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Stress Reactivity as a Pathway from Attentional Control Deficits in Everyday Life to Depressive Symptoms in Adolescent Girls

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Abstract The goal of this research was to expand theoretical models of adolescent depression to determine whether individual differences in cognitive processing—specifically attentional control deficits—help to explain increased risk for depression during adolescence. We also examined whether this pathway was stronger in girls than in boys. A longitudinal design was used to examine whether poor attentional control in everyday life (i.e., difficulties shifting between ideas, tasks, and activities) contributes to depression over time by fostering higher levels of stress reactivity. Youth (298 boys, 338 girls) completed questionnaires assessing stress reactivity (6th and 7th grades) and depressive symptoms (6th, 7th and, 8th grades); teachers completed the shifting subscale of the Behavior Rating Scale of Executive Function (Gioia et al. 2000a) to assess attentional control (6th and 7th grades). Structural equation modeling analyses provided support for the predicted pathway in girls but not boys, yielding a significant indirect effect from 6th grade shifting deficits to 8th grade depressive symptoms via 7th grade stress reactivity. These results suggest that attentional control deficits in early adolescence heighten girls' sensitivity to stress and consequent depressive symptoms, providing a critical direction for efforts to decrease adolescent girls' risk for depression.

Keywords Attentional control · Stress reactivity · Depression · Gender

Adolescence is a stage of heightened risk for depression, particularly in girls (Hankin and Abramson 2001; Hyde et al. 2008; Rudolph 2009). Why adolescents in general, and girls in particular, show a dramatic rise in depression is a focus of much attention and concern, with significant implications for efforts to identify, prevent, and treat depression before it exerts debilitating effects on youths' development and sets the stage for lifelong impairment. Prior research attempting to solve this puzzle has considered a range of risk factors, many of which are more common or salient in girls, including heightened biological (Gunnar et al. 2009) and neural (Guyer et al. 2009) sensitivity, puberty-related risks (Rudolph 2014), emotional vulnerability (Charbonneau et al. 2009; for a review, see Hyde et al. 2008), and exposure and reactivity to social stress (Hankin et al. 2007; Rudolph 2002, 2009; Shih et al. 2006). In this research, we sought to build on existing theoretical models and a growing body of empirical data to determine the role of cognitive processing, specifically poor attentional control, as a domain of risk. In particular, we examined whether attentional control deficits, as reflected in everyday manifestations of cognitive inflexibility, contribute to elevated risk for depression during early adolescence. Moreover, we attempted to identify one potential pathway—namely heightened reactivity to interpersonal stress—through which attentional control deficits prospectively contribute to depressive symptoms and we examined whether this pathway is more robust in girls.

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Conceptualizing Attentional Control and Its Link to Depression

Attentional control is one dimension of executive function, a set of cognitive processes that regulate thoughts, feelings, and actions (Barkley 1997; Miyake et al. 2000). In particular, attentional control involves the ability to focus and shift attention as needed, flexibly attend to particular tasks or goals, and shift between mental sets (i.e., disengage from irrelevant task sets; engage in relevant task sets; Banich 2009; Miyake et al. 2000; Muris et al. 2008b; Whitmer and Gotlib 2012). Within the context of performance-based tasks, attentional control involves switching one's attentional set to respond to new information (e.g., changes in instructions or task demands; Banich 2009). Within the context of everyday life, attentional control may play a role in youths' broad capacity to control thoughts, emotions, and behaviors (Rueda et al. 2010) by helping maintain attention to, or switch attention between, tasks and activities (Miyake et al. 2000; Rothbart et al. 2000) in order to self-regulate and adapt to current contextual demands. Thus, deficits in attentional control may undermine youths' ability to effectively regulate cognition and emotion, thereby increasing risk for depression (Wilkinson and Goodyer 2006). Indeed, a growing body of research using diverse conceptualizations and assessment approaches suggests that individuals with attentional control deficits manifest higher levels of depression and associated internalizing symptoms, although research with adolescents is in its early stages.

One relevant line of investigation focuses on laboratory tasks of attentional control. This research reveals that depressed youth demonstrate deficits in their ability to switch attention relative to nondepressed youth (Gunther et al. 2011; Wilkinson and Goodyer 2006), particularly under emotionally valenced conditions such as switching attentional set away from a sad focus (Kyte et al. 2005). A recent meta-analysis confirms that adolescents with major depressive disorder (MDD) show significantly worse performance on shifting tasks than those without MDD (Wagner et al. 2015). Research with depressed adults reveals similar difficulties in set-shifting and associated attentional biases (for a review, see Joormann and Vanderlind 2014), with some research also suggesting specificity to attentional processes in the context of negative stimuli (Sanchez et al. 2013). Moreover, a few training studies suggest that improving cognitive control (Chambers et al. 2008; Siegle et al. 2007), including attentional switching abilities, reduces depressive symptoms in adults.

A second relevant line of investigation focuses on informant reports of attentional control as well as everyday executive function and related dimensions of temperament such as effortful control, typically measured as a composite of attentional control and inhibitory control (i.e., the ability to intentionally direct internal resources towards goals or to inhibit inappropriate behaviors; Rothbart and Bates 2006). Several studies have revealed that self-reports of attentional control deficits (e.g., focusing, shifting; Melendez et al. 2016; Muris et al. 2008a; Verstraeten et al. 2011) are concurrently associated with depressive symptoms. Research using broader self-, parent-, or teacher-report measures of executive function and effortful control that include items reflecting attentional control (e.g., shifting, distractibility, focus) also establishes concurrent (Agoston and Rudolph 2015; Hocking et al. 2011; Lengua 2002; Verstraeten et al. 2009) and prospective (Lengua 2006; Letkiewicz et al. 2014; Snyder and Hankin 2016) associations with depressive and internalizing symptoms.

Despite this preliminary evidence for linkages between attentional control deficits and depression, few longitudinal studies have examined whether poor attentional control predicts subsequent depression across early adolescence. Moreover, empirical studies of attentional control have yet to identify specific processes through which cognitive inflexibility conveys risk for depression (for a relevant study examining effortful control, see Snyder and Hankin 2016). Finally, minimal attention has been paid to whether there are gender differences in the contribution of attentional control deficits to depression. The present study used a prospective longitudinal design to (a) examine the role of stress reactivity as one explanatory mechanism linking attentional control (in the form of shifting attention) deficits to depression across adolescence: and (b) examine gender differences in this process.

Attentional Control Deficits as a Predictor of Heightened Stress Reactivity

Cognitive inflexibility or difficulty shifting attention may foster rigid thought patterns and perseveration on ineffective responses (Miyake 2000), particularly within demanding or stressful situations (De Lissnyder et al. 2012). Being able to shift attention away from stressors and accompanying negative emotions and toward coping efforts is vital to responding in a purposeful and effective manner (Compas et al. 2004). Thus, youth who have difficulty refocusing their attention may fail to engage in constructive efforts to resolve stressors (e.g., problem solving and emotion regulation), instead showing heightened involuntary stress reactivity marked by cognitive perseveration (e.g., dwelling on unpleasant thoughts and events) along with more intense and prolonged emotional and physiological arousal (Joormann and Vanderlind 2014). Indeed, several theoretical conceptualizations of coping and emotion regulation consider the role of attentional control processes in determining how individuals respond to stress and negative emotions.

Whitmer and Gotlib's (2012) attentional scope model of depressive rumination proposes that dysfunctional attentional

control processes (i.e., a narrowing in attentional focus that results in a constricted array of thoughts, perceptions, and actions) contribute to individual differences in the tendency to engage in negative and repetitive thinking. In support of this model, they review evidence from several lines of research with adults demonstrating that poorer intentional suppression of irrelevant information, difficulty disengaging from no-longer relevant negative information, and impaired ability to shift attention are associated with depressive rumination, as reflected in repetitive brooding about negative personal concerns and/or about the implications, causes, and meanings of negative emotions (Altamirano et al. 2010; Davis and Nolen-Hoeksema 2000; cf. Wilkinson and Goodyer 2006, in adolescents).

Some theory and research focus more specifically on the role of attentional control over negative emotionally valenced stimuli and within stressful contexts (for a review, see Joormann and Vanderlind 2014). For example, Joormann and Vanderlind (2014) propose that deficits in cognitive control influence attention to emotion-eliciting aspects of events, which then undermine effective emotion regulation and responses to stress (see also Koster et al. 2011). Consistent with this idea, difficulty shifting attention away from negative emotional (but not non-emotional) stimuli predicts rumination (Demeyer et al. 2012), particularly in response to stress (De Lissnyder et al. 2012), demonstrating the importance of considering the role of attentional control in stress reactivity. Moreover, difficulties disengaging attention from negative stimuli are associated with heightened emotional reactivity in response to negative mood and stress induction in adults (Compton et al. 2000; Sanchez et al. 2013), whereas stronger switching abilities are associated with more effective emotion regulation (i.e., downregulation of negative affect) in response to a negative mood induction (Malooly et al. 2013). In two recent studies of youth, difficulty inhibiting negative emotional information on a switching task (Hilt et al. 2014) and difficulty disengaging attention from emotional stimuli (Hilt et al. 2016) were associated with trait depressive rumination. Providing more direct support for the idea that strong attentional control may diminish stress reactivity, cognitive bias training studies reveal that teaching individuals to disengage their attention from negative stimuli and to increase cognitive control reduces rumination (Siegle et al. 2014; Siegle et al. 2007) and reactivity to stressful events (for a review, see Joormann and Vanderlind 2014).

More broadly, theoretical accounts of temperament, executive function, and coping suggest that deficits in attentional control processes can impede adaptive emotion regulation, responses to stress, and more general social competence (Compas et al. 2004). For instance, self-reports and behavioral indices of stronger attentional and effortful control (including attentional focus) are positively associated with adaptive emotion regulation (Simonds et al. 2007) and inversely associated with rumination in youth (Hilt et al. 2012; Verstraeten et al. 2011) and young adults (White and Turner 2014). Moreover, poor attentional control (e.g., selective attention, shifting) is linked to heightened stress reactivity and maladaptive coping responses (Hocking et al. 2011; for a review, see Compas et al. 2004). Finally, teacher and parent reports of stronger attentional control (e.g., focus; Eisenberg et al. 2000; Rudasill and Konold 2008) and effortful control (including attentional focus, shifting; Spinrad et al. 2006) are associated with higher levels of social competence, which may facilitate responding to stressful peer experiences.

In sum, several theoretical perspectives and some empirical evidence suggest that attentional control deficits cause individuals to dwell on negative thoughts or emotions, particularly under conditions of stress, and may interfere with youths' ability to effectively navigate their social contexts. However, much of the prior evidence involves adults and uses concurrent research designs, making the direction of effect between attentional control difficulties and stress reactivity unclear. We therefore examined whether shifting deficits in the context of everyday life (e.g., impaired ability to disengage from certain topics or situations; difficulty transitioning between ideas or activities) would predict heightened stress reactivity over time in adolescents, as reflected in higher levels of emotional and physiological arousal, cognitive perseveration, and sensitivity to challenges and stressors.

Stress Reactivity and Depression

In turn, heightened stress reactivity may serve as a risk factor for subsequent depression. Involuntary, dysregulated stress responses intensify youths' negative emotions and undermine their ability to engage in adaptive coping responses that successfully address stressors (Agoston and Rudolph 2011; Compas et al. 2001; Flynn and Rudolph 2007, 2010; Troop-Gordon et al. 2015). Heightened negative emotions and failure to resolve stressors may lead to a sense of helplessness, low self-efficacy, and consequent depression. Maladaptive stress responses also may cause youth to generate new stressors, which then foster depression (Flynn and Rudolph 2011). Adolescence may be a period during which maladaptive stress responses play an especially strong role in depression given that youth start to face more stress, with girls exposed to particularly high levels of interpersonal stressors (Rudolph 2009). Indeed, several studies support the idea that heightened stress reactivity (in adults; Krueger et al. 1996; Lara et al. 1997; Miller et al. 2003) as well as involuntary cognitive (e.g., rumination; Abela and Hankin 2011; Nolen-Hoeksema et al. 2007; Rood et al. 2009), emotional (Charbonneau et al. 2009), and physiological (e.g., cortisol reactivity; for a review, see Guerry and Hastings 2011) engagement with stressors (Troop-Gordon et al. 2015) predict concurrent and subsequent depression in adolescence.

Gender Differences

A secondary goal of this study was to examine gender differences in the hypothesized pathway from attentional control deficits to depressive symptoms. During adolescence, girls are faced with particularly high levels of social stress (Rudolph 2009) and are more likely to engage in perseverative thinking (Jose and Brown 2008). This heightened stress exposure may place demands on girls' cognitive resources and amplify the link between attentional control and stress reactivity in girls relative to boys. In turn, perseverative thinking (Hilt et al. 2010; Stange et al. 2014) and maladaptive responses to stress (Agoston and Rudolph 2011) more strongly predict depression in adolescent girls than boys. Consistent with this idea, a recent study (Agoston and Rudolph 2015) revealed that exposure to peer stress predicted subsequent depression in adolescent girls but not boys with executive function deficits (including poor shifting), suggesting the need to consider potential gender differences in the risk posed by cognitive control deficits. Thus, we hypothesized that the path from attentional control deficits to depression via stress reactivity would be stronger in girls than in boys.

Alternative Directions of Effect

Although our primary focus was on the extent to which heightened stress reactivity accounts for the contribution of attentional control deficits to subsequent depressive symptoms, it also is reasonable to expect transactional processes. For example, engaging in more cognitive perseveration and involuntary reactions to stress can overload cognitive resources and thus interfere with attentional control processes (Watkins 2008); in one study, inducing state rumination interfered with depressed adults' ability to switch between two tasks (Whitmer and Gotlib 2013). Likewise, being in a negative mood can increase rumination (Moberly and Watkins 2008), suggesting a reciprocal relation between stress reactivity and depression. Thus, reciprocal influences among poor attentional control, heightened stress reactivity, and depressive symptoms may create a self-perpetuating cycle of impairment. Using a prospective longitudinal design allowed us to examine the direction of influence among these processes.

Study Overview

The overall goal of this study was to examine whether heightened stress reactivity serves as one pathway through which attentional control deficits contribute to subsequent depression across early adolescence. We focused on attentional control as reflected in behavioral manifestations of shifting in everyday life for several reasons. First, the dimension of shifting best matches with theoretical models focused on attentional control processes, stress reactivity, and depression (e.g., Whitmer & Gotlib's attentional scope model of depressive rumination; Joormann & Vanderlind's model of attentional control, rumination, and depressive symptoms). Second, because our measures of stress reactivity assessed cognitive, emotional, and physiological over-engagement with stressors (e.g., rumination, emotional/physiological arousal), cognitive inflexibility (i.e., poor shifting) seems most relevant as a risk factor for heightened reactivity. Third, we focused on manifestation of shifting in everyday life because it reflects the accumulation of cognitive deficits across time and situations. Studying attentional processes within laboratory settings is a critical part of identifying their role as a risk factor for psychopathology. However, performance-based tasks typically tap the ability to exert attentional control under optimal conditions (e.g., low emotions and stress; dampened investment in task outcomes), which can be viewed as attentional control *capacity*. These abilities may differ from typical or daily manifestations of attentional control, when cognitive resources may be taxed, motivation is high, and emotions often are intensified (Denckla 2002; Muris et al. 2008b), which can be viewed as attentional control *allocation*. To understand the role of daily behavioral manifestations of attentional control deficits, teachers provided information about general difficulties in the ability to shift attention as needed, engage in flexible problem solving, and cope effectively with new task demands and situations. Assessing these deficits in daily contexts likely taps into youths' allocation of attentional control.

A three-wave prospective longitudinal design was used to test the proposed pathway following youth from 6th through 8th grade, a critical developmental transition period during which rates of depression begin to rise, particularly in girls (Hankin and Abramson 2001). This design allowed us to examine the contributions of attentional control and stress reactivity to depressive symptoms over time, to identify bidirectional effects, and to adjust for prior and concurrent levels of depressive symptoms when examining the link between attentional control and stress reactivity. Moreover, we examined whether there were gender differences in the pathways of interest.

Method

Participants and Procedures

Participants were 636 youth (298 boys, 338 girls; *M* age at recruitment = 7.97 years, *SD* = .37; 66.7% White, 21.7% African American, 11.6% other; 34.7% received a subsidized school lunch) from several Midwestern towns. In 2nd grade, parents provided written consent, and youth provided oral assent. Of the 725 eligible children, 576 (80%) received

parental consent to participate. In 2nd grade, participants and nonparticipants did not significantly differ in gender, $\chi^2(1) = .15$, *ns;* age, $t(723) = .63$, *ns;* ethnicity (white vs. minority), $\chi^2(1) = .59$, *ns;* or school lunch status (full pay vs. subsidized), $\chi^2(1) = .35$, *ns*. In the 3rd grade, an additional 60 classmates of the participating children were recruited, yielding a total of 636 participants. Given our focus on the development of depressive symptoms during adolescence, the present analyses used data from the 6th, 7th, and 8th grades.

Of the original 636 participants, 548 (86%) had data on shifting deficits in 6th grade, 474 (75%) had data on stress reactivity in 7th grade, 470 (74%) had data on involuntary engagement in 7th grade, and 474 (75%) had data on depressive symptoms in 8th grade. Youth with 6th grade self-report or teacher-report data did not differ from those without data in gender, $\chi^2(1) = .02$, *ns;* age, $t(634) = 1.68$, *ns;* ethnicity (white vs. minority), $\chi^2(1) = 1.37$, *ns;* school lunch status (full pay vs. subsidized), $\chi^2(1) = .35$, *ns*; or 2nd grade depressive symptoms, $t(574) = .52$, *ns*. All of the participating 636 children were included in the central analyses (see Results).

All study procedures were approved by the university's Institutional Review Board. In the winter of each year, questionnaires were administered during two classroom sessions to groups of 15–20 students. Teachers returned their surveys to a locked box at their school, in person, or by mail. Youth received a small gift and teachers received a monetary reimbursement for participation; each participating middle school received a school-wide honorarium.

Measures

Table 1 presents descriptive data and reliability of the measures for girls and boys. All of the measures showed strong internal consistency across waves.

Attentional Control To assess attentional control in the 6th and 7th grades, teachers completed the shifting subscale of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al. 2000a). This measure assesses everyday behavioral manifestations of shifting deficits (8 items; e.g., "Thinks too much about the same topic." "Tries the same approach to a problem over and over, even when it does not work." "Has trouble getting used to new situations [classes, groups, friends]." "Resists or has trouble accepting a different way to solve a problem with schoolwork, friends, chores, etc."). Each item was rated on a 3-point scale (1 = *Never a Problem* to 3 = *Often a Problem*). Scores were calculated as the mean of the items, with higher scores reflecting more shifting deficits. The BRIEF has strong internal consistency (Gioia and Isquith 2004) and inter-rater and test-retest reliability (Gioia et al. 2000b). It also shows strong ecological validity (Denckla 2002) and construct validity, including high convergent and divergent validity for the full measure (Gioia et al. 2000a;

Table 1 Descriptive Information and Intercorrelations among the Variables

Measure	α	Girls		Boys		*d*	1	2	3	4	5	6	7	8	9
		M (*SD*)	Range	*M* (*SD*)	Range										
1. 6th Grade Shifting Deficits	0.90	1.20 (0.36)	1.00–3.00	1.26 (0.38)[a]	1.00–2.88	0.16	---	0.38**	0.16*	0.12	0.19**	0.07	0.14*	0.09	0.02
2. 7th Grade Shifting Deficits	0.89	1.16 (0.29)	1.00–2.75	1.25 (0.38)[b]	1.00–3.00	0.27	0.36**	---	0.22**	0.14*	0.12	0.04	0.12	0.13*	0.08
3. 6th Grade MPQ Stress Reactivity	0.84	0.36 (0.29)	0.00–1.00	0.30 (0.27)[b]	0.00–1.00	0.21	0.17**	0.25**	---	0.60**	0.61**	0.38**	0.56**	0.45**	0.39**
4. 7th Grade MPQ Stress Reactivity	0.83	0.35 (0.27)	0.00–1.00	0.27 (0.26)[b]	0.00–1.00	0.30	0.25**	0.28**	0.63**	---	0.47**	0.62**	0.46**	0.62**	0.51**
5. 6th Grade Involuntary Engagement	0.86	1.92 (0.67)	1.00–3.80	1.78 (0.57)[b]	1.00–4.00	0.23	0.13*	0.19**	0.69**	0.54**	---	0.44**	0.52**	0.39**	0.39**
6. 7th Grade Involuntary Engagement	0.86	1.91 (0.62)	1.00–3.80	1.66 (0.54)[b]	1.00–3.40	0.43	0.23**	0.16**	0.53**	0.67**	0.65**	---	0.35**	0.44**	0.38**
7. 6th Grade Depressive Symptoms	0.90	1.49 (0.55)	1.00–4.69	1.40 (0.44)[a]	1.00–3.69	0.18	0.16**	0.28**	0.70**	0.56**	0.61**	0.49**	---	0.42**	0.38**
8. 7th Grade Depressive Symptoms	0.89	1.45 (0.53)	1.00–3.92	1.32 (0.33)[b]	1.00–2.77	0.29	0.17**	0.22**	0.54**	0.65**	0.48**	0.54**	0.57**	---	0.53**
9. 8th Grade Depressive Symptoms	0.92	1.55 (0.61)	1.00–3.77	1.30 (0.31)[b]	1.00–2.62	0.50	0.23**	0.25**	0.44**	0.54**	0.43**	0.49**	0.50**	0.58**	---

Intercorrelations below the diagonal are in girls; intercorrelations above the diagonal are in boys

MPQ = Multidimensional Personality Questionnaire—Simplified-Wording Form. *$p < 0.05$. **$p < 0.01$

[a] Mean difference at $p < 0.05$. [b] Mean difference at $p < 0.01$

Gioia et al. 2000b) and the subscale scores (e.g., Joyner et al. 2009; Semrud-Clikeman et al. 2010). Factor analyses (e.g., Gioia and Isquith 2004) support the subscales for both community and clinical samples (Gioia et al. 2000a; Gioia and Isquith 2004; Reddy et al. 2011; Slick et al. 2006), as well as across both parent and teacher reports (Gioia et al. 2002). The measure has been validated in preschool-age children to adults (e.g., Christ et al. 2010).

Stress Reactivity To assess stress reactivity in the 6th and 7th grades, youth completed two measures. First, youth completed the stress reactivity subscale of the Multidimensional Personality Questionnaire—Simplified-Wording Form (MPQ-SF; Patrick et al. 2002; Patrick et al. 2013). This 12-item scale assesses youths' general tendency to be reactive to everyday stressors (e.g., "I am too sensitive for my own good." "Little hassles sometimes irritate me too much."). Youth checked a box indicating whether each item was True (1) or False (0) for them. Scores were computed as the mean of the items. The MPQ-SF items converge strongly with the original MPQ items and replicate the original factor structure; further, the MPQ-SF stress reactivity subscale demonstrates adequate internal consistency and both convergent and discriminant validity (Patrick et al. 2013).

Second, youth completed the involuntary engagement subscale of a revised version (Rudolph et al. 2011) of the Responses to Stress Questionnaire (Connor-Smith et al. 2000), modified to assess responses to peer stress (i.e., when other kids are mean). This subscale assesses youths' tendency to show automatic responses involving over-engagement with stressors, such as rumination (e.g., "I keep remembering what happened or can't stop thinking about what might happen."), emotional arousal ("I get upset by things that don't usually bother me."), and physiological arousal (e.g., "I feel sick to my stomach or get headaches."). Youth checked a box indicating on a 4-point scale (*Not at All* to *Very Much*) how often they engaged in each response. Scores were computed as the mean of the items, with higher scores reflecting more involuntary engagement. Validity of the original (Connor-Smith et al. 2000) and revised (Rudolph et al. 2011; Troop-Gordon et al. 2015) versions of the measure has been well-established.

Depressive Symptoms Youth completed the Short Mood and Feelings Questionnaire (Angold et al. 1995). This measure includes 13 items describing depressive symptoms (e.g., "I felt unhappy or miserable."). Youth checked a box indicating on a 4-point scale (1 = *Not at All* to 4 = *Very Much*) how often they had experienced each symptom in the past two weeks (Lau and Eley 2008). Scores were computed as the mean of the items, with higher scores reflecting more depressive symptoms. Reliability and validity have been documented (Angold et al. 1995), and this measure differentiates depression from other psychiatric diagnoses (Thapar and McGuffin 1998). This measure has good convergent validity with a widely used diagnostic depression measure, and discriminates clinically depressed children from non-depressed children, and clinically referred psychiatric children from pediatric patients (Angold et al. 1995).

Overview of Analytic Approach

First, we conducted descriptive analyses to examine gender differences in the variables and intercorrelations among variables. Second, we conducted structural equation modeling using Amos Version 17.0 (Arbuckle 2008) to examine whether 6th grade shifting deficits indirectly predicted 8th grade depressive symptoms through 7th grade stress reactivity as well as to test whether this path was stronger in girls than in boys. All models were tested using full information maximum likelihood estimation (FIML; Enders and Bandalos 2001), allowing for parameter estimation based on all available data from the 636 children. Shifting deficits were represented by manifest variables in 6th and 7th grade; stress reactivity was represented by latent variables in 6th and 7th grade with MPQ stress reactivity and involuntary engagement as indicators; depressive symptoms were represented by manifest variables in 6th, 7th, and 8th grades (measures of shifting and MPQ stress reactivity were not administered in 8th grade). To test the hypothesized indirect effect, Model 1 included lagged paths between 6th grade shifting deficits and 7th grade stress reactivity, and between 6th and 7th grade stress reactivity and 7th and 8th grade depressive symptoms, respectively. To provide a conservative estimate of the lagged effects, the model also included stability paths for each variable and covariances between constructs within each wave. To test the alternative directions of effect, we compared the original model with a model (Model 2) that included the reciprocal paths (6th grade stress reactivity predicting 7th grade shifting deficits, and 6th grade depressive symptoms predicting 7th grade stress reactivity). Multi-group comparison analyses were conducted to test for gender differences in the paths. Several model fit indices were examined, including Comparative Fit Index (CFI), Incremental Fit Index (IFI), and Root Mean Square Error of Approximation (RMSEA). Good model fit is indicated by CFI and IFI values ≥ 0.97, and RMSEA values ≤ 0.05 (Browne and Cudeck 1993; Hu and Bentler 1999; Kline 1998; Schermelleh-Engel et al. 2003).

Results

Descriptive Analyses

A series of *t*-tests revealed several significant gender differences (see Table 1). Compared to girls, boys showed higher levels of shifting deficits in 6th and 7th grade. Compared to

boys, girls showed higher levels of MPQ-SF stress reactivity and involuntary engagement in 6th and 7th grades as well as higher levels of depressive symptoms across all grades. In girls, shifting deficits were significantly associated with MPQ-SF stress reactivity and involuntary engagement as well as with depressive symptoms within and across waves; MPQ-SF stress reactivity and involuntary engagement also were significantly associated with depressive symptoms within and across waves. In boys, the pattern of intercorrelations was less consistent, with shifting primarily associated with MPQ stress reactivity, involuntary engagement, and depressive symptoms concurrently but not over time.

Examination of Mediation

A multi-group comparison analysis comparing the fully constrained Model 1 (all seven directional paths were constrained to be equal across gender) with a fully unconstrained model (all seven directional paths were allowed to vary across gender) revealed that the fully unconstrained model provided a significantly better fit than the fully constrained model, $\Delta\chi^2(7) = 22.17$, $p = 0.002$. Moreover, the unconstrained model showed a good fit to the data, $\chi^2(38) = 91.06$, CFI = 0.97, IFI = 0.97, RMSEA = 0.05. To verify that the focal mediation pathway differed by gender, the fully constrained model also was compared to (a) a model in which the path from 6th grade shifting deficits to 7th grade stress reactivity was allowed to vary by gender; and (b) a model in which the path from 7th grade stress reactivity to 8th grade depressive symptoms was allowed to vary by gender. Both models provided a significantly better fit, $\Delta\chi^2(1) = 5.47$, $p = 0.02$ and $\Delta\chi^2(1) = 10.59$, $p = 0.001$, than the fully constrained model, supporting gender differences in each of these paths.

Adding the reciprocal paths to the fully unconstrained model (Model 2) significantly improved the model fit, $\Delta\chi^2(4) = 18.21$, $p = 0.001$. Further, a multi-group comparison analysis comparing the fully constrained Model 2 (all nine directional paths were constrained to be equal across gender) with a fully unconstrained model (all nine directional paths were allowed to vary across gender) revealed that the fully unconstrained model provided a significantly better fit than the fully constrained model, $\Delta\chi^2(9) = 23.17$, $p = 0.006$. To verify that the focal pathways differed by gender, the fully constrained model was compared to (a) a model in which the path from 6th grade shifting deficits to 7th grade stress reactivity was allowed to vary by gender; and (b) a model in which the path from 7th grade stress reactivity to 8th grade depressive symptoms was allowed to vary by gender. Both models provided a significantly better fit, $\Delta\chi^2(1) = 5.48$, $p = 0.02$ and $\Delta\chi^2(1) = 10.62$, $p = 0.001$, than the fully constrained model, supporting gender differences in each of these paths. The fully unconstrained model was adopted as the final model, $\chi^2(34) = 72.85$, CFI = 0.98, IFI = 0.98, RMSEA = 0.04.

Figure 1 displays the standardized path coefficients for the final model. All stability paths were significant in girls and boys, with the exception of the stability of depressive symptoms from 6th grade to 7th grade in boys; moreover, the paths from 6th grade stress reactivity to 7th grade depressive symptoms and from 7th grade stress reactivity to 8th grade depressive symptoms were significant in girls and boys. However, the path from 6th grade shifting deficits to 7th grade stress reactivity was significant in girls but not boys. The indirect effect of 6th grade shifting deficits on 8th grade depressive symptoms via 7th grade stress reactivity was significant in girls (IE = 0.049, 95% CI [0.012–0.167]; MacKinnon et al. 2007; Tofighi and MacKinnon 2011) but not boys (IE = −0.01, 95% CI [−0.042–0.026]; MacKinnon et al. 2007; Tofighi and MacKinnon 2011). The path from 6th grade stress reactivity to 7th grade shifting deficits was significant in girls and boys (βs > 0.15, ps < 0.05) whereas the path from 6th grade depressive symptoms to 7th grade stress reactivity was nonsignificant in girls and boys ($|\beta|$s < 0.06, *ns*).

Discussion

Adolescence is characterized by changes across multiple domains of functioning and increasing exposure to stress (Rudolph 2009), which may tax youths' coping resources. Building on prior research, this study examined the idea that poor attentional control would interfere with adolescents' ability to effectively regulate their cognitive, emotional, and physiological responses to stress, which would heighten depressive symptoms over time, particularly in girls. In support of this proposition, prospective longitudinal modeling analyses revealed that 6th grade shifting deficits predicted higher levels of involuntary engagement responses to social stress and general sensitivity to minor stressors in 7th grade in girls but not in boys. In turn, 7th grade stress reactivity predicted depressive symptoms in 8th grade, yielding an indirect pathway from shifting deficits to depressive symptoms in early adolescent girls.

Attentional Control Deficits Predict Stress Reactivity

Compromised attentional control during the early adolescent years, as reflected in cognitive inflexibility and an inability to deal with new demands or situations in everyday life, predicted subsequent stress reactivity in adolescent girls but not boys. When girls had difficulty shifting attention according to daily task demands or feedback and showed inflexible approaches to solving daily problems, they were more likely to engage in perseverative thinking, to be overly sensitive, and to show heightened emotional and physiological arousal in response

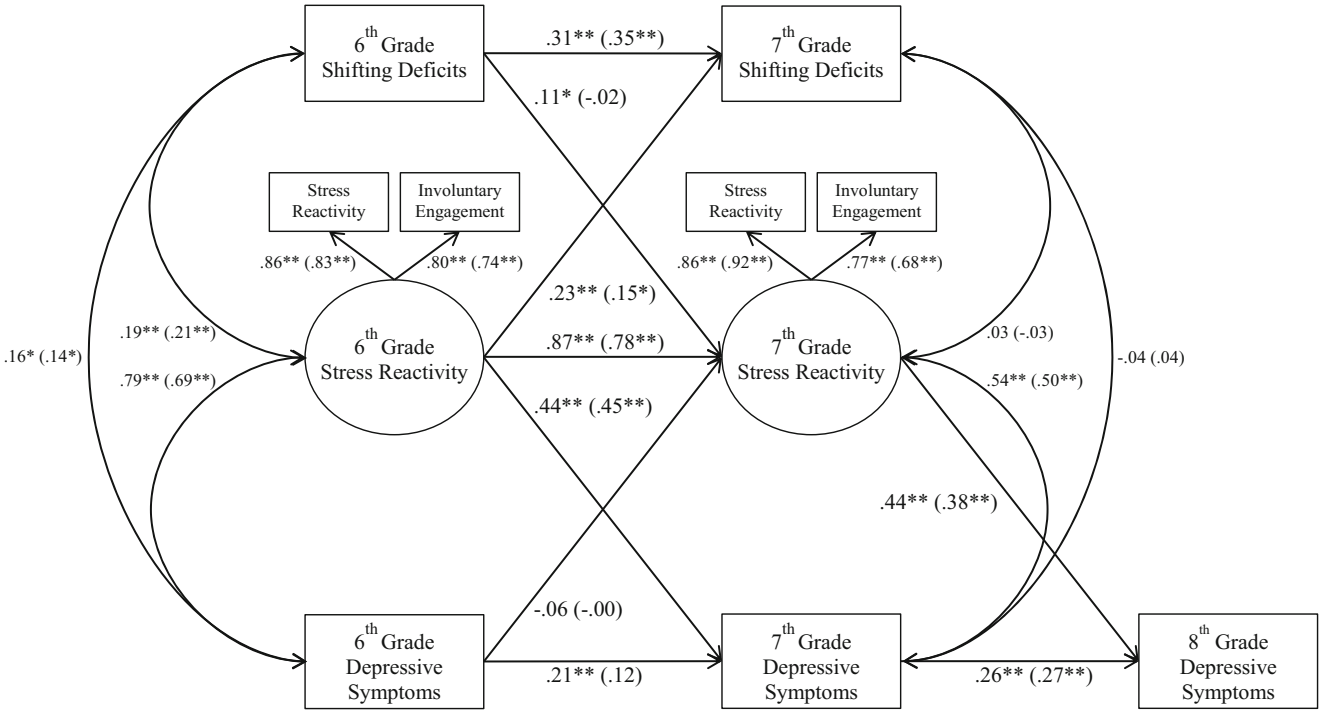

Fig. 1 Structural equation modeling analysis displaying the standardized prospective effects among shifting deficits, stress reactivity, and depressive symptoms in girls and boys. *Note.* Coefficients without parentheses are for girls; coefficients in parentheses are for boys

to stress. It is possible that this link is strengthened in adolescent girls relative to boys because girls are exposed to higher levels of social stress (Rudolph 2009) and are more likely to engage in perseverative thinking (Jose and Brown 2008); thus, heightened stress reactivity stemming from poor attentional control may be activated more frequently or more intensely in girls than in boys.

These findings are consistent with theory and prior research suggesting that being unable to shift or refocus attention in a purposeful manner (Compas et al. 2004; Compton et al. 2000; Hocking et al. 2011) or a narrowing in attentional focus (Whitmer and Gotlib 2012) interferes with constructive coping efforts and results in heightened reactivity to stress and negative emotions (Joormann and Vanderlind 2014; Koster et al. 2011). When youth are unable to readily shift attention from stressful stimuli, they may maintain a negative mindset and continue to dwell on unpleasant thoughts, emotions, and events. However, this study builds on prior research establishing concurrent associations by demonstrating that shifting deficits in everyday life contribute to stress reactivity over time, potentially helping to account for increasing emotional and biological sensitivity to social and emotional stimuli in adolescent girls (Guyer et al. 2009). Moreover, by examining bidirectional effects, this research established that stress reactivity predicts poorer attentional control over time, suggesting that dysregulated responses to stress may deplete cognitive resources and impede purposeful and adaptive shifting of attention (Watkins 2008). Thus, these findings shed light on the dynamic interchange between cognitive processing and stress reactivity across a critical stage of development, suggesting that a self-perpetuating cycle may develop in which adolescent girls with poor attentional control experience heightened stress reactivity, which then further compromises their cognitive flexibility and problem-solving ability.

Stress Reactivity Predicts Depressive Symptoms

In turn, stress reactivity predicted subsequent depressive symptoms in both girls and boys although the link was significantly stronger in girls than in boys. We proposed that youths' tendency to show involuntary and dysregulated responses to stress may cause them to get "caught up" in stress rather than to cope in an effortful and adaptive manner. These uncontrolled cognitive, emotional, and physiological reactions may threaten their sense of self, intensify negative emotions, and generate further stress in their lives, creating risk for depressive symptoms (Nolen-Hoeksema et al. 2007; Rood et al. 2009; Troop-Gordon et al. 2015). Consistent with our proposed model, heightened stress reactivity helped to explain the prospective association between shifting deficits and depressive symptoms in girls, providing novel data about one explanatory pathway through which attentional control processes heighten risk during adolescence (for a similar study in adults, see Demeyer et al. 2012). Moreover, the relevance of this pathway to girls but not boys helps to shed light on gender-specific risk for depressive symptoms across early

adolescence, a stage during which girls begin to surpass boys in rates of depression.

Strengths, Limitations, and Future Directions

The prospective longitudinal design provided an opportunity to examine dynamic linkages among attentional control, stress reactivity, and depressive symptoms across a key developmental period, allowing us to better understand how girls' vulnerability to depression emerges over time as well as to elucidate the bidirectional effects between attentional control and stress reactivity. The design also was enhanced by the use of teacher reports of attentional control, thereby reducing the effects of shared method variance. However, stress reactivity and depressive symptoms were both assessed via self-reports. Although the influence of method variance was likely reduced by adjusting for prior levels of each construct, it would be informative in future research to assess stress reactivity through multiple informants (e.g., parents, teachers) as well as methods (e.g., in vivo assessment of physiology and behavior).

This research clarifies the role that everyday attentional control processes play in stress reactivity and depression. There are several advantages of measuring attentional control in everyday contexts. First, the BRIEF likely taps the molar expression of attentional control across real-world situations and time, making it a more reliable and generalizable assessment than performance-based measures, which tend to have low test-retest reliability (Miyake et al. 2000) and thus may provide more situation-specific and variable assessments. Second, attentional control deficits may be most salient or detrimental under "hot" conditions when cognitive systems are challenged, youth are more invested, or emotions are intensified (Muris et al. 2008b), which is more likely to be the case in everyday contexts. Indeed, research suggests that executive function deficits, including attentional control, predict rumination (De Lissnyder et al. 2012) and depressive symptoms (Agoston and Rudolph 2015) specifically in the presence of high stress exposure. Because performance-based measures often assess attentional control in "cold" conditions, they may be less relevant to understanding the interrelation between attentional control and stress reactivity. The allocation of attentional control in everyday situations may therefore be more meaningful than attentional control capacity when predicting how youth respond to everyday stressors.

However, using the BRIEF also introduces some limitations. First, it is difficult to distinguish exactly which aspects of shifting (e.g., ignoring distractors in the environment vs. inhibiting previously, but no longer, relevant information; Friedman and Miyake 2004) are assessed by the BRIEF. Second, the BRIEF assesses attentional control only in the form of shifting, thus omitting other important aspects of attentional control such as attentional focus. Third, associations between questionnaire and performance-based measures of attentional control and related executive functions tend to be modest (Toplak et al. 2013). Given these limitations, it would be beneficial for future research to directly examine the relative contributions of performance-based versus everyday manifestations of attentional control as well as to carefully assess distinct aspects of attentional control and their contribution to stress reactivity and depressive symptoms. It also will be important to examine the specificity of the observed pathway to attentional control deficits versus other aspects of executive function.[1]

Finally, it is important to note that the indirect effect from shifting deficits to depressive symptoms in girls was relatively small. Thus, it is likely that processes other than stress reactivity help to account for the contribution of shifting deficits to depression. In fact, a recent study found that self-generated stressors and rumination mediated the link between poor cognitive control and subsequent depressive symptoms (Snyder and Hankin 2016), suggesting that individuals with cognitive control deficits both create more stress in their lives and react to this stress in ways that heighten risk for depressive symptoms.

Implications for Practice

This research provides a novel perspective on adolescent vulnerability to depression as well as gender-specific vulnerability that may help explain the greater rise in depression over the course of adolescence in girls relative to boys. Effective prevention may involve intervening at different stages of the observed process. On the one hand, teaching effective coping strategies (e.g., how to problem solve or reappraise stressful situations) may interrupt the progression from compromised attentional control to depressive symptoms. On the other hand, girls with poor attentional control may have difficulty learning or implementing such strategies, such that direct training and practice in attentional control strategies (e.g., Siegle et al. 2007; Siegle et al. 2014) may be needed to help them take advantage of coping interventions aimed at fostering more effortful, planful strategies and diminishing involuntary and dysregulated responses. Most likely, intervening at both levels would be most beneficial for inoculating girls against the downward spiral of negative cognitions and emotion leading to depression across the early adolescent years and beyond.

[1] In our study, we examined specificity to three other dimensions on the BRIEF: inhibition, working memory, and planning/organization. These analyses indicated that there was a significant indirect effect of inhibition on depression via stress reactivity for girls (IE = 0.05, 95% CI [0.01–0.13], but not for boys (IE = −0.02, 95% CI [−0.03–0.01]). The indirect effects of working memory and planning on depression via stress reactivity were not significant for girls (for working memory, IE = 0.03, 95% CI = −0.01–0.08; for planning, IE = 0.03, 95% CI = −0.01–0.08) or for boys (for working memory, IE = −0.04, 95% CI = −0.05–0.01; for planning, IE = −0.03, 95% CI = −0.04–0.01).

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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