actions."); and Shift (8 items; for example, "Thinks too much about the same topic."). Each item was rated on a 3-point scale (1 = *never a problem* to 3 = *often a problem*). This measure has strong internal consistency (Gioia & Isquith, 2004) and inter-rater and test-retest reliability (Gioia, Isquith, Guy, & Kenworthy, 2000a). The BRIEF also shows strong ecological validity (Denckla, 2002) and construct validity, including high convergent and divergent validity for the full measure (Gioia et al., 2000a, 2000b) and the subscale scores (e.g., Joyner, Silver, & Stavinoha, 2009; Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010). Factor analyses (e.g., Gioia & Isquith, 2004) support the subscales for both community and clinical samples (Gioia & Isquith, 2004; Gioia et al., 2000b; Reddy, Hale, & Brodzinsky, 2011; Slick, Lautzenhiser, Sherman, & Eyrl, 2006), as well as across both parent and teacher reports (Gioia, Isquith, Retzlaff, & Espy, 2002). Finally, the measure has been validated in preschoolage children to adults (e.g., Christ, Kanne, & Reiersen, 2010). Because of the high intercorrelations among the subscales (rs = .52–.92, ps < .001), a mean composite EF score was calculated as the average of the subscale scores.

Clinical assessment of depression—In sixth grade (W_5), trained graduate students and a post-BA-level research assistant administered an interview modified from the Mini-

International Neuropsychiatric Interview for Children and Adolescents (MINI-KID), a structured clinical interview yielding diagnoses of psychiatric disorders according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) or the International Statistical Classification of Diseases and Related Health Problems (10th revision, ICD-10; Sheehan et al., 1998). The interview has high reliability and high correspondence (Sheehan et al., 2010) with the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version-5 (K-SADS-E; Orvaschel, 1995). Interviewers assessed for symptoms of major depressive disorder (MDD) and dysthymic disorder (DD) within the past year. The MINI-KID was modified to allow interviewers to ask detailed follow-up questions about the timing, duration, and context of symptoms. Interviewers rated each symptom on a scale modified from a yes/no criterion to a 2-point scale to enable ratings of subthreshold severity: 0 = symptom absent, 1 = symptom present at subthreshold levels (i.e., failed to meet required threshold for duration or severity under *DSM-IV* criteria), 2 = symptom present at diagnostic levels. Finally, several categories of symptoms were divided into two separate prompts to increase the range of reported number and severity of symptoms. For example, cognitive symptoms of major depression consisted of separate prompts for low self-worth and excessive/inappropriate guilt, allowing participants to endorse none, one, or both symptoms at either threshold or subthreshold severity. The modified interview was administered individually to youth (and some caregivers[1]) to assess youths' levels of depression.

Coding took place through consultation with a clinical psychology faculty member. Symptom ratings were summed within each diagnosis (and across multiple MDD episodes) and across diagnostic categories (MDD + DD) to create a single continuous depression score. Higher ratings reflected more severe symptoms within a single diagnosis and/or presence of symptoms from separate episodes and/or separate depressive disorders (for a similar approach, see Hammen, Shih, Altman, & Brennan, 2003). Supporting the use of a continuous index, contemporary conceptualizations, derived in part from taxometric analyses, suggest depression is best represented on a dimensional continuum (Hankin, Fraley, Lahey, & Waldman, 2005). Providing evidence for concurrent validity, continuous scores for depression were significantly correlated ($r = .73$, $p < .001$) with self-reports on the Short Mood and Feelings Questionnaire (SMFQ; Angold, Costello, Messer, & Pickles, 1995). Independent coding of 119 interviews by an advanced graduate student in clinical psychology yielded strong inter-rater reliability (one-way random-effects Intraclass Correlation Coefficient = .94).

Self-report of depression—Because clinical interview data were not available in second grade (W_1), a self-report measure of depressive symptoms was used to adjust for prior levels of depression. Youth completed the SMFQ (Angold et al., 1995), which includes 13 items assessing depressive symptoms (e.g., "I felt unhappy or miserable."). The scoring format was modified from a 3- to 4-point scale (1 = *not at all* to 4 = *very much*) to provide a format

[1]A number of youth were unwilling to provide information or provided incomplete information. In these cases, caregivers were interviewed instead of, or in addition to, youth. Of the 494 participants, 474 were administered to youth only, 30 were administered to caregivers only, and 8 were administered to both youth and caregivers. For interviews in which both types of data were available, consensual diagnoses were assigned using a best-estimate approach (Klein, Ouimette, Kelly, Ferro, & Riso, 1994).

similar to other study questionnaires (see also Lau & Eley, 2008). Scores were computed as the mean of items. This measure shows significant correlations with the Children's Depression Inventory and the Diagnostic Interview Schedule for Children (Angold et al., 1995), and differentiates depression from other psychiatric disorders (Thapar & McGuffin, 1998).

Academic performance—In sixth grade (W_5), teachers provided ratings of youths' academic performance in four specific subject areas (English, Math, Science, and Social Studies). Each item was rated on a 5-point scale (1 = *far below grade level* to 5 = *far above grade level*). Scores were computed as the mean of ratings across subject areas, with higher scores reflecting better performance compared with the expected level for sixth grade.

Negative emotionality—In sixth grade (W_5), youth completed the negative emotionality subscale of the Temperament in Middle Childhood Questionnaire (Simonds, Kieras, Rueda, & Rothbart, 2007). The measure includes 25 items that assess susceptibility to experiencing heightened negative emotions, including sadness (10 items; for example, "I become tearful when I'm tired.") and anger (7 items; for example, "I get angry when I have trouble with a task."), and difficulty being soothed once aroused (8 items; for example, "I have a hard time calming down when I am upset."). Youth checked a box that best described their behavior on a 5-point scale (1 = *almost always untrue* to 5 = *almost always true*). Scores for negative emotionality were computed by averaging the means of the three subscales. This measure has high reliability and stability (Rothbart, Ahadi, Hershey, & Fisher, 2001) and demonstrates significant correlations with parent reports of negative emotionality (e.g., Lengua, 2003), behavioral observations of youth (Wilson, 2006), and computer assessments (Simonds et al., 2007). Factor analyses of the negative emotionality subscale demonstrate a unitary structure and factorial invariance over time, and also support a distinction between negative emotionality and related constructs, such as depression (Sugimura & Rudolph, 2012). Divergent validity is further supported by minimal content overlap with measures of depressive symptoms (e.g., the SMFQ; Angold et al., 1995), as well as differential stability of constructs, with negative emotionality demonstrating higher stability than depressive symptoms (Sugimura & Rudolph, 2012).

Data Analytic Approach

For descriptive purposes, we conducted a series of *t* tests to examine sex differences in the key variables of interest and we examined intercorrelations among the variables. To address our primary hypothesis, we conducted a hierarchical multiple regression analysis predicting sixth-grade depression, adjusting for initial levels of depression as well as lunch status, academic performance, and negative emotionality. Predictors and covariates were mean-centered before entry into the analysis and calculation of the interaction terms. Covariates (W_1 depression, lunch status, W_5 academic performance, and W_5 negative emotionality) were entered at the first step, main effects (peer stress, EF, and sex) were entered at the second step, two-way interactions (Stress × EF, EF × Sex, Stress × Sex) were entered at the third step, and three-way interactions (Stress × EF × Sex) were entered at the fourth step. Significant three-way interactions were interpreted using the slopes difference test outlined by Dawson and Richter (2006) calculated for the following contrasts: girls versus boys at

higher (+1 *SD*) levels of EF, girls versus boys at lower (−1 *SD*) levels of EF, higher versus lower EF within girls only, and higher versus lower EF within boys only. Unstandardized regression equations were decomposed and graphed by solving for peer stress predicting depression at higher and lower levels of EF.

Results

Descriptive Analyses

Table 1 presents descriptive and psychometric data and intercorrelations among the variables in girls and boys. Compared with boys, girls showed significantly higher levels of W_5 negative emotionality ($t = 4.15$, $p < .001$, $d = .38$) and W_5 depression ($t = 3.19$, $p = .002$, $d = .29$). Compared with girls, boys showed significantly more EF deficits ($t = 4.09$, $p < .001$, $d = .37$). No significant sex differences were found for W_1 depression ($t = .92$, $p = .36$), lunch status ($t = 1.18$, $p = .24$), W_5 academic performance ($t = .25$, $p = .80$), or W_1 to W_4 peer stress ($t = .99$, $p = .32$). In girls, there were significant positive correlations between peer stress and EF deficits, peer stress and W_5 depression, and EF deficits and W_5 depression. In boys, there was a significant correlation between peer stress and EF deficits but not between these variables and depression.

Regression Analysis

The regression analysis revealed significant positive main effects of W_1 depression, W_5 negative emotionality, peer stress, and sex, a significant Peer stress × Sex interaction, and a significant Peer stress × EF × Sex interaction (Table 2). As shown in Figure 1, decomposition of the significant peer stress × sex interaction revealed that higher levels of peer stress predicted more depression in girls (B = .06, $t = 4.29$, $p < .001$), but not boys (B = .01, $t = .54$, $p = .59$).

As shown in Figure 2, decomposition of the significant Peer stress × EF × Sex interaction revealed that peer stress predicted more depressive symptoms in girls ($B = .07$, $t = 4.35$, $p < .001$) but not boys ($B = -.01$, $t = -.59$, $p = .55$) with higher EF deficits, with a significantly stronger effect for girls than boys (slope difference test: $t = 3.50$, $p = .001$). In addition, peer stress significantly predicted depressive symptoms in girls ($B = .04$, $t = 2.48$, $p = .01$) but not boys ($B = .03$, $t = 1.52$, $p = .13$) with lower EF deficits, with no significant difference in effects between sexes (slope difference test: $t = .38$, $p = .71$). There were no significant differences at higher versus lower levels of EF deficits within girls ($t = 1.59$, $p = .11$) or boys ($t = -1.61$, $p = .11$).

Discussion

Although exposure to peer stress can serve as a risk factor for subsequent depression, some youth are more vulnerable whereas others are more resilient to these adverse effects. Using a longitudinal design tracking youth from middle childhood through early adolescence, this research provided evidence that youths' levels of EF, as reflected in observed performance during everyday situations, moderated the contribution of cumulative peer stress during childhood (second-fifth grades) to subsequent depression in early adolescence (sixth grade).

The interactive contribution of peer stress and EF deficits to depression differed across sex, with significantly stronger effects in girls than in boys.

Effects of Peer Stress

As anticipated, cumulative peer stress across childhood significantly contributed to depression in early adolescence, adjusting for earlier symptoms. These findings are consistent with previous research documenting concurrent (Rudolph, 2002) and prospective (Aseltine et al., 1994; Hankin et al., 2007) linkages between peer stress and depression in youth. This study confirms the robust nature of this effect, which held after adjusting for demographic (SES), cognitive (academic performance), and temperamental (negative emotionality) variables. Thus, exposure to peer stress is a particularly salient risk factor for depression during this developmental period.

Also as expected, a significant two-way interaction between peer stress and sex revealed that heightened stress significantly predicted subsequent depression in girls but not boys. Girls' stronger emphasis on interpersonal connectedness and greater concerns about peer evaluation and relationship disruption relative to boys (Rose & Rudolph, 2006; Rudolph, 2002) likely amplify their sensitivity to peer stress, resulting in negative self-evaluation, sad affect, and other symptoms of depression. This study adds to a growing body of research documenting the role of peer stress, and interpersonal stress more generally, as a potent risk factor for depression in adolescent girls (Hankin et al., 2007; Rudolph, 2002; Rudolph, Flynn, Abaied, Groot, & Thompson, 2009; Rudolph & Hammen, 1999).

Moderation by Executive Function Deficits

The primary goal of this research was to examine whether EF deficits amplified the contribution of cumulative peer stress to early adolescent depression, particularly in girls. Supporting this hypothesis, a significant three-way Stress × EF deficits × Sex interaction was found such that peer stress predicted more subsequent depression in girls but not boys with heightened EF deficits. EF deficits may limit youths' processing resources, cause them to become easily overwhelmed by emotion, and hinder them from placing stressful events in context and generating purposeful coping attempts. EF deficits also may foster impulsive, dysregulated responses to stress and lead to excessive focus on problems, both internally (e.g., rumination) and in the context of interpersonal interactions (e.g., co-rumination). These deficits may suppress adaptive stress responses (e.g., planful problem solving, effective emotion regulation, healthy support seeking) and exacerbate maladaptive patterns of responding (e.g., emotional and physiological arousal, rumination, impulsive action), thereby heightening vulnerability to depression.

Moderation by Sex

EF deficits may play a particularly salient role in moderating the effects of peer stress in girls relative to boys for several reasons. First, girls place a stronger value on interpersonal connectedness than do boys (Rose & Rudolph, 2006); peer stress may therefore threaten girls' sense of self-worth and lead to more emotional arousal. These patterns may be amplified in the context of poor EF. Second, impulsive and uninhibited responses to stress stemming from EF deficits are more normative in boys than in girls (Tiet, Wasserman,

Loeber, McReynolds, & Miller, 2001); thus, girls exhibiting these behaviors may elicit peer disapproval and rejection, heightening their risk for depression. Third, girls engage in more maladaptive cognitive (e.g., rumination; Roelofs et al., 2009) and behavioral (e.g., co-rumination; Rose, 2002) responses to stress than do boys, which may be exacerbated by EF deficits. These responses to stress also contribute more strongly to depression in girls than in boys (Agoston & Rudolph, 2011; Hilt et al., 2010; Prinstein et al., 2005; Rose, 2002), potentially accounting for why girls with EF deficits may be more likely than boys to develop depression following exposure to cumulative peer stress.

Overall, minimal research has examined whether EF deficits (or related constructs) moderate the contribution of peer stress to depression. Our results are consistent with the few prior studies suggesting such effects in youth (e.g., Goodman et al., 1995; Lengua, 2002; Lengua & Long, 2002) and young adults (Nezu & Ronan, 1988) but build on prior research in several ways. First, we used teacher reports to assess behaviors reflecting EF difficulties in everyday life rather than relying on self-reports of responses to hypothetical scenarios (e.g., Goodman et al., 1995; Nezu & Ronan, 1988). Second, whereas most prior research examined concurrent associations (e.g., Goodman et al., 1995; Lengua, 2002; Lengua & Long, 2002), we used a prospective longitudinal design to examine effects of cumulative childhood stress on adolescent depression, providing a clearer understanding of early antecedents to adolescent depression. Third, we examined (and documented) sex differences in the moderating effects of EF deficits, contributing to possible explanations for the observed heightened vulnerability to depression in adolescent girls.

Implications for Theory, Research, and Practice

The present research contributes to theoretical models aiming to understand how individual and interpersonal risks interact to heighten risk for adolescent depression, especially in girls (Cyranowski, Frank, Young, & Shear, 2000; Nolen-Hoeksema & Girgus, 1994; Rudolph, 2009; Rudolph & Flynn, 2014; Rudolph, Hammen, & Daley, 2006). In particular, this study elucidates the moderating role of EF deficits and lays the foundation for future research exploring mechanisms explaining the role of EF deficits in adolescent depression.

This study also reveals potential points of intervention for preventing depression in girls. Interventions targeting EF deficits, such as EF coaching in elementary school, may help girls maintain a positive trajectory and reduce negative outcomes after experiencing stressful peer events. Addressing EF deficits may be effective in promoting more competent cognitive and behavioral responses in girls facing peer stress, thereby reducing further disruption in their relationships and consequent vulnerability to future depression.

Limitations and Future Directions

Despite these contributions, several limitations should be noted. First, although a significant minority of youth (34.6%) reported at least one symptom of depression, the use of a community sample restricted the severity of depressive symptoms. In light of evidence for the dimensional nature of depression (Hankin et al., 2005), replication, and perhaps even more robust findings, would be expected in youth with severe symptoms. However, future research needs to test the generalizability of these findings.

Second, our measure of EF involved teacher reports of typical behavior rather than performance-based measures (i.e., computer tasks). On the one hand, teacher reports are sensitive to EF difficulties encountered in everyday life (Denckla, 2002) and thus may best reflect the active role of EF in moderating responses to peer stressors. Moreover, teacher ratings of EF have established validity (e.g., Gioia & Isquith, 2004; Gioia et al., 2000b). On the other hand, the use of this measure may have restricted our ability to identify the distinct role of particular EF processes. Notably, performance-based EF tasks are not uniquely correlated with domains on the BRIEF (Alloway et al., 2009; Anderson et al., 2002; Mahone et al., 2002; Toplak, Bucciarelli, Jain, & Tannock, 2009), so we might find different results when using such measures. In addition, the BRIEF does not measure maximal, or optimal, EF performance (Toplak et al., 2013); it is possible that youth mobilize EF reserves when responding to peer stressors, although teacher reports likely incorporate how youth deal with everyday stressful situations. Overall, it would be useful for future studies to examine these processes using performance-based measures of EF to determine whether similar findings emerge when tapping typical versus optimal performance.

An additional area of interest for future study is the specificity of these findings to cumulative peer stress. We speculated that girls would be particularly sensitive to peer stress and that EF deficits would interfere with girls' ability to cope effectively with peer stress, resulting in heightened risk for depression. It is possible that heightened risk in boys would emerge in other domains, such as academic or other noninterpersonal stressors, in light of evidence for stronger associations between these types of stressors and depression in boys than in girls (e.g., Sund, Larsson, & Wichstrom, 2003).

Finally, it would be fruitful to identify the precise pathways through which EF deficits amplify depressive responses to peer stress. For example, EF deficits predict poorer social-emotional competence (e.g., Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008), biases in processing social information (e.g., Muris, Meesters, & Rompelberg, 2006), and compromised coping (e.g., Lengua & Long, 2002). Disruption of these processes may help to account for why stress contributes to subsequent depression in youth with such deficits.

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Biographies

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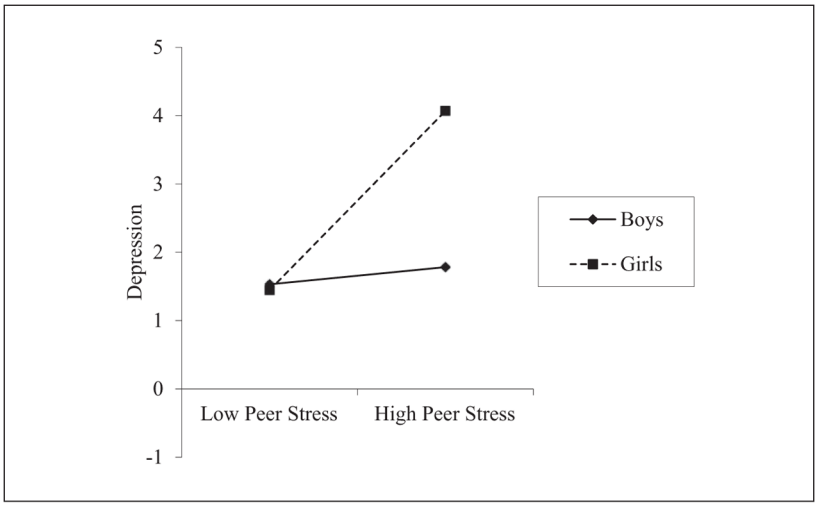

Figure 1.

The interactive contribution of peer stress and sex to W_5 depressive symptoms, adjusting for W_1 depressive symptoms, W_1 lunch status, W_5 academic performance, and W_5 negative emotionality.

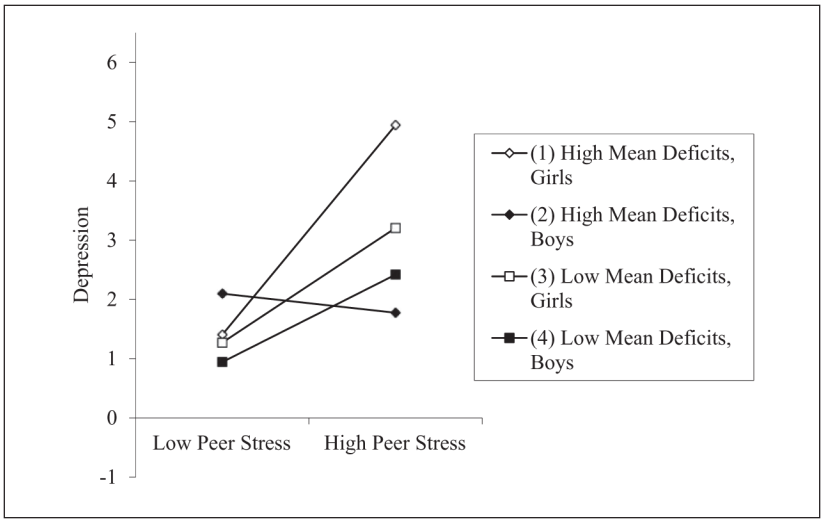

Figure 2.

The interactive contribution of peer stress and EF deficits to W_5 depressive symptoms in girls and boys, adjusting for W_1 depressive symptoms, W_1 lunch status, W_5 academic performance, and W_5 negative emotionality.

Table 1

Descriptives and Intercorrelations Among the Variables.

	Girls			Boys										
Measure	$\bar{X}^a$	SD^a	$\bar{X}^b$	$\bar{X}^a$	SD^a	$\bar{X}^b$	α	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. W_1 depression	1.75	0.68	1.77	1.69	0.66	1.70	.88	—	$.13^{\dagger}$	$-.30^{***}$	$.23^{***}$	$.32^{***}$	$.19^{**}$	$.23^{***}$
2. W_1 lunch status	0.40	0.49	0.40	0.35	0.48	0.35	—	.05	—	$-.40^{***}$	$.17^{**}$	$.16^{*}$	$.42^{***}$	.03
3. W_5 academic performance	3.22	0.96	3.20	3.19	0.98	3.19	.96	$-.24^{***}$	$-.43^{***}$	—	$-.28^{***}$	$-.14^{*}$	$-.58^{***}$	$-.16^{*}$
4. W_5 negative emotionality	2.61	0.77	2.61	2.34	0.64	2.34	.92	$.15^{*}$	$.16^{*}$	$-.18^{**}$	—	$.29^{***}$	$.27^{***}$	$.42^{***}$
5. W_1–W_4 peer stress	56.19	24.88	56.19	58.41	24.91	58.41	—	$.18^{*}$	$.12^{\dagger}$	$-.18^{**}$	$.19^{**}$	—	$.19^{**}$	$.31^{***}$
6. W_5 EF deficits	1.30	0.40	1.30	1.46	0.47	1.46	.98	$.13^{\dagger}$	$.34^{***}$	$-.63^{***}$	$.26^{***}$	$.27^{***}$	—	$.19^{**}$
7. W_5 depressive symptoms	2.82	5.87	2.82	1.44	3.12	1.44	.94	.11	−.03	$-.20^{**}$	.08	$.12^{\dagger}$	$.12^{\dagger}$	—

Note. Correlations above the diagonal are for girls; correlations below the diagonal are for boys. Lunch status is coded 0 = full price, 1 = reduced price/free.

[a]Calculated from original data.

[b]Calculated from imputed data.

$^{\dagger}p < .10$.

$^{*}p < .05$.

$^{**}p < .01$.

$^{***}p < .001$.

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Table 2

Hierarchical Linear Regressions Predicting Sixth-Grade Depression.

	B **(unstandardized)**[a]	**β (standardized)**[b]	***t***[a]
Step 1			
W_1 depression	0.72	.11	2.18*
W_1 lunch status	−0.71	−.09	−1.52
W_5 academic performance	−0.47	−.07	−1.94†
W_5 negative emotionality	2.07	.30	6.92***
Step 2			
W_1–W_4 peer stress	0.03	.19	3.39**
W_5 EF deficits	0.39	−.03	0.64
Sex (0 = boys, 1 = girls)	1.06	.12	2.49*
Step 3			
Peer stress × EF	0.00	.01	−0.01
EF × Sex	1.32	.07	1.39
Peer stress × Sex	0.05	.17	2.83**
Step 4			
Peer stress × EF × Sex	0.08	.18	2.36*

[a] Calculated from imputed data.

[b] Calculated from original data.

† $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.