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Stress and the Development of Cognitive Vulnerabilities to Depression Explain Sex Differences in Depressive Symptoms during Adolescence

Jessica L. Hamilton,
Temple University

Jonathan P. Stange,
Temple University

Lyn Y. Abramson, and
University of Wisconsin-Madison

Lauren B. Alloy
Temple University

Abstract

Although cognitive vulnerabilities to depression have received considerable empirical support, little research has evaluated the differential development of cognitive vulnerabilities in adolescent girls and boys. The current study examined the role of stressful life events, as well as sex differences in reactivity and exposure to stress, in the development of negative cognitive style and rumination in a multi-wave study of 382 adolescents. Path analyses indicated that interpersonal dependent stress predicted higher prospective levels of negative cognitive styles and rumination. Additionally, girls' greater exposure to interpersonal dependent stress explained their higher levels of rumination, which accounted for girls' higher levels of depressive symptoms than boys. These findings suggest that interpersonal dependent stress is a significant risk factor for the formation of cognitive vulnerabilities to depression during adolescence, and that the sex difference in depressive symptoms may result from girls' greater exposure to interpersonal dependent stress and ruminative response style than boys.

Keywords

cognitive vulnerability; stress; adolescence; depression; sex differences

Adolescence is a crucial developmental period during which the rates of depressive symptoms and episodes dramatically increase (Avenevoli, Knight, Kessler, & Merikangas, 2008; Hankin et al., 1998). Whereas symptoms of depression rise for both boys and girls during this time (Ge, Lorenz, Conger, Elder, & Simons, 1994), research consistently has documented that the emergence of the sex difference in depression occurs in early

Correspondence concerning this article should be addressed to Lauren B. Alloy, Department of Psychology, Temple University, Weiss Hall, 1701 N. 13th St., Philadelphia, PA 19122. lalloy@temple.edu..

adolescence and continues into adulthood (Hankin et al., 1998). Although numerous risk factors have been identified in the etiology of depression, cognitive vulnerabilities have been implicated in the rise of depression during adolescence, and specifically in girls' elevated risk for depressive symptoms during this time (Abela & Hankin, 2008).

Two prominent cognitive vulnerabilities that have received considerable empirical support as risk factors for depression among children, adolescents, and adults are negative cognitive style and rumination (Abela & Hankin, 2008). Specifically, negative cognitive style refers to the tendency of individuals to attribute negative events to stable and global causes, and to infer negative consequences and self-implications following the occurrence of negative events (Abramson, Metalsky, & Alloy, 1989). For example, an individual with a negative cognitive style may attribute the end of a romantic relationship to the fact that he always will be unlovable (stable), which will badly affect all of his relationships (global), means there is something wrong with him (self), and will result in more bad things happening to him (consequences). However, someone without a negative cognitive style may attribute the termination of the relationship to causes that are unstable, specific, and without negative self-implications (e.g., the partner was not ready for a serious relationship and it won't affect my future relationships or other events in my life) and without any negative consequences (e.g., it is just this one person and has no bearing on my future romantic success). Additionally, rumination is defined as the tendency to focus repetitively and passively on one's depressive symptoms, as well as on the causes, meanings, and consequences of one's dysphoric mood (Nolen-Hoeksema, 1991). Adolescence represents a unique window for the identification of factors that contribute to cognitive vulnerability development, as evidence suggests that these cognitive vulnerabilities form during middle childhood and early adolescence and consolidate by later adolescence (Cole et al., 2008; Hankin, 2008; Hankin et al., 2009). Once these cognitive vulnerabilities are developed, they continue to be potent risk factors for depression throughout adolescence and adulthood (Alloy et al., 2006; Hankin, 2008). Thus, it is crucial to identify the developmental origins of negative cognitive style and rumination when these vulnerabilities are still forming.

Consistent with the timing of cognitive vulnerability development is the dramatic rise of stressful life events that occurs during adolescence (Ge, Lorenz, Conger, Elder, & Simons, 1994). Indeed, stressful life events have been found to predict the development of negative cognitive styles and the tendency to engage in rumination among adolescents (Calvete, Oroe, & Hankin, 2013; Garber & Flynn, 2001; Mezulis, Hyde, & Abramson, 2006; Michl et al., 2013; Nolen-Hoeksema et al., 1992). But, how might stressors contribute to the development of cognitive vulnerabilities? First, the occurrence of negative life events may provide adolescents with an opportunity to learn and practice making negative inferences for events. Although individuals initially may make benign attributions for the occurrence of events, benign attributions become difficult to maintain with continued exposure to negative events, thereby leading to the formation of negative cognitive styles (Rose & Abramson, 1992). Additionally, given that negative events often induce dysphoric mood, stressors may lead individuals to spend more time focusing on their depressed mood and its causes and consequences, thereby leading to habitual rumination. Further, stressful events interfere with coping and problem-solving strategies (Baumeister, Gailliot, DeWall, & Oaten, 2006), thereby reducing the ability to disengage from negative information and mood, which may

lead to more negative inferences and ruminative thinking (Joormann, 2006). Thus, individuals exposed to stress may make negative inferences and ruminate more frequently, ultimately contributing to these cognitions becoming more trait-like.

Although stress has been found to predict cognitive vulnerability formation, less research has focused on whether this could account for the sex difference in depressive symptoms that emerges during adolescence. Understanding the processes through which stressful events contribute to the formation of cognitive vulnerabilities and sex differences in depression is important for developing interventions that might lessen such cognitive risk for depression and prevent the life-long pattern of girls' higher incidence of depression than boys that emerges during adolescence.

In search of an explanation for girls' higher rate of depressive symptoms than boys beginning in adolescence, several models have focused on the roles of cognitive vulnerabilities and stressful events (e.g., Hankin & Abramson, 2001; Hyde et al., 2008; Nolen-Hoeksema & Girgus, 1994). For instance, an *exposure mediation model* suggests that the sex difference in depressive symptoms may emerge during early adolescence as a result of either girls' greater cognitive vulnerabilities or exposure to stressful events (Hyde et al., 2008; Mezulis et al., 2010). Additionally, the *reactivity moderation model* suggests that girls are more vulnerable or reactive to the occurrence of stress that arises in early adolescence and experience greater increases in depressive symptoms than boys (Nolen-Hoeksema & Girgus, 1994; Mezulis et al., 2010). However, neither of these models has examined stress in the context of cognitive vulnerability development and subsequent depressive symptoms, the aim of the present study.

Consistent with the *exposure mediation* model, there is considerable evidence that girls are exposed to more stressful events than boys during adolescence, particularly events that are interpersonal rather than achievement-related (Hankin et al., 2007). Several studies have found that girls' greater depressive symptoms than boys are a result of girls' greater exposure to interpersonal stressors, specifically those that are in some way *dependent* upon their behaviors or characteristics (Hankin et al., 2007; Rudolph, 2002; Rudolph & Hammen, 1999; Shih et al., 2006; Stange et al., 2014), but not events that are *independent* (fateful). Examples of interpersonal dependent stressors include events such as fights with friends or family members and end of romantic relationships, whereas interpersonal independent stressors are events such as death of a loved one or parental loss of employment. Further, prior research also indicates that girls' higher levels of cognitive vulnerability accounts for girls' greater increase in depressive symptoms during adolescence (Hankin & Abramson, 2002; Jose & Weir, 2008). Building upon prior research examining separate pieces of this model, our model proposes that girls' elevated exposure to interpersonal (specifically dependent) stress may provide them with more opportunities to ruminate and make negative inferences, and thus, may contribute to the development of more negative cognitive styles and ruminative tendencies among girls. This greater cognitive vulnerability, in turn, may lead to girls' greater increases in depressive symptoms than boys during adolescence. However, the present study is the first to examine the exposure mediation model in relation to the development of cognitive vulnerabilities, and to further investigate whether girls'

heightened exposure to stressors and subsequent levels of cognitive vulnerability explain the sex difference in depressive symptoms.

Additionally, there is some evidence to support the *reactivity moderation model*. Several studies have found that even at comparable levels of stress, girls are more likely than boys to have depressive reactions to certain types of stress, particularly interpersonal dependent stress (Hankin et al., 2007; Rudolph, 2002; Rudolph & Hammen, 1999; Shih et al., 2006). There may be pre-existing sex differences in vulnerability that make girls more reactive to the occurrence of stress in early adolescence (i.e., stress reactivity). Thus, it is possible that adolescent girls may be more stress-reactive than boys in general, and may experience greater increases in cognitive vulnerabilities in reaction to the occurrence of stressful interpersonal events. Further, these greater increases in negative cognitive style and rumination following stress also may explain the emerging sex difference in depressive symptoms during this time. In this way, girls may experience greater increases in cognitive vulnerabilities in response to stress (i.e., greater stress reactivity), which, in turn, leads to increases in depressive symptoms. To date, only one study has examined this pathway, failing to find evidence that girls are more reactive to the occurrence of stressful events in the development of rumination (Michl et al., 2013). However, this study only examined the total number of stressful events, but did not examine different domains of events to which girls might be more reactive, such as interpersonal dependent events.

The existing literature reviewed above has provided a fragmented and incomplete evaluation of these two theoretical models of the sex difference in depression that emerges during adolescence. To address these critical gaps, the purpose of the current study was to prospectively examine stressful life events as predictors of cognitive vulnerabilities among early adolescents, and whether this contributes to the sex difference in depressive symptoms during this time. First, we examined the impact of three types of stressful events (interpersonal dependent, interpersonal independent, and achievement events) on prospective levels of negative cognitive style and rumination. Second, the current study evaluated two developmental models of cognitive vulnerabilities and depressive symptoms: the exposure mediation model (i.e., that girls' greater exposure to stressful life events contributes to greater cognitive vulnerabilities, which, in turn, explains the sex difference in depressive symptoms), and the reactivity moderation model (i.e., girls would be more reactive to the occurrence of stress in the form of experiencing greater cognitive vulnerabilities, which would explain sex differences in depressive symptoms).

We hypothesized that only interpersonal dependent stressors, but not interpersonal independent or achievement stressors, would predict prospective levels of negative cognitive style and rumination. Additionally, it was expected that both models of sex differences would be supported, such that girls would experience greater prospective levels of negative cognitive style and rumination as a result of greater exposure and reactivity to stress. Further, we hypothesized that greater prospective levels of negative cognitive style and rumination would explain sex differences in depressive symptoms, as a result of both girls' greater reactivity and exposure to interpersonal dependent stress compared to boys.

Method

Sample Recruitment

The current sample of 382 adolescents were recruited as part of the Temple University Adolescent Cognition and Emotion Project, an ongoing longitudinal study to evaluate sex and racial differences in the development of depression among Caucasian and African-American adolescents (Alloy et al., 2012). Specifically, Caucasian and African American adolescents who were 12- or 13- years old were recruited from Philadelphia-area middle schools through either school mailings and follow-up phone calls (approximately 68% of the sample) or advertisements placed in Philadelphia-area newspapers (approximately 32% of the sample). Interested participants completed a screening over the phone to initially determine eligibility. To be eligible for the study, adolescents had to be 12 or 13 years old (which is just prior to the age of greatest risk for depression), self-identify as Caucasian/White, African-American/Black, or Biracial (Hispanic adolescents were eligible if they also identified as White or Black), and have a mother/primary female caretaker also willing to participate in the study.[1] Adolescents were ineligible for the study if there was no mother/primary female caretaker available to participate; the mother or adolescent was psychotic, mentally retarded, had a severe developmental disorder, or a severe learning disability; and 3) the mother or adolescent was unable to complete study measures due to the inability to read or speak English or for any other reason (see Alloy et al., 2012, for further details regarding recruitment).

Study Sample

The sample for the current study consisted of 382 adolescents who completed an initial baseline assessment (Time 1) and up to three follow-up assessments (Times 2, 3, and 4), each of which were approximately seven months apart. Thus, the follow-up assessments were conducted approximately across ages 12-15 (Time 1 mean age = 12.87 years, *SD* = 0.61; Time 4 mean age = 14.67 years; *SD* = 0.89). The study sample was 51% African-American and 53% female. In terms of socioeconomic status, 26% of participants had family incomes falling below $30,000, 35% between $30,000 - $59,999, 18% between $60,000 - $89,999, and 21% above $90,000. Overall, 46% of participants were eligible for free school lunch, a measure of financial need that accounts for the number of dependents being supported on the family's income.

Of the original 382 adolescents who completed the Time 1 assessment, 366 families (95.8%) completed a Time 2 assessment, 306 (80.1%) completed a Time 3 assessment, and 275 (72.0%) completed Time 4. Analyses comparing adolescents with and without longitudinal data revealed that adolescents who completed only the Time 1 assessment were significantly more likely to be Caucasian than those who completed assessments at Time 2 (χ^2 = = 5.73, p = .02), Time 3 (χ^2 = = 3.81, p < .05), and Time 4 (χ^2 = 7.38, p <. 01). There was no evidence of significant differences or attrition bias on any other demographic characteristics or study variables for adolescents who completed assessments at Time 2, but not Times 3 and 4, or

[1]Mothers were selected to participate in this longitudinal study because maternal psychopathology has been linked to the development of depression in their offspring (Goodman et al., 2011).

those who participated at Times 2 and 3, but not Time 4. Because list-wise deletion would have unnecessarily omitted data, the current analyses were conducted using the full sample of 382 adolescents. Analyses conducted using only those adolescents with complete data at all four times yielded similar patterns of results.

Procedures

Four assessments spaced approximately seven months apart (M = 208.33 days; SD = 73.62 days) were utilized in the current study to provide a fully prospective design and a strong test of the mediation hypothesis that prospective levels of negative cognitive style and rumination following stress would mediate girls' higher levels of depressive symptoms over time. At Time 1, adolescents completed self-report questionnaires evaluating cognitive vulnerabilities, including rumination and negative cognitive style, and current depressive symptoms. At the Time 2 assessment, participants completed self-report questionnaires assessing experiences of stressful life events that occurred between the Time 1 and Time 2 assessments; adolescents were then interviewed to obtain further information on event occurrences. Adolescents also returned for the Time 3 assessment in which they again completed self-report questionnaires assessing rumination and negative cognitive style. Finally, at the Time 4 assessment, adolescents completed a self-report questionnaire of current depressive symptoms. Adolescents were compensated for their participation at each study visit.

Measures

Depressive symptoms—The Children's Depression Inventory (CDI; Kovacs, 1985) is a 27-item self-report measure designed to assess affective, behavioral, and cognitive symptoms of depression in youth ages 7 to 17. Each of the 27 items is rated on a 0 to 2 scale and items are summed for a total depression score (ranging from 0 to 54), with higher scores indicating more depressive symptoms. The CDI has good reliability and validity (Klein, Dougherty, & Olino, 2005). Internal consistency in this sample was α = .85 at Time 1 and α = .88 at Time 4.

Negative Cognitive Style—The Adolescent Cognitive Style Questionnaire-Modified(ACSQ-M; Alloy et al., 2012) is a modified version of the ACSQ (Hankin & Abramson, 2002), which assesses adolescents' cognitive styles based on their interpretations of the causes and consequences of negative life events. In addition to events in the achievement and interpersonal domains from the original ACSQ, the ACSQ-M also contains negative events in the appearance domain, which is another area of importance during adolescence. The ACSQ-M presents adolescents with 12 hypothetical negative events in the achievement, interpersonal, or appearance domains (4 events per domain). Examples of different hypothetical events are "You want to go to a big party, but nobody invites you," "You take a test and get a bad grade," and "You get into a big fight with your parents." Adolescents are asked to make inferences regarding the stability ("will it cause [the same event] to happen in the future?"), and globality ("will it cause problems in other parts of your life?") of causes, as well as the consequences ("will other bad things happen to you in the future because of [the event]?") and self-worth implications ("Is there something wrong with you because of [the event]?") of each event. Each dimension is rated on a 1 to 7 scale,

with higher scores indicating a more negative cognitive style. A composite negative cognitive style was calculated by summing the dimensions of stability, globality, consequences, and self across the achievement, interpersonal, and appearance domains. The ACSQ and ACSQ-M have demonstrated excellent internal consistencies, good retest reliabilities, and adequate factor structure as measures of negative cognitive style among adolescents (Hankin & Abramson, 2002; Alloy et al., 2012). Internal consistency in this sample for overall negative composite score at Time 1 was $\alpha = .93$ and $\alpha = .96$ for Time 3.

Rumination—The Children's Response Styles Questionnaire (CRSQ; Abela, Vanderbilt, & Rochon, 2004) is a 25-item self-report questionnaire assessing youths' responses to sad or depressed mood with rumination, distraction, or problem-solving. Adolescents rate the frequency of their thoughts or feelings when they are sad on 4-point scales ranging from never (1) to almost always (4), with higher scores within a subscale indicating a greater tendency to use that response style when experiencing sad/depressed mood. The current study used only the rumination subscale. The CRSQ has shown good validity and moderate internal consistency in previous studies (Abela et al., 2004). Internal consistency for the rumination subscale at Time 1 in this sample was $\alpha = .79$ and $\alpha = .78$ for Time 3.

Negative Life Events—The Adolescent Life Events Questionnaire (ALEQ; Hankin & Abramson, 2002) is a self-report questionnaire designed to assess the occurrence of negative or stressful life events that typically occur during adolescence, including family, peer, and school/achievement events. Adolescents and their mothers completed separate versions of the 63-item ALEQ and indicated all events that occurred in the adolescent's life since the Time 1 assessment. Following completion of the ALEQ, adolescents completed the Life Events Interview (LEI; Safford, Alloy, Abramson, & Crossfield, 2007) with trained interviewers to determine whether events endorsed on the ALEQ by adolescents and/or their mothers met a priori definitional criteria and occurred during the outlined time period. Interviewers used a priori probes specific to each event to aid in determining event eligibility. Any events that did not meet the stringent criteria were disqualified, thus reducing the potential for reporter bias.

All events were divided into separate domains, including interpersonal and achievement events, and were categorized as either dependent (occur at least in part because of the characteristics or behavior of an individual) or independent (fateful events to which an individual would not be expected to contribute) (e.g., Hammen, 1991). A team of four doctoral students in clinical psychology independently provided a priori dependence and independence ratings for all 63 events ($\kappa = .76$). Any discrepancies of ratings were discussed before a consensus rating was made, resulting in a total of 42 dependent and 21 independent events. All events were further categorized as either interpersonal (e.g. romantic break up) or achievement (e.g. failed a test), resulting in 47 interpersonal events (31 dependent; 16 independent), 10 achievement events (all 10 were categorized as dependent), and 6 events that were judged as neither interpersonal nor achievement-based that were not included in the current analyses. The present study analyzed stressors that were interpersonal dependent ("You weren't friends with the people you wanted to be friends with"), interpersonal independent ("Your parents had arguments with each other"), and achievement ("You did

not understand the material the teacher was teaching you"). All qualifying events based on the LEI were totaled in each category, with higher scores indicating more exposure to the type of stressors in each category. The ALEQ and LEI have demonstrated excellent reliability and validity (e.g., Hankin & Abramson, 2002; Safford et al., 2007).

Results

Descriptive Analyses

Descriptive statistics for the overall sample and by sex are presented in Table 1. Analyses also were conducted to determine if primary outcome variables were associated with sex (*t*-tests and effect sizes reported in Table 1). There were no sex differences on Time 1 depressive symptoms or rumination, but adolescent boys reported significantly more negative cognitive styles than girls at Time 1. As anticipated, sex differences occurred at follow-up assessments, with girls reporting significantly more rumination at Time 3 and depressive symptoms at Time 4 than boys. However, adolescent boys and girls exhibited comparable levels of negative cognitive styles at Time 3, with adolescent boys experiencing reductions in negative cognitive style from Time 1 to Time 3. Further, girls reported significantly higher levels of interpersonal dependent stress and interpersonal independent stress, but not more achievement stress, than boys at Time 2.

Table 2 presents correlations for all primary study variables. As expected, Time 1 negative cognitive style and rumination were significantly positively correlated with each other, and both were significantly positively correlated with Time 3 negative cognitive style and rumination. Additionally, all types of stress were significantly positively correlated with each other, Time 3 rumination, and depressive symptoms at Time 1 and Time 4. Only interpersonal dependent stress was positively correlated with negative cognitive style at both time points. Further, symptoms of depression at Times 1 and 4 were positively associated with all other study variables.

Prospective Analyses of Direct Effects

Direct paths were examined with path analysis using structural equation modeling (SEM) software (Mplus 6.11) with full information maximum likelihood estimation to examine study hypotheses (Muthén & Muthén, 2007). This method allowed parameters to be estimated for all 382 participants, including those without complete data at all assessments. [2] For all analyses, Time 1 cognitive vulnerabilities (rumination and negative cognitive style), Time 1 depressive symptoms, and sex served as covariates. First, we examined whether Time 2 stress (interpersonal dependent, interpersonal independent, and achievement) predicted Time 3 negative cognitive style and rumination (i.e., direct effect paths).

As hypothesized, interpersonal dependent stress predicted higher levels of negative cognitive style, controlling for initial cognitive style, depressive symptoms, and sex (Table 3), whereas interpersonal independent and achievement stress did not significantly predict Time 3 negative cognitive style, controlling for Time 1 negative cognitive style (Table 3).

[2]These analyses also were conducted with participants who had complete data on all study measures. These analyses revealed the same pattern of results as reported here.

Further, consistent with hypotheses, interpersonal dependent stress also significantly predicted prospective levels of rumination, controlling for initial rumination, depressive symptoms, and sex (Table 3). However, interpersonal independent and achievement stress did not predict prospective levels of rumination (Table 3).

Moderation Analyses of Stress Reactivity Model

To determine whether girls were more reactive to stress than boys, we examined whether sex moderated the effects of Time 2 stress by testing interactions between sex and each type of stress as predictors of prospective levels of Time 3 negative cognitive style and rumination. Sex did not significantly moderate the effects of any stressors on levels of negative cognitive style or rumination (results available upon request). Thus, girls were not more likely to experience greater prospective levels of cognitive vulnerabilities following the occurrence of stress in any domain (i.e., girls did not show greater reactivity to stress in the form of negative cognitive style or rumination).

Mediational Analyses of Stress Exposure Model

To evaluate the hypothesis that girls' greater exposure to stress accounts for prospective levels of cognitive vulnerabilities, which, in turn, predicts prospective levels of depressive symptoms, mediational analyses were conducted using path analysis and bootstrapping procedures. The nonparametric bootstrapping procedure approximates the sampling distribution of a statistic from the available data and is recommended for tests of mediation (MacKinnon et al., 2004). Bias-corrected confidence intervals of indirect effects were obtained using 10,000 resamples (Hayes, 2009). To meet criteria for mediation, each pathway in the model must be significant and the direct effect between the independent and dependent variables must be reduced when the mediator is entered into the model (i.e., a significant indirect effect). Consequently, the stress reactivity model was not further examined in the mediational framework.

Given that there was only evidence of a direct relationship between interpersonal dependent stress and negative cognitive style and rumination, mediational hypotheses were examined using one model to examine paths with interpersonal dependent stress. Specifically, the SEM model was fitted to test whether (1) greater exposure to interpersonal dependent stress at Time 2 mediated the relationship between being female and having higher levels of negative cognitive style and rumination at Time 3, and (2) whether the effect of sex on depressive symptoms at Time 4 was accounted for by interpersonal dependent stress at Time 2 and subsequent negative cognitive style and rumination at Time 3, controlling for initial depressive symptoms and initial cognitive vulnerabilities. Time 1 variables (CDI, ACSQ, and CRSQ) and sex were allowed to covary with one another, as well as with Time 3 ACSQ and CRSQ.

First, we tested the direct effect of sex on Time 4 depressive symptoms, controlling for initial depressive symptoms. As expected, sex significantly predicted Time 4 depressive symptoms, such that girls reported higher levels of depressive symptoms than boys ($\beta = .15$, $p < .01$), controlling for initial depressive symptoms. Next, we tested the mediational hypothesis. This model had a satisfactory fit, ($\chi^2 = 40.65$ ($df = 20$), $p < .01$; comparative fit

index (CFI) = .95; root mean square error of approximation (RMSEA) = .05 [CI = .03 - .07]; standardized root mean square residual (SRMR) = .06). Consistent with study hypotheses, all pathways in the model presented above were significant (Figure 1), with the exception of the pathway between sex and Time 3 negative cognitive style (β = .03, p = .57). Consequently, all hypothesized mediation paths including negative cognitive style were rendered nonsignificant. Overall, there was evidence for a significant indirect relationship between sex and prospective levels of rumination via interpersonal dependent stress (β = .05, SE = .02, CI = .03 – .13, p < .01). Further, there was a significant indirect effect between sex and prospective levels of depressive symptoms via interpersonal dependent stress and subsequent levels of rumination (β = .01, SE = .01, CI = .003 - .03, p = .03), with the effect of sex on depressive symptoms significantly reduced when both interpersonal dependent stress and rumination were entered into the model (Figure 1).

Thus, consistent with hypotheses, exposure to interpersonal dependent stress mediated the sex difference in rumination at Time 3, and the sex difference in depressive symptoms was accounted for by interpersonal dependent stress and levels of rumination, respectively. Contrary to hypotheses, there was no significant relationship between sex and negative cognitive style or between Time 3 negative cognitive style and subsequent depressive symptoms. Thus, although interpersonal dependent stress predicted higher prospective levels of negative cognitive style, this did not account for the relationship between sex and depressive symptoms.

Discussion

Although negative cognitive style and rumination are well-established risk factors for depression, less research has identified factors that contribute to the development of these cognitive vulnerabilities. The current study prospectively examined whether the occurrence of stress, specifically interpersonal dependent, interpersonal independent, and achievement events, contributed to the formation of negative cognitive style and rumination during adolescence. In support of our hypotheses, interpersonal dependent stress, but not interpersonal independent or achievement stress, predicted higher prospective levels of negative cognitive style and rumination, controlling for initial levels of cognitive vulnerabilities. Further, this study examined two models through which stress might explain sex differences in cognitive vulnerabilities and depressive symptoms. Our results supported the exposure mediation model, but not the reactivity moderation model, indicating that girls' greater exposure to interpersonal dependent stress contributed to sex differences in rumination at Time 3. There was no support for either model in relation to the development of negative cognitive style. Further, this is the first study to demonstrate that girls' higher levels of depressive symptoms than boys during early adolescence are accounted for by both girls' greater exposure to interpersonal dependent stress and ruminative tendencies relative to adolescent boys.

Our finding that interpersonal dependent stress predicted higher prospective levels of negative cognitive style and rumination is consistent with the notion that cognitive vulnerabilities continue to change during early adolescence (e.g., Abela & Hankin, 2008), and extends past research demonstrating that stressful life events predict more negative

cognitive styles and rumination during adolescence (e.g., Calvete et al., 2013; Mezulis et al., 2011; Michl et al., 2013) by examining specific domains of stressors and simultaneously examining both cognitive vulnerabilities. Specifically, our results indicate that adolescents are vulnerable to developing negative cognitive styles and ruminative tendencies as a result of interpersonal stress that is in some way dependent on them, but not stress that is interpersonal and independent or achievement-based. These findings support the notion that adolescents are particularly sensitive to dependent stress in the interpersonal domain (Furman & Buhrmester, 1992), perhaps due to a greater sense of personal responsibility for interpersonal events to which they directly or indirectly contributed. Thus, adolescents may appraise these events with more global and stable attributions, as well as more negative self-implications and consequences. Additionally, given that interpersonal dependent stress tends to include events such as conflict and rejection by family or peers, these stressors often induce dysphoric mood, which may generate more rumination about the depressive affect and its possible causes and consequences. Consequently, interpersonal dependent stress specifically contributes to the development of more negative cognitive styles and ruminative tendencies during adolescence.

Importantly, our results provide support for an exposure mediation model in which girls' heightened exposure to stress explains girls' greater engagement in rumination than boys in adolescence. However, contrary to hypotheses, we did not find evidence for the stress reactivity model that adolescent girls would be more prone to experiencing higher prospective levels of cognitive vulnerabilities in response to the occurrence of stress. Although several studies have found that adolescent girls are more reactive to stress in the form of depressive symptoms (Hankin et al., 2007; Shih et al., 2006), this reactivity may be specific to emotional reactions following stress and have little impact on the development of cognitive vulnerabilities (Rudolph, 2002). Thus, given similar levels of stress, girls and boys may be equally likely to develop negative cognitive styles and ruminative response styles. However, our findings suggest that it is girls' greater exposure to interpersonal dependent stressors that contributes to their higher levels of rumination than boys, which accounts for the sex difference in depressive symptoms that continues to increase across adolescence.

There are several reasons why adolescent girls may experience more interpersonal, particularly dependent, stress than boys. For one, the nature of male and female interpersonal relationships may increase girls' exposure to stress. Specifically, whereas male relationships are based more on companionship and activity, female relationships tend to be focused on emotional support and self-disclosure (Maccoby, 1990). This may increase the possibility of betrayal or girls' awareness of stress in the lives of friends or family. Additionally, adolescent girls' self- esteem relies more on interpersonal relationships than boys, and girls place more value on loyalty and intimacy within relationships (Gore, Aseltine, & Colten, 1993). Thus, normative shifts and changing dynamics in relationships or social networks may create more stressful events for adolescent girls than boys. Consequently, girls' greater exposure to interpersonal dependent events may explain the development or maintenance of girls' greater ruminative tendencies, which, in turn, leads to girls' depressive symptoms. Although past theory and empirical research implicates girls' higher levels of stress and cognitive vulnerabilities in the rise of depression among adolescent girls (Hankin & Abramson, 2001; Hyde et al., 2008), this is the first study to

demonstrate the sequential pathway through which greater exposure to stress and prospective levels of rumination explain the sex difference in depressive symptoms in adolescence.

Interestingly, one unexpected finding that emerged in our study was that girls' greater exposure to stress did not mediate the relationship between sex and negative cognitive style. However, this was likely due to the absence of a sex difference in negative cognitive styles at Time 3 in the current sample. Consistent with several prior studies (e.g., Mezulis et al., 2010; Nolen-Hoeksema et al., 2001), adolescent boys reported significantly more negative cognitive styles than girls at Time 1, whereas girls and boys reported comparable levels of negative cognitive styles by Time 3, which suggests that girls may only exhibit more negative cognitive styles than boys in later adolescence (Hankin & Abramson, 2001). However, given that interpersonal dependent stress prospectively predicts negative cognitive styles, girls' heightened exposure to interpersonal dependent stress may continue to influence the development of negative cognitive styles among girls throughout adolescence, which may also contribute to the rise of depressive symptoms among girls during mid- to-late adolescence. Taken together, these findings suggest that relative to boys, girls' greater vulnerability in ruminating may appear earlier, whereas girls' greater vulnerability in the form of negative cognitive styles may continue to become more pronounced throughout adolescence.

It is important to note that adolescent girls did not experience *increases* in rumination or depression per se from Time 1 to Time 3 or Time 4. However, girls maintained relatively higher levels of depressive symptoms and rumination than boys across this period, whereas boys experienced a decline in symptoms and rumination. Thus, our study suggests that girls' greater exposure to interpersonal dependent stress may serve as a factor that maintains higher levels of rumination, thereby conferring risk for depression among adolescent girls. Further, less exposure to stressors, particularly interpersonal dependent stressors, among adolescent boys may reduce the tendency to ruminate, which subsequently reduces boys' risk for depressive symptoms during adolescence. Although the absolute levels of rumination and depressive symptoms did not increase as expected during this time, higher levels of cognitive vulnerabilities *relative* to same- age peers also may be an important indicator of risk for depression with the potential to increase across adolescence. Given that the largest increase in depression in adolescence occurs between the ages of 15 and 18 (Hankin et al., 1998), and our sample was only just beginning to turn age 15 by Time 4, it is possible that greater exposure to interpersonal dependent events in girls will lead to actual *increases* in rumination and negative cognitive styles and depressive symptoms as the girls in our sample age further.

Overall, the current study contributes to our understanding of the interplay between stressful life events, cognitive vulnerabilities, and sex differences in depressive symptoms during a phase of adolescence when depressive symptoms and stressful life events are increasing and cognitive vulnerabilities are coalescing. This study offered several methodological strengths that bolster the current findings and extend past research. These strengths included the use of a fully prospective design across four waves of data within the framework of structural equation modeling, which allowed for the simultaneous examination of several dependent

variables and mediational models with bootstrapping. Additionally, the use of a life stress interview with objective event dependency ratings likely enhanced the accuracy of our life event data and reduced the likelihood of shared method variance. Finally, this study examined a large demographically diverse sample of adolescents, which strengthens the generalizability of our findings. However, our sample only included adolescents from a metropolitan area who self- identify as African American and/or Caucasian, and thus, might not be representative of adolescents from other racial and ethnic backgrounds, or from less-populated regions.

It is important to note several other limitations. First, this study assessed symptoms of depression and vulnerabilities using self-report measures. Future research would benefit from the use of interviewer-based methods for assessing symptoms of depression and behavioral measures of cognitive vulnerabilities to combat potential self-report bias. Additionally, the measure of depressive symptoms may have been too time-specific and thus, only provided a snapshot of adolescents' depressive symptoms. Further, it is unclear whether our findings generalize to adolescents with diagnoses of depression. Although future studies would be enhanced by the inclusion of a diagnostic interview to assess depression, recent research suggests that depression may be better conceptualized as continuous rather than as discrete categories (Hankin, Fraley, Lahey, & Waldman, 2005). Another limitation is that the current study only included two prominent cognitive vulnerabilities to depression (negative cognitive style and rumination). Therefore, future research should examine the proposed pathway by evaluating other known cognitive vulnerabilities to depression, such as negative information-processing biases and dysfunctional attitudes. Further, the current study only examined sex differences in symptoms of depression. However, adolescence is a well-documented period for increases in a range of psychopathology, such as anxiety, particularly among girls. Thus, future research should examine whether the proposed pathway is specific to depression.

Despite these limitations, the current study adds to a growing body of research examining the role of cognitive vulnerabilities and stressful life events in the emerging sex difference in depressive symptoms during adolescence. Our findings highlight the importance of distinguishing between different types of stress and examining sex differences when evaluating the influence of stress on the development of cognitive vulnerabilities during adolescence. Specifically, our findings document the particularly detrimental effect of interpersonal dependent stress for adolescent girls (Rudolph, 2002; Shih et al., 2006), and demonstrate that interpersonal dependent stress, but not interpersonal independent or achievement stress, contributes to negative cognitive styles and rumination during adolescence. Further, this study extends past research by finding support for the stress exposure model. Specifically, girls' greater exposure to interpersonal dependent stress contributes to the development of a ruminative response style, which, in turn, leads to greater depressive symptoms among adolescent girls than boys. These findings highlight the importance of implementing prevention programs during early adolescence when these vulnerabilities are still consolidating. Further, our study suggests that prevention and intervention programs that incorporate both cognitive and interpersonal components may be the most beneficial in reducing depressive symptoms, particularly among girls. Specifically, programs should focus on reducing girls' greater exposure to interpersonal dependent stress

and promoting more adaptive (e.g., non-ruminative) coping strategies for girls to manage this type of stress, which is consistent with the goals of interpersonal psychotherapy for depressed adolescents (IPT-A; Mufson, Dorta, Moreau, & Weissman, 2011).

Although this study has significant implications for both research and practice, as it contributes to our understanding of stress exposure in cognitive vulnerability formation and its role in the sex difference in depressive symptoms during adolescence, there remain important directions for future research. First, given that the etiological foundations of depression are complex and multifaceted, an ambitious study to deepen our understanding of the development of potential sex differences in vulnerabilities to depression should evaluate the *reactivity* moderation and *exposure* mediation models across multiple domains of vulnerabilities, including cognitive (e.g., rumination), affective (e.g., emotional reactivity and dysregulation), and interpersonal (e.g., co-rumination) vulnerabilities, using multiple assessments from middle childhood to late adolescence. This multi-wave, longitudinal study also should incorporate other potential risk factors, ranging from environmental (e.g., stressful life events) to biological (e.g., psychophysiological reactivity or genetic) factors, in examining girls' greater vulnerability to depression. A study design of this nature would provide more nuanced information regarding the temporal precedence of these risk factors and vulnerabilities in relation to each other, as well as a better understanding of the timing in which cognitive and other vulnerabilities to depression first emerge. For example, a study with multiple assessments from childhood throughout adolescence would enable us to examine the trajectories of vulnerability development and the role of chronological age and pubertal maturation on differential development of vulnerabilities to depression among girls and boys.

Ecological momentary assessment designs also would allow for more frequent assessments that could be used to elucidate temporal relationships between cognitions, affect, and behaviors that may contribute to the occurrence of interpersonal dependent events among girls (i.e., explaining the stress exposure model). This type of design also could assess more precisely whether girls are more likely than boys to experience negative cognitions following stressful events (i.e., the reactivity model), which over time could consolidate into more negative cognitive styles. Future research utilizing these designs could provide insight into two important follow-up questions to the present study: 1) what leads girls to experience higher levels of certain types of stressors during adolescence, and 2) what are the mechanisms through which these stressors lead to cognitive vulnerability development?

Given that our findings regarding cognitive vulnerability development were specific to interpersonal *dependent* stressors, which suggests that individuals may be most vulnerable to cognitive vulnerability formation following stressors that are in some way dependent upon them, research is needed that integrates theory on *stress generation* (i.e., the process by which individuals play a role in the occurrence of stress in their lives) within cognitive vulnerability development. For example, the aforementioned studies could evaluate whether girls possess certain characteristics or behaviors during childhood or early adolescence that contribute to heightened exposure to interpersonal dependent stressors, which then leads to elevated cognitive vulnerabilities among girls and higher risk of depression. Further, these studies could also explore potential mechanisms through which stress exposure leads to

cognitive vulnerabilities (or other potential vulnerabilities). Specifically, does interpersonal dependent stress in particular lead to changes in the brain (e.g., prefrontal cortex) or executive functioning, which then facilitates the development and consolidation of rumination and negative cognitive styles? Thus, additional conceptual and empirical work is needed to extend the findings of this study to evaluate the antecedents of girls' greater exposure to interpersonal dependent stressors and mechanisms through which stress leads to cognitive vulnerability development.

In conclusion, the present study suggests that interpersonal dependent stressors may be important in understanding the development of cognitive vulnerabilities to depression in adolescence, particularly among girls. Extending the theoretical and empirical approach of the present study will be important for scientific advancement and greater understanding the sex difference in depression that emerges during adolescence.

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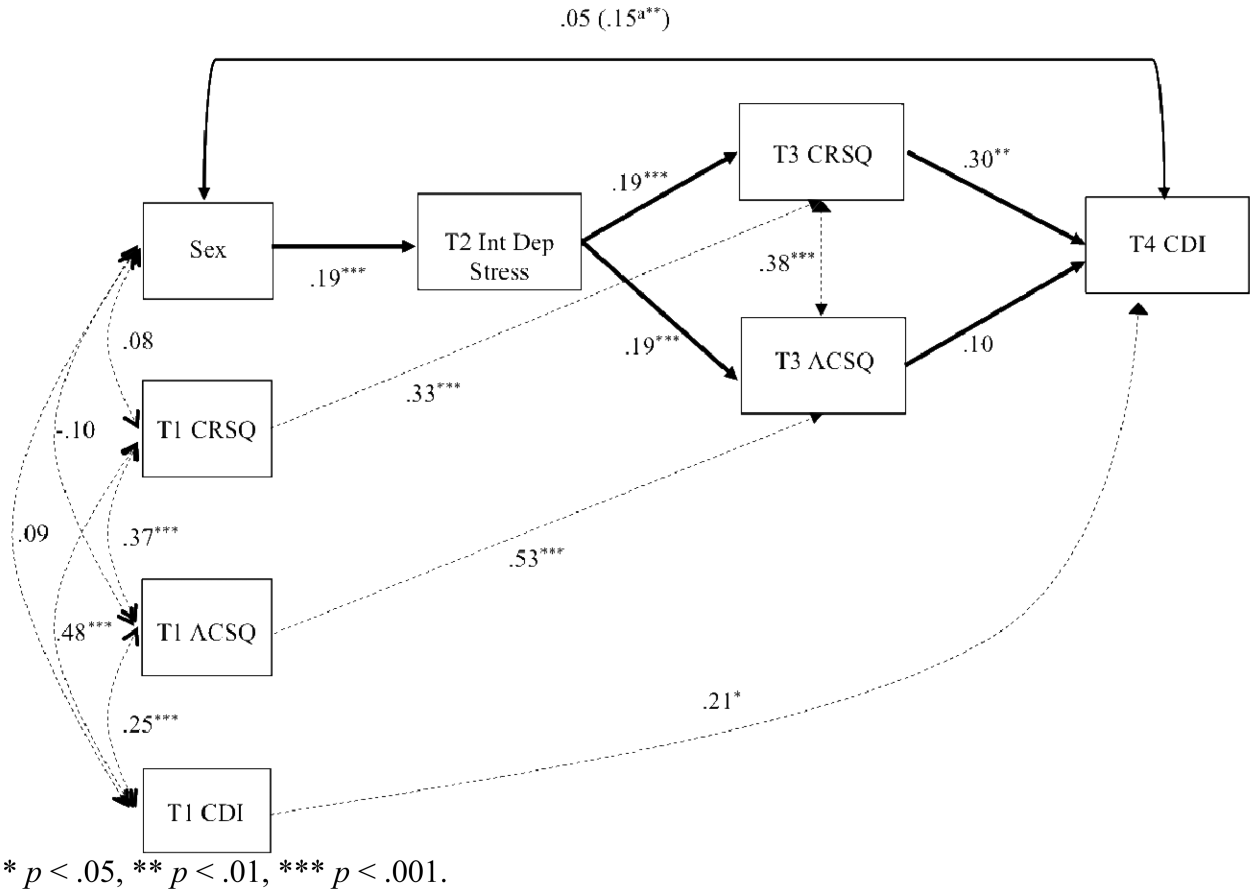

Figure 1.

Standardized path coefficients for the exposure mediational model. Note. [a]The direct effect of sex on depressive symptoms without the mediators in the model. T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4; ACSQ = Adolescent Cognitive Style Questionnaire; CRSQ = Children's Response Styles Questionnaire; CDI = Children's Depression Inventory. Sex coded as 0 = male, 1 = female. Paths parameterized but not displayed (for clarity of presentation) include paths between control variables (T1 CDI, T1 ACSQ, and T1 CRSQ) and T3 cognitive vulnerabilities and T4 CDI, as well as sex and T3 ACSQ (β = .03, $p = .63$) and T3 CRSQ (β = .19, $p < .001$), and T2 interpersonal dependent events and T4 CDI (β = .26, $p < .001$).

Table 1

Descriptive Statistics and Sex Differences in Study Variables

Measure	Overall Sample		Boys		Girls		Sex Difference	Cohen's d
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*	*d*
Time 1 (N = 382)								
CDI	7.12	6.15	6.53	5.13	7.64	6.88	1.82	0.18
ACSQ	117.29	40.33	121.76	41.32	113.35	39.11	2.05*	0.21
CRSQ	24.62	7.65	23.93	6.97	25.23	8.16	1.69	0.17
Time 2 (N = 366)								
Int. Dep	5.49	4.06	4.69	3.29	6.26	4.51	3.84***	0.40
Int. Indep	1.96	1.91	1.76	1.42	2.18	1.82	2.50*	0.26
Ach	2.79	1.66	2.79	1.82	2.85	1.99	0.30	0.03
Time 3 (N = 306)								
ACSQ	115.74	44.65	115.79	44.97	115.70	44.55	0.02	< 0.01
CRSQ	23.79	7.83	21.35	5.92	25.67	8.58	4.67***	0.59
Time 4 (N = 275)								
CDI	6.22	6.38	4.77	4.27	7.33	7.42	3.58***	0.42

Note.

** $p < .01$

CDI = Children's Depression Inventory; ACSQ = Adolescent Cognitive Style Questionnaire; CRSQ = Children's Response Style Questionnaire; Int Dep= Interpersonal Dependent Events; Int Indep = Interpersonal Independent Events; Ach = Achievement Events.

* $p < .05$

*** $p < .001$.

Table 2

Bivariate correlations among primary study variables.

	1	2	3	4	5	6	7	8	9
1. T1 CDI	--								
2. T1 ACSQ	.25**	--							
3. T1 CRSQ	.48***	.37***	--						
4. T2 Int Dep	.30***	.23***	.21***	--					
5. T2 Int Indep	.16**	.07	.10	.41***	--				
6. T2 Ach	.23***	.04	.05	.51***	.34***	--			
7. T3 ACSQ	.15**	.57***	.23***	.29***	.10	.09	--		
8. T3 CRSQ	.33***	.24**	.44**	.39***	.26***	.23***	.44***	--	
9. T4 CDI	.37***	.26***	.25***	.47***	.29***	.38***	.35***	.49***	--

Note.

* $p < .05$

CDI = Children's Depression Inventory; ACSQ = Adolescent Cognitive Style Questionnaire; CRSQ = Children's Response Style Questionnaire; Int Dep= Interpersonal Dependent Events; Int Indep = Interpersonal Independent Events; Ach = Achievement Events.

** $p < .01$

*** $p < .001$.

Table 3

Life Events Predicting Prospective Levels of Cognitive Vulnerabilities at Time 3

Outcome	Predictor	β	*SE*	R^2
Time 3 Negative Cognitive Style	T1 CDI	< .01	.06	.29***
	T1 ACSQ	.50	.05***	
	Sex	< .01	.06	
	Int Dep	.19	.07**	
	Int Indep	< .01	.06	
	Ach	−.02	.07	
Time 3 Rumination	T1 CDI	.08	−.06	.30***
	T1 CRSQ	.35	.06***	
	Sex	.19	.06***	
	Int Dep	.19	.07**	
	Int Indep	.11	.06	
	Ach	.08	.07	

Note.

* $p < .05$

CDI = Children's Depression Inventory; ACSQ = Adolescent Cognitive Style Questionnaire; CRSQ = Children's Response Style Questionnaire; Int Dep= Interpersonal Dependent Events at Time 2; Int Indep = Interpersonal Independent Events at Time 2; Ach = Achievement Events at Time 2. Sex coded as 0 = Male and 1 = Female.

** $p < .01$

*** $p < .001$.