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ORIGINAL ARTICLE

Gender Differences in the Cognitive Vulnerability-Stress Model of Depression in the Transition to Adolescence

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Abstract This study examined whether the cognitive vulnerability-stress model of depression may contribute to our understanding of the gender difference in depression in adolescence. Specifically, we examined emergent gender differences in depressive symptoms, cognitive style, and stress in the context of *exposure*, *cognitive scar*, and *stress generation* models. We also examined whether gender moderated the cognitive vulnerability-stress effects on depression. Participants were 366 youth from a community sample who completed measures of depressive symptoms, stress, and negative cognitive style at ages 11, 13, and 15. Data were analyzed longitudinally using multi-level modeling and structural equation modeling. Results indicated that gender differences in depressive symptoms emerged prior to gender differences in cognitive vulnerability and stressful life events; depressive symptoms significantly mediated the emergent gender difference in cognitive style and dependent interpersonal stress. Gender also moderated several components of the cognitive vulnerability-stress model. Girls showed stronger associations between stress and depression over time, and the cognitive vulnerability-stress interaction was significant in predicting girls' but not boys' depression trajectories.

Keywords Gender · Depression · Cognitive vulnerability · Stress

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Predicting Depressive Symptoms in the Transition to Adolescence: The Cognitive Vulnerability-Stress Model

A dramatic rise in depression occurs during adolescence, such that while less than 6% of children under age 11 become depressed, nearly 20% of youth will experience a depressive episode by age 18 (Cohen et al. 1993; Kessler et al. 1993). Research also indicates that much of this increase is accounted for by a rise in depression among girls in particular; although rates of depression between boys and girls are comparable in childhood, by age 18 females are twice as likely as males to become depressed (Kessler et al. 1993; Lucht et al. 2003). This gender difference in depression emerges in early-to-middle adolescence (between ages 13 and 15), and has been demonstrated both for depressive symptoms as well as diagnoses (Allgood-Merten et al. 1990; Hankin et al. 1998; Twenge and Nolen-Hoeksema 2002). Although the gender difference in depression has been well documented, researchers have only limited understanding of the processes by which this gender difference emerges.

Cognitive vulnerability-stress models of depression posit that the meaning or interpretation that people make about their experiences will significantly influence their vulnerability to depression following stressful life events (Abramson et al. 2002). The hopelessness theory of depression defines cognitive vulnerability as making negative inferences about cause (*attributional style*), self, and future consequences, and further suggests that it is this cognitive vulnerability which, in interaction with stressful life events, predicts depression (Abramson et al. 1989). The trinity of negative inferences defined by the hopelessness theory is termed a "negative cognitive style" and has been demonstrated, in interaction with

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stress, to predict depressive symptoms in adults, college students, and high school students (Alloy et al. 2000; Hankin and Abramson 2002; Hankin et al. 2001). Expanding upon the cognitive vulnerability-stress model of depression, several researchers have attempted to apply this model to understanding the emergent gender difference in depression (e.g. Hankin and Abramson 2001; Hyde et al. 2008).

The Exposure Model: Do Gender Differences in Cognitive Vulnerability or Stress Explain the Emergent Gender Difference in Depression in Adolescence?

In their integrated model of the emergence of the gender difference in depression ("ABC Model"), Hyde et al. (2008) articulated several ways by which the cognitive vulnerability-stress model defined by hopelessness theory may explain the emergence of the gender difference in depression. One possibility is that gender differences in mean levels of negative cognitive style and/or stress emerge in the transition to adolescence which subsequently mediate the emergent gender difference in depressive symptoms. This hypothesis represents an *exposure* model (see Hankin and Abramson 1999; Hankin et al. 2007; Hyde et al. 2008). Several studies have demonstrated that children under age 11 demonstrate no gender difference in cognitive style or attributional style, or even that boys display the more negative style (Abela 2001; Mezulis et al. 2006; Nolen-Hoeksema et al. 1991; Thompson et al. 1998). Research with adolescents, however, has been inconsistent. Some researchers report no gender difference in cognitive or attributional style (Lewinsohn et al. 1997), whereas others find that by age 15 girls do display a more negative cognitive style (Hankin and Abramson 2002). In one of the only studies to explicitly examine the mediation hypothesis, Hankin and Abramson (2002) found that more negative cognitive styles among adolescent girls did in fact mediate the gender difference in depressive symptoms. However, this study was conducted cross-sectionally with older adolescents (mean age 15.8 years) and thus does not directly address the question of whether it is an emergent gender difference in cognitive style that may mediate a later gender difference in depression.

Several studies have found that gender differences in the frequency of stressful events emerge in early and middle adolescence (Compas et al. 1985; Davies and Windle 1997; Ge et al. 1994; Graber et al. 1995). Davis and colleagues, in a meta-analysis of gender differences in stressful life events, found that a gender difference in stress exposure was not present in childhood but emerged in adolescence (Davis et al. 1999). However, the effect was very small ($d = .12$), raising the question as to whether such a modest gender difference in stress in adolescence is sufficient to explain the marked gender difference in depression. Few studies have examined whether gender differences in stress mediate gender differences in depression in adolescence. However, Liu and Kaplan (1999) found that sensitivity to peer stressors in particular partially mediated the gender difference in internalizing symptoms in early to middle adolescence. Hankin et al. (2007) similarly found that sex differences in depressive symptoms were partially mediated by girls reporting more peer stressors.

Gender differences in stressful events may also vary across domain, and global measures of stress may mask gender differences in specific domains. Stressor domains may be differentiated both by the content domain (e.g. interpersonal versus achievement) as well as by the relative independence of the stressor from the individual. Phelps and Jarvis (1994), for example, found that high school boys reported more school problems while girls reported more interpersonal problems. Similarly, Hankin et al. (2007) found that adolescent girls reported significantly more interpersonal and peer stressors than boys, and that the gender difference in these types of events may be larger than previously believed. Hammen (1991, 2009) has argued that while some stressors occur independently of the individual's actions, others are likely to be at least partly dependent on individuals' actions, characteristics, or mood. Several studies have suggested that females are more likely to generate dependent stressors, particularly when depressed, than are boys (see Hammen 2009, for a review). Thus, attempts to link the emergent gender difference in depression to emergent gender differences in stressful life events should distinguish among events in multiple domains to best detect gender differences.

The Cognitive Scar and Stress Generation Models: Do Gender Differences in Depression Precede and Predict Gender Differences in Cognitive Vulnerability and/or Stress?

The *exposure* hypothesis articulated above, that gender differences in cognitive vulnerability or stress may mediate the emergent gender difference in depression, assumes that gender differences in vulnerability or stress emerge prior to and subsequently predict gender differences in depression. However, this is only one of three potential directions of effects among cognitive vulnerability, stress, and depression during this developmental period. However, the *stress generation* (Hammen 1991, 2005) and *cognitive scar* (Nolen-Hoeksema et al. 1992) models suggest that the temporal direction of effects may be reversed; in other words, gender differences in depression symptoms may

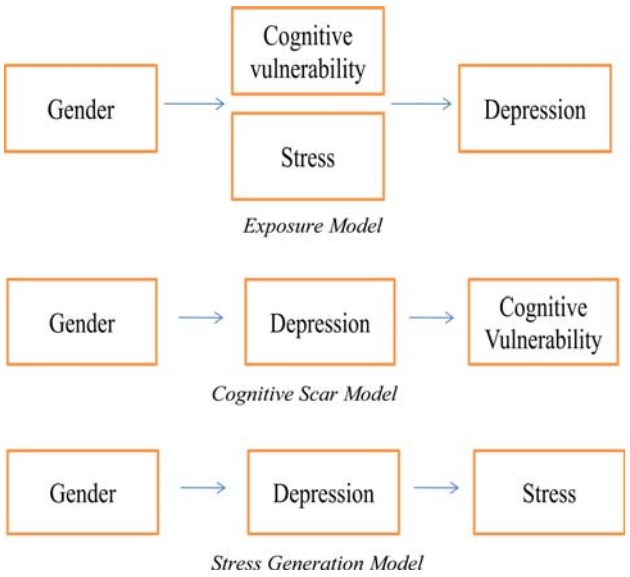

Fig. 1 Conceptual representation of direction of effects among study variables

precede and explain later gender differences in cognitive vulnerability and/or stressors. These three models are depicted in Fig. 1. It is important to note that *exposure*, *stress generation*, and *cognitive scar* models need not be mutually exclusive explanations for change in these constructs over time; in fact, some studies have documented bidirectional changes over time among these constructs (see, e.g., McCarty et al. 2007; Nolen-Hoeksema et al. 1992).

The Moderation Hypothesis: Does Gender Moderate the Predictive Relationships Between Cognitive Style, Stressors, and/or the Cognitive Vulnerability-Stress Interaction and Depression?

Another way in which the cognitive vulnerability-stress model may explain the emergent gender difference in depression is through gender differences in the predictive relationship between cognitive vulnerability, stressors, and/or the cognitive vulnerability-stress interaction and depression (Hyde et al. 2008). In other words, gender may moderate the predictive relationship(s) between vulnerability, stress, and/or the vulnerability-stress interaction and depression. Gladstone et al. (1997) reported that negative cognitive style was more strongly linked to depression for high school girls than boys (Gladstone et al. 1997). The relationship between stress and depression may also be stronger for girls than boys. Rudolph and Hammen (1999) found that the correlation between negative events and depression was higher for girls than boys; Silberg similarly found that negative events prospectively predicted clinical depression more strongly in pubertal girls than in boys (Silberg et al. 1999). In a recent study, Bouma et al. (2008) found that girls were more likely to develop depressive symptoms in response to stress than were boys. In particular, the relationship between interpersonal stress and depression may be stronger for girls than boys (Liu and Kaplan 1999; Rudolph and Hammen 1999).

Finally, the cognitive vulnerability-stress interaction may be more strongly implicated in the generation of depressive symptoms among girls than boys (see, e.g., Nolen-Hoeksema 1990). In the ABC Model, Hyde and colleagues further specify that girls may be particularly cognitively vulnerable to negative life events in the peer domain, which would be manifest in a stronger relationship between the cognitive vulnerability-peer stress interaction and depressive outcomes for girls than for boys (Hyde et al. 2008). In support of this hypothesis, Prinstein and Aikins (2004) found that negative attributional style, in interaction specifically with peer stress, predicted increases in depressive symptoms for adolescent girls but not for adolescent boys.

The Current Study

Although previous research has suggested that gender differences in components of the cognitive vulnerability-stress model or in the strength of the predictive relationship between those components and depression may explain the gender difference in depression, no studies to date have systematically examined the extent to which developmental changes in cognitive vulnerability, stressors, or the interaction thereof may contribute to developmental changes in depression levels or the emergence of the gender difference in depression. In the current study, we examined all components of the cognitive vulnerability-stress model of depression in a longitudinal study of youth as they transitioned from early to middle adolescence. We assessed depressive symptoms, cognitive vulnerability, and stressors across multiple domains at ages 11, 13, and 15. In doing so, we address the following questions:

1. Are there gender differences in cognitive vulnerability and/or stressors in the transition to adolescence?
2. Do gender differences in cognitive vulnerability and/or stressors mediate the emergence of the gender difference in depression?
3. Do gender differences in depression symptoms mediate the emergence of the gender difference in cognitive vulnerability and/or stressors?
4. Does gender moderate the predictive relationships between cognitive style, stressors, and/or the cognitive vulnerability-stress interaction and depression?

Methods

Participants

Participants were 366 youth who have participated in a longitudinal study of child development and family well-being since birth. Mothers were recruited during pregnancy for participation in the Wisconsin Maternity Leave and Health Project, now named the Wisconsin Study of Families and Work (Hyde et al. 1995). Approximately 78% of the sample was recruited from the Milwaukee area and the remaining 22% came from the Madison area. 90% of youth were white, 3.5% were African–American, 1.4% were Hispanic, 1.6% were Asian–American, and 3.3% were Native American.

The current study included all participants from the original sample who participated in the relevant assessments in the summers following 5th, 7th, and/or 9th grades. At the time of interview, fifth graders were between the ages of 10 and 12, with a mean age of 11.2 years. Seventh graders were between the ages of 12 and 14, with a mean age of 13.2 years. Ninth graders were between the ages of 14 and 16, with a mean age of 15.2 years. Of 570 original participants, 313 participated at age 11 (162 girls), 366 at age 13 (185 girls), and 317 at age 15 (164 girls). Participation at each assessment varied primarily by willingness of the child (and his/her family) to participate at that time. Additionally, due to funding constraints, some youth who lived farther distances from the study center were not interviewed at age 11 but were invited to re-join the study at ages 13 and 15. Of the 366 youth, 287 youth completed all three assessments and 312 completed at least two of three assessments. We conducted ANOVAs comparing youth who completed one, two, or three assessments and found no significant differences at the $p < .05$ level on any study variable.

Procedure

As part of the ongoing Wisconsin Study of Families and Work project, youth completed questionnaires on laptop computers during in-home assessments. Parents provided consent and children provided assent for their participation.

Measures

Depressive Symptoms

Youth depressive symptoms were assessed with the Children's Depression Inventory (CDI; Kovacs 1985). The CDI is a 27-item self-report inventory which inquires about the presence of depressive symptoms in the previous 2 weeks. The CDI was designed for use with children between ages 8 and 17; several studies have documented its reliability and validity (Kovacs 1981, 1985). Total scores on the CDI can range from 0 to 54, with higher scores indicating more severe symptom levels. In the current study, given that assessments were conducted in summer, we omitted three items which referenced school. Participants' scores on the remaining 24 items were averaged and then multiplied by 27 to create a total score that is comparable to the complete 27-item CDI. The CDI has repeatedly demonstrated excellent internal consistency, test-retest reliability, and predictive and construct validity, especially in community samples (e.g., Blumberg and Izard 1986). Internal consistency reliabilities in the current sample were .80 or greater at all assessments. As is common with depressive symptom scales among this age group, scores were not normally distributed but demonstrated significant positive skewness; thus, CDI scores were square root transformed prior to use in analyses.

Negative Cognitive Style

Negative cognitive style was assessed with the Children's Cognitive Style Questionnaire (CCSQ; Mezulis et al. 2006).[1] The CCSQ provides children with hypothetical scenarios to which they are asked to agree with statements regarding the internality, stability, and globality of attributions for the event (3 items per scenario); self-inferences (1 item); and anticipated consequences (1 item). Children indicate agreement with each item on a 5-point scale from 1 (don't agree at all) to 5 (agree a lot). Children respond to six scenarios in total, four negative (e.g. You did poorly on an exam at school) and two positive (e.g. You did well on an assignment at school). Children's responses to the attributional items (12 items) are averaged for a negative attributional style composite. Their responses to the self-inference items (4 items) are averaged for a negative self-inferences composite, and their responses to the consequences items are averaged for a negative consequences composite. The three composite scores are then averaged to compute a negative cognitive style composite score. Higher scores on the CCSQ negative cognitive style composite indicate greater endorsement of internal, stable, global attributions, negative self-inferences, and negative inferred consequences in response to negative events. Construct validity was reported by Mezulis et al. (2006) by demonstrating significant positive correlations with the Children's Attributional Style Questionnaire—Revised (CASQ-R; Thompson et al. 1998) at ages 9 and 11, and a significant CCSQ-stress interaction predicting concurrent depressive

[1] The authors note that the Children's Cognitive Style Questionnaire used in the current study is distinct from the Chidren's Cognitive Style Questionnaire developed by Abela and Sarin (2002).

symptoms at age 11. Internal consistency in the current sample was high (>.80 at all assessments).

Stressful Life Events

Stressful life events were assessed using a shortened version of the young adolescent version of the Adolescent Perceived Events Scale (APES; Compas et al. 1987). Youth were administered 59 items representing both major and daily life events. For each event, participants indicated whether it had occurred in the past year. The 59 items were then rated by three coders (one Ph.D. level clinical psychologist and two MA level graduate students in clinical psychology); coders were trained to rate the degree of dependency of each event, or the extent to which the adolescent may have contributed to the event's occurrence. Coders rated each event on a scale of 1 (*completely independent*) to 5 (*completely dependent*). For example, the event "Death of a family member" was given a rating of "1" by all three coders. By contrast, the events "Having few or no friends" and "Doing poorly on an exam" were both given ratings of "4" by all three coders. We computed inter-rater reliability using Fleiss' kappa, which was .86. We then defined dependent events as those rated 3 or higher, and independent events as those rated 2 or lower. We created scores representing counts of *total stressful events* (total possible events = 59), as well as counts specifically of *dependent events* (total possible events = 32) and *independent events* (total possible events = 27). We further categorized the dependent events as *interpersonal dependent events* or *noninterpersonal dependent events*. Interpersonal dependent events were dependent events involving a significant interaction between the youth and another person (total possible events = 22). Examples of interpersonal dependent events include peer ("Having few or no friends"), romantic ("Breaking up with boyfriend or girlfriend"), and family ("Problems with a family member") stressors. Noninterpersonal dependent events (total possible events = 10) were predominantly in the achievement domain, such as "Got bad grades."

Results

Gender Differences in Study Variables

Means and standard deviations for study variables by gender and age are shown in Table 1.

Before testing the meditation hypotheses, we first examined gender differences in cognitive vulnerability, stressors, and depression symptoms. We examined gender differences in trajectories of cognitive vulnerability, stress, and depression symptoms over time utilizing multi-level modeling in HLM 6.04. The analysis of multiple levels of data in multi-level modeling is accomplished by constructing Level 1 and 2 equations. At Level 1, regression equations are constructed that model variation in the repeated measure (i.e., depressive symptoms) as a function

Table 1 Means and (standard deviations) for study variables by age and gender

	Age 11				Age 13				Age 15			
	Boys	Girls	*t*	*d*	Boys	Girls	*t*	*d*	Boys	Girls	*t*	*d*
CDI	3.71	3.75	.04	.01	3.71	4.97	2.71**	.15	3.86	5.79	2.91**	.23
	(3.99)	(4.26)			(4.27)	(5.29)			(2.86)	(3.43)		
CCSQ	1.28	1.35	1.49	.10	1.66	1.61	1.07	.07	1.77	1.91	2.82**	.30
	(.31)	(.41)			(.41)	(.43)			(.44)	(.49)		
Total stressors	15.02	16.07	1.05	.17	16.74	17.53	.79	.12	17.06	19.45	2.38**	.32
	(6.25)	(5.61)			(6.67)	(6.52)			(7.41)	(7.76)		
Independent stressors	6.91	7.48	1.55	.17	7.76	8.00	1.28	.07	7.43	8.57	3.03**	.29
	(3.28)	(3.24)			(3.32)	(3.81)			(3.72)	(4.18)		
Dependent stressors												
Total	8.11	8.59	1.21	.14	9.14	9.45	.76	.08	9.73	10.78	2.07*	.23
	(3.79)	(3.25)			(4.32)	(3.75)			(4.59)	(4.47)		
Interpersonal	4.63	5.04	1.38	.14	5.19	5.65	1.46	.15	5.82	6.79	2.36*	.26
	(2.78)	(2.50)			(3.11)	(2.96)			(3.52)	(3.81)		
Noninterpersonal	3.94	3.80	.44	.09	3.91	3.99	.84	.05	4.64	4.92	1.47	.18
	(1.78)	(1.40)			(1.79)	(1.44)			(1.69)	(1.34)		

Notes: *CDI* Children's Depression Inventory, *CCSQ* Children's Cognitive Style Questionnaire

Asterisks (*) indicate significant gender differences according to independent samples *t*-tests with * indicating $p < .05$ and ** indicating $p < .01$

of time (i.e., from age 11 to 15). Each equation includes parameters to capture features of an individual's trajectory over time: an *intercept* that describes the expected initial level on the variable (e.g. when time = 0) and a *slope* that describes change in that level over time. At Level 2, equations are specified that model individual differences in the Level 1 variables as a function of Level 2 variables (here, gender). Thus, the Level 1 equations capture a single individual's trajectories for a given variable over time as a function of time and the Level 2 model organizes and explains the between-subjects differences among these trajectories as a function of gender, e.g. as cross-level interactions. A significant advantage of multi-level modeling is that it can flexibly handle cases with missing data. Random-effects models do not require that every participant provide complete, nonmissing data. In the current analyses, time was coded 0 (age 11); 1 (age 13); and 2 (age 15) and entered uncentered so that the resulting intercept reflects the expected value of the dependent variable at age 11. Gender was coded -1 (male) and 1 (female).

In all analyses, the outcome of interest was modeled in Level 1 as a function of intercept, slope, and random error and in Level 2 as a function of gender. These equations are shown here:

$$\text{Level 1}: \text{Outcome}_{ij} = \beta_{0j} + \beta_{1j}(\text{Time}) + e_{ij}$$

$$\text{Level 2}: \beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Gender}) + r_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Gender}) + r_{1j}$$

Outcome_{ij} represents the dependent variable (respectively, depression symptoms, cognitive style, or stress) across i level-1 units nested within j level-2 units. β_{0j} and β_{1i} are level-1 coefficients representing the estimated random intercept (β_{0j}) and slope (β_{1j}), and e_{ij} is the level-1 error term. At Level 2, γ_{01} and γ_{11} are the cross-level interaction terms representing the effects of gender on the respective Level 1 effects, with r_{0j} and r_{1j} representing the error terms.

Results of these multi-level models indicated that depression symptoms, as expected, showed a significant and positive growth slope over time. Depression slope varied as a function of gender (coefficient = .54, t = 6.56, p = .001). The positive coefficient for the effect of the Level 2 variable (gender) on depression slope indicates that girls had a more positive slope than boys; in other words, depression symptoms increased more for girls than for boys from age 11 to 15.

Negative cognitive style in the entire sample demonstrated significant change over time (slope coefficient = .25, t = 10.77, $p < .001$). However, the Level 2 analysis suggested that slope varied as a function of gender (slope coefficient = .05, t = 2.48, p = .011). The positive value for the slope coefficient indicates that girls demonstrated a more positive slope of change in negative cognitive style over time than did boys.

Multi-leveling modeling indicated that stressors in all domains showed significant increases over time. While the Level 2 analyses indicated that stressor intercepts did not vary as a function of gender in any domain, gender was a significant moderator of time slope for total stressors (coefficient for gender on time slope = .33, t = 2.61, p = .023), dependent stressors (coefficient for gender on time slope = .48, t = 2.51, p = .013), independent stressors (coefficient for gender on time slope = .48, t = 2.93, p = .004), and dependent interpersonal stressors (coefficient for gender on time slope = 38, t = 2.52, p = .013). The only type of stressor not showing gender differences in slope over time was noninterpersonal dependent stress (coefficient for gender on time slope = .11, t = 1.53, p = .125). In all cases, the positive slope coefficients indicate that girls demonstrated greater increases in stressful events over time.

T-tests indicated no significant gender differences in depressive symptoms at ages 11, but significant gender differences in depressive symptoms at age 13 (t = 2.71, p = .007) and age 15 (t = 2.93, p = .004), with girls having higher depression scores at both timepoints. *T*-tests indicated no gender differences in cognitive style at ages 11 or 13, but that girls had significantly more negative cognitive styles at age 15 (t = 2.36, p = .014). Finally, *t*-tests indicated significant gender differences in stressors at age 15 only. Girls reported more total stressors, independent stressors, and dependent stressors at age 15 than did boys. The gender difference in dependent stressors appears to be explained primarily by gender differences in dependent interpersonal stressors, for which there was a significant gender difference at age 15, rather than in dependent noninterpersonal stressors, which did not demonstrate a significant gender difference at any age.

Testing Mediation Hypotheses: The Vulnerability-Stress Exposure Model

We hypothesized that gender differences in cognitive vulnerability or stressors may mediate the emergent gender difference in depression (e.g. the *exposure* hypothesis). However, this hypothesis requires that gender differences in cognitive vulnerability or stressors precede gender differences in depression symptoms. As our descriptive analyses indicated, gender differences in depression symptoms were present by age 13 while gender differences in cognitive vulnerability and stressors were not observed until age 15. Thus, the exposure model was not supported as an explanation of emergent gender differences in depressive symptoms.

Testing Mediation Hypotheses: Cognitive Scar and Stress Generation Models

We also hypothesized that gender differences in depressive symptoms may precede and subsequently mediate emergent gender differences in cognitive vulnerability (e.g. the *cognitive scar* hypothesis) or stressors (e.g. the *stress generation* hypothesis). To examine whether gender differences in depression symptoms mediated the emergence of the gender difference in cognitive vulnerability or stressors, we utilized structural equation models in M-Plus 4.2.1. All models were estimated using maximum likelihood estimation of missing data. As the descriptive analyses indicated that gender differences in cognitive style and stressors emerged between the second and third assessment points (ages 13 and 15 respectively), these two timepoints were used to construct structural equation models estimating paths between child sex, age 13 depressive symptoms, and age 15 cognitive style or age 15 stressors. Child sex was hypothesized to directly predict depressive symptoms at age 13, which in turn was hypothesized to directly predict cognitive style or stressors at age 15. Prior values of the outcome variable (e.g. cognitive style or stressor) at age 13 were controlled for in all models.

Baron and Kenney (1986) outlined four conditions for establishing mediation. The four conditions are: (1) the independent variable (here, gender) must be significantly related to the outcome of interest (i.e. age 15 cognitive style or stressor); (2) the independent variable must be significantly related to the mediator (i.e. age 13 depression symptoms); (3) the hypothesized mediator must directly predict the outcome; and (4) the effect of the independent variable (gender) on the outcome (age 15 cognitive style or stressor) must be substantially reduced or no longer significant after entering the mediator (Baron and Kenny 1986). However, the Baron & Kenny approach to mediation has been shown to have low statistical power for small effect sizes and greater power for large effect sizes in samples over 100 participants (MacKinnon, Lockwood, Hoffman, West, & Sheets 2002). MacKinnon and colleagues suggested that a product of coefficients test has the greatest power for detecting effects (MacKinnon et al. 2002). Both methods are reported in this study.

The mediation conditions were tested using estimates from the structural equation models. To test the first condition, direct effects models were run to examine the effect of gender on age 15 outcomes (cognitive style; total stressors; dependent stressors; independent stressors; and dependent interpersonal stressors). Next, a series of structural equation models were run to test the second and third conditions, namely that gender would directly predict the potential mediator (age 13 depressive symptoms) and that the potential mediator would directly predict the outcomes. Finally, to test the meditational hypotheses, it was necessary to compare the coefficients for the direct relation between gender and the outcomes with and without the hypothesized mediator in the model. To test if differences in coefficients were significant, the product of coefficients test uses the path weights for each indirect pathway (e.g. from the predictor to the mediator, and from the mediator to the outcome variable) and the corresponding standard errors to compute the test statistic (MacKinnon et al. 2002; Sobel 1990). This formula yields a z statistic which is then interpreted in relation to a standard normal distribution to evaluate the significance of the mediator variable.

Full mediation analyses are shown in Table 2. After controlling for age 13 cognitive style, the direct pathway from gender to cognitive style at age 15 was significant, with a standardized beta of .13 (t = 2.06, p = .041). As expected, gender was related to age 13 depression (pathway α), as indexed by a beta coefficient of .14 (t = 2.76, p = .006). Age 13 depression was in turn related to age 15 cognitive style (pathway β), as shown by a beta coefficient of .38 (t = 5.51, $p < .001$). With the mediator in the model, the direct pathway from gender to cognitive style at age 15 became nonsignificant, as shown by a beta coefficient of .03 (t = .49, p = .63). The product of coefficients test yielded a z statistic of 2.61, which is significant at the $p < .01$ level. Thus, according to both the Baron and Kenny conditions and the product of coefficients test, depression symptoms at age 13 were a significant mediator of the gender difference in cognitive style at age 15, even after controlling for age 13 cognitive style.

We then examined whether gender differences in depression at age 13 mediated the emergent gender differences in total stress; dependent stress; dependent interpersonal stress; and independent stress. Full mediation statistics are shown in Table 2. There was support only for depressive symptoms to mediate the gender difference in dependent interpersonal stress. Although gender differences in depressive symptoms were present prior to the emergence of gender differences in total stress, independent stress, and dependent stress, depression was not a significant mediator of the gender difference in these stressors.

Testing the Moderation Hypothesis

In our final analyses, we examined the complete cognitive vulnerability-stress model as it predicts depression trajectories over time. Using multi-level modeling, we examined time and stress as Level 1 predictor variables, with gender, cognitive style at age 11, and gender × cognitive style as Level 2 moderators of Level 1 predictors. Separate models were computed for each stressor type (total; independent;

Table 2 Mediator models: Depressive symptoms at age 13 as mediator of gender differences in cognitive style and stressors at age 15

Outcome	Direct effect	Gender on mediator (α)	Mediator on outcome (β)	Gender on outcome w/ mediator	z
Cognitive style					
Beta	.13*	.14**	.38**	.03	2.61**
SE	(.06)	(.05)	(.07)	(.05)	
Total stress					
Beta	.10*	.14**	.07	.09^{+}	1.16
SE	(.05)	(.05)	(.08)	(.06)	
Dependent stress					
Beta	.08^{+}	.14**	.08	.07	1.78^{+}
SE	(.06)	(.05)	(.07)	(.06)	
Dependent interpersonal stress					
Beta	.14*	.14**	.11*	.08	2.05*
SE	(.05)	(.05)	(.05)	(.06)	
Independent stress					
Beta	.11*	.14**	.06	.10*	1.04
SE	(.06)	(.05)	(.08)	(.06)	

Notes: Values are standardized beta weights. Age 13 levels of all outcome variables are controlled for. $^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

dependent; interpersonal dependent; and noninterpersonal dependent).

The Level 1 model in these HLM analyses was:

$$\text{Depression}_{ij} = \beta_{0j} + \beta_{1j}(\text{Time}) + \beta_{2j}(\text{Stressor}) +_{ij} e_{ij}$$

The Level 2 model in these HLM analyses was:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Gender}) + \gamma_{02}(\text{Cognitive style}) + \gamma_{03}(\text{Gender} \times \text{Cognitive style}) + r_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Gender}) + \gamma_{12}(\text{Cognitive style}) + \gamma_{13}(\text{Gender} \times \text{Cognitive style}) + r_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{Gender}) + \gamma_{22}(\text{Cognitive style}) + \gamma_{23}(\text{Gender} \times \text{Cognitive style}) + r_{2j}$$

This model allows us to examine whether cognitive style moderates the relationship between stress and depressive symptoms over time, and whether any of the predictive relationships between stress, cognitive style, and the cognitive style × stress interaction are moderated by gender.

Results are shown in Table 3. There were significant main effects of stress over time on depression over time for all stressors except noninterpersonal dependent stressors. However, level 2 analyses indicated that the relationship between stress and depression was moderated by child gender. The positive coefficient values indicate that the time-varying correlation between stress and depression was significantly stronger for girls for total stressors, independent stressors, dependent stressors, and dependent interpersonal stressors (see the Gender × Stress cross-level interactions in Table 3). There was no main effect of cognitive style at age 11 on depression slope over time, and none of the Cognitive Style × Gender interactions were significant.

The two-way cross-level Cognitive Style × Stress interactions were not significant in any stressor domain. However, there were significant three-way cross-level Cognitive Style × Gender × Stress interactions in the total stress, total dependent stress, and total noninterpersonal dependent stress domains. To better examine these interactions, separate multi-level models were run for boys and girls in the three stressor domains for which there were significant three-way interactions (Table 4).

For boys, the multi-level models indicated that there were no main effects of stress on depressive symptom trajectories for any stressor type. There was little evidence of a main effect of cognitive style on depression slope; one of the three multi-level models indicated a negative relationship between cognitive style at age 11 and depression slope, but this effect was not demonstrated in the other two models. There was also no evidence that cognitive style moderated the effects of stress on depression over time; all three cross-level Cognitive Style × Stress interactions were nonsignificant. The overall models explained relatively little of the total variance in boys' depression slopes over time (percent variance account for in each model was less than 5%; for a discussion of percentage of variance accounted for in HLM, see Bryk and Raudenbush 1992, pp. 74, 141–142).

For girls, however, the multi-level models indicated main effects of both total stress and dependent stress on depression symptom trajectories. Similarly to boys, there were no main effects of cognitive style on depression slope. However, the cross-level Cognitive Style × Stress interaction was significant in each of the three stressor

Table 3 Moderator models: Multi-level model predicting depressive symptoms as a function of cognitive vulnerability, stress, and vulnerability-stress interactions

	Total stress		Independent stress		Dependent stress					
					Total		Interpersonal		Noninterpersonal	
	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*
Predicting depressive symptoms from age 11–15										
Level 1										
Stress	.37 (.15)	2.44*	.43 (.18)	2.48*	.37 (.15)	2.44*	.47 (.21)	2.17*	.28 (.36)	.69
Level 2										
CCSQ	.53 (.45)	1.18	.58 (.33)	1.76^{+}	.53 (.45)	1.18	.39 (.35)	1.11	.73 (.45)	1.62
Gender	.77 (.31)	2.48*	.56 (.31)	1.81^{+}	.48 (.24)	2.00*	.80 (.45)	1.78^{+}	.80 (.76)	1.05
CCSQ × gender	.72 (.50)	1.44	.03 (.38)	.09	.70 (.45)	1.55	.30 (.32)	.88	.12 (.45)	.26
Cross-level interactions										
CCSQ × stress	.09 (.08)	1.09	.06 (.10)	.61	.08 (.09)	.93	.11 (.13)	.76	−.05 (.21)	.24
Gender × stress	.27 (.13)	2.01*	.34 (.15)	2.27*	.37 (.19)	1.98*	.90 (.33)	2.73**	.25 (.31)	.81
Gender × CCSQ × stress	.19 (.09)	2.15*	.19 (.10)	1.81^{+}	.19 (.08)	2.15*	.14 (.13)	1.07	.35 (.17)	2.07*

Notes: + indicates $p < .10$, * $p < .05$, ** $p < .01$

Table 4 Moderator models: Gender comparisons of multi-level models

	Total stress				Dependent stress				Noninterpersonal dependent stress			
	Boys		Girls		Boys		Girls		Boys		Girls	
	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*	Estimate (SE)	*t*
Predicting depressive symptoms from age 11–15												
Level 1												
Stress	.10 (.10)	.97	.39 (.13)	3.07**	−.65 (.44)	1.45	.55 (.20)	2.77**	.25 (.36)	.69	.51 (.37)	1.40
Level 2												
CCSQ	.02 (.44)	.05	.72 (.79)	.90	−.86 (.42)	2.03*	.51 (.71)	.72	−.11 (.44)	.24	.44 (.60)	.73
Cross-level interactions												
CCSQ × stress	.04 (.08)	.54	.14 (.06)	2.33*	.45 (.35)	1.29	.29 (.12)	2.42*	.18 (.26)	.70	.38 (.19)	2.01*

Notes: + indicates $p < .10$, * $p < .05$, ** $p < .01$

domains. The interaction was explored by examining the main effect of stress on depression slope separately for girls with high and low negative cognitive style at age 11 (using +1 SD and −1 SD cutoffs). All three interactions were consistent with a pattern in which low cognitively vulnerable girls had a significantly weaker association between stress and depression than did high cognitively vulnerable girls. For total stress, the coefficient for stress on depression slope for low cognitively vulnerable girls was .23 ($t = 1.98$, $p < .05$) while the coefficient for high cognitively vulnerable girls was .46 ($t = 3.227$, $p < .01$). For dependent stress, the coefficient for stress on depression slope for low cognitively vulnerable girls was .33 ($t = 2.01$, $p < .05$) while the coefficient for high cognitively vulnerable girls was .69 ($t = 3.77$, $p < .01$). Finally, for dependent noninterpersonal stress, the coefficient for stress on depression slope for low cognitively vulnerable girls was .31 ($t = 1.45$, $p > .10$) while the coefficient for high cognitively vulnerable girls was .52 ($t = 2.07$, $p < .05$). Thus, high cognitively vulnerable girls appeared more likely to display depressive symptoms as stressors increased in adolescence than did low cognitively vulnerable girls.

The full cognitive vulnerability-stress models also predicted more variance in girls' depressive symptoms over time. The model for total stress explained 13.1% of the variance in girls' depressive symptoms, while the model for dependent stress predicted 11.6%.

Discussion

This is one of the first studies to use a longitudinal design, multi-level modeling, and mediational analyses to

examine questions related to how the cognitive vulnerability-stress model of depression can contribute to our understanding of the emergence of the gender difference in depression symptoms in adolescence. Following a community sample of over 350 youth, we examined cognitive style, stressors across multiple domains, and depressive symptoms in three assessments as youth transitioned from early adolescence (age 11) to middle adolescence (age 15). Using multi-level and structural equation modeling, we were able to describe the relationship between developmental changes in cognitive vulnerability and stress and developmental growth in depression symptoms, both for all youth and separately by gender. Below we summarize our findings and their contribution to our understanding of the emergence of depression symptoms during the adolescent transition.

Do Gender Differences in Cognitive Vulnerability and/or Stress in Adolescence Mediate the Emergence of the Gender Difference in Depression?

One hypothesis regarding the emergent gender difference in depression symptoms in the transition to adolescence is that girls develop more cognitive vulnerability or experience more stressors relative to boys during this time, and that it is these emergent gender differences in vulnerability and stress that mediate the emergent gender difference in depression. This hypothesis has been termed an *exposure* mediation model. Our results demonstrated that boys and girls do display significantly different cognitive style trajectories between ages 11 and 15. Multi-level modeling indicated that although boys and girls did not differ in their cognitive vulnerability at age 11, girls had a greater rate of growth in negative cognitive style from age 11 to age 15 such that by age 15 girls displayed significantly greater cognitive vulnerability than boys. This study contributes to our understanding of gender differences in cognitive vulnerability over time. Several authors have examined cognitive style or attributional style change over time (Cole et al. 2008; Nolen-Hoeksema et al. 1992) but have not examined gender differences, whereas other studies have reported gender differences (Abela 2001; Hankin and Abramson 2002; Mezulis et al. 2006) but not examined them longitudinally. Our results are also consistent with other child and adolescent cognitive style studies demonstrating no gender difference in cognitive style in childhood, or boys having the more negative cognitive styles, but a gender difference in cognitive style with girls having the more negative cognitive styles in adolescence (Abela 2001; Hankin and Abramson 2002; Mezulis et al. 2006; Nolen-Hoeksema et al. 1991; Thompson et al. 1998), and provide further data examining developmental changes in cognitive vulnerability by specifying the adolescent transition from ages 11 to 15 as critical for understanding the emergent gender difference in cognitive vulnerability.

There was also evidence of gender differences in trajectories of stressful life events. While boys and girls did not differ on their stress levels at age 11 or 13, both boys and girls experienced increases in stressful life events in all domains from age 11 to 15. However, girls experienced greater rates of growth in total stressors, both independent and dependent. The gender difference in trajectory for dependent stressors was accounted for by more dependent interpersonal stressors among girls than boys; there were no gender differences in dependent noninterpersonal stressors. Our results are consistent with the extant literature on gender differences in stress in adolescence, which suggest that gender differences in stress emerge only in adolescence and are modest at best (Davis et al. 1999; Ge et al. 1994). Our results also support other recent findings indicating that examinations of gender differences in stress levels in adolescence must examine these differences separately by stress domain. As with other studies, we found that gender differences in stress were found predominantly among stressors generated dependently in the interpersonal domain (see Hammen 2009). There were no gender differences at any age in noninterpersonal dependent stressors, which in our sample were predominantly school and achievement stressors, which is, again, consistent with other samples (Hankin et al. 2007).

However, the timing of the emergence of gender differences in depressive symptoms, cognitive style, and stress did not support the exposure mediation model, as gender differences in depressive symptoms preceded gender differences in both cognitive style and stressful life events in our sample. Very few studies have examined cognitive style as a mediator of the gender difference in depression symptoms, and we are not aware of any other study to have done so prospectively across a multi-year period. Hankin and Abramson (2002) found that gender differences in cognitive style mediated the gender difference in depressive symptoms among high school students, with both constructs measured concurrently. It is very possible that the two findings are consistent with one another, as gender differences in depression will likely continue to intensify from age 15 into late adolescence (see, e.g., Hankin et al. 1998), and the gender difference in cognitive vulnerability we observed at age 15 in our sample and observed by Hankin and Abramson among their high school sample may well contribute to that still-emerging gender difference in depressive symptoms. Other studies have also suggested that gender differences in other cognitive vulnerabilities, such as rumination, may emerge at younger ages and may mediate the gender

difference in depression symptoms even in early to middle adolescence (Nolen-Hoeksema et al. 2008; Wichstrom 1999).

We further examined alternative meditational models to explain emergent gender differences among these constructs. The *cognitive scar* model suggests that developmental changes in depression symptoms may emerge prior to and predict subsequent changes in cognitive vulnerability. Nolen-Hoeksema et al. (1992) found evidence in support of this hypothesis, observing that depressive symptoms were a predictor of prospective changes in cognitive style from childhood into early adolescence. McCarty et al. (2007) similarly found that the relationships between depressive symptoms and cognitive vulnerability were bidirectional among middle school students. As far as we are aware, no studies have examined the cognitive scar model in the context of explaining gender differences in depression or cognitive vulnerability. We found evidence for the cognitive scar model in our sample. We found that depression symptoms at age 13 significantly mediated the gender difference in cognitive vulnerability observed at age 15, even after controlling for initial levels of cognitive vulnerability. These findings contribute to a growing body of literature suggesting that one source of change in cognitive vulnerability in the transition to adolescence may be depressive symptoms, and extends this research to understanding emergent gender differences in cognitive style.

Another meditational model is the *stress generation* model, which suggests that depressive symptoms actually contribute to greater stress levels in the depressed individual's life (Hammen 1991, 2005). We found support for the stress generation effects, finding that depression symptoms at age 13 significantly mediated the gender difference in dependent interpersonal stress at age 15. Although other studies have found that depression among both males and females is associated with the generation of additional stress (see Hammen 2006, for a review), few have examined this relationship in the context of understanding how gender differences in stressful life events emerge. Several recent studies have suggested that greater exposure and/or greater sensitivity to interpersonal stress may help explain why adolescent girls report more depression symptoms than adolescent boys (Little and Garber 2004; Rose and Rudolph 2006; Shih et al. 2006). Our findings suggest that the direction of effects between interpersonal stress and depression may also be reversed such that as the gender difference in depression emerges in adolescence it may in turn contribute to these emergent gender differences in stress exposure, particularly in the interpersonal domain. Depressed mood has been associated with a variety of interpersonal behaviors that may negatively impact interpersonal relationships, including irritability, excessive reassurance seeking, helplessness, low social initiative, and rumination (see Hammen 2005; Rudolph 2009).

Does Gender Moderate the Relationships Between Cognitive Vulnerability, Stress, and/or the Vulnerability-Stress Interaction and Depression?

Following up on several recent studies suggesting that cognitive vulnerability, stress, or the vulnerability-stress interaction may be more strongly linked to depression for girls than boys in adolescence, we examined whether gender moderates the predictive relationship between cognitive vulnerability, stress, and/or the vulnerability-stress interaction and depression. We found interesting evidence for gender as a significant moderator of several predictor-depression relationships.

We observed that there was a stronger relationship between stressful life events and depression over time for girls than for boys. Across nearly all domains, with the exception of dependent noninterpersonal events, gender moderated the stress-depression relationship over time such that girls showed stronger main effects of stress on depression than did boys. Again, these findings are highly consistent with several other recent studies suggesting greater stress reactivity, in the form of depressive symptoms, among girls than boys. Rudolph and Hammen (1999) reported stronger correlations between depressive symptoms and general stressors among girls than boys. Ge and colleagues found a similar gender difference in stress reactivity specifically for independent stressors (Ge, Conger, & Elder 2001), and several studies have documented greater female stress reactivity to dependent, interpersonal, and peer stressors (Hankin et al. 2007; Little and Garber 2004; Liu and Kaplan 1999; Rudolph 2002).

Finally, there was evidence that the cognitive vulnerability-stress interaction predicted by the cognitive model of depression was present only for girls across the adolescent transition. This finding contributes to a growing body of literature reporting mixed findings with regards to gender moderation effects of the vulnerability-stress interaction. At least two studies have reported that the vulnerability-stress hypothesis was supported among adolescent boys but not adolescent girls (Hankin et al. 2001; Morris et al. 2008), while others have reported that the interaction was significant for girls but not boys (Abela 2001; Abela and McGirr 2007).

These results continue to highlight the fact that boys and girls may differ in their pathways to depression in adolescence, and that attempting to identify global differences in vulnerability, stress, or depression may mask these gender differences. Our results also highlight the importance of simultaneously considering mediation and moderation models when examining gender differences.

Clinical Implications

The current study suggests many potential opportunities for clinical intervention. Given the alarmingly high rates of adolescent depression, especially in the late high school years (ages 15–18), identifying pre-existing vulnerability factors that may be targets of preventive interventions is critical. One such target is clearly cognitive vulnerability, which this study and other recent studies (e.g. Cole et al. 2008) have demonstrated is still highly malleable during the transition to adolescence. Another clinical implication derives from our finding of gender differences in the fit of the cognitive vulnerability-stress model to predicting depressive symptoms. The overall model predicted a much greater percentage of the variance in depression symptoms for girls than for boys. Most notably, our results echo several other recent findings that girls are particularly vulnerable to developing depression in response to dependently generated peer stressors. Interventions targeted at helping girls develop better coping skills when faced with peer stressors may be particularly effective in preventing depression.

Study Limitations

Several limitations to the current study suggest avenues for future research. First and foremost, the current study is limited by its reliance upon self-report measures of all study constructs as well as depressive symptoms for the outcome. Although the vast majority of studies examining relationships between cognitive style, stress, gender, and depression in childhood and adolescence have relied upon similar methodologies, the strongest test of the cognitive vulnerability-stress model in adolescence would, of course, utilize cognitive vulnerability to predict onset of clinically diagnosed depressive episodes with clinician interviews to assess stress exposure. Second, our assessment points are 2 years apart; smaller, incremental changes in cognitive style, stress, and depressive symptoms were not captured and these may be especially important for better specification of the temporal direction of effects, especially gender effects. Third, we utilized a summer assessment schedule. Although youth were asked to report on stressors during the entire past year, it is possible that their self-report of academic and some peer stressors is suppressed by this schedule. Finally, our community sample was predominantly middle-class and white. As such, our results provide data regarding the cognitive vulnerability-stress model among non-referred white youth. Expanding this research to other racial and ethnic groups and to clinical samples would be a valuable contribution to the literature.

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