

SEX DIFFERENCES IN THE CONTRIBUTION OF PUBERTY TO DEPRESSION: THE  
ROLE OF OTHER-SEX RELATIONSHIP STRESS

BY

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THESIS

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## ABSTRACT

Research suggests that the pubertal transition, particularly when experienced early relative to peers, is associated with heightened depression in girls but less depression in boys. This study examined whether exposure to stress within other-sex relationships serves as one process through which puberty differentially contributes to depression for girls and boys. Youth (51 girls; 34 boys;  $M$  age = 12.68,  $SD$  = 1.28) and their caregivers reported on pubertal status and age of menarche for postmenarcheal girls. Semi-structured interviews were conducted to assess youths' depression and exposure to romantic and platonic other-sex stress. As anticipated, more advanced status and earlier timing were associated with more depression in girls and less depression in boys. More advanced status and earlier timing were associated with less other-sex stress in boys, whereas earlier age of menarche was associated with more other-sex stress in girls. Other-sex stress partially mediated the association between earlier age of menarche and depression in girls, suggesting one process through which puberty is linked to risk for depression in girls.

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## Introduction

Ample research documents sex differences in the ways that adolescents negotiate the pubertal transition. In particular, evidence has indicated a difference in the relationship between pubertal development and the onset of depression. Before the onset of puberty, boys and girls share a similar risk for depression. However, at the onset of puberty the trajectories of depression begin to diverge, such that girls begin to outnumber boys in prevalence rates (Angold, Costello & Worthman, 1998; Hankin & Abramson, 2001; Wade, Cairney & Pevalin, 2002); this difference persists throughout the life course. Moreover, girls who exhibit earlier timing of puberty (Ge, Conger & Elder, 2001) and boys who exhibit later timing of puberty (Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997) are at the greatest risk for depression. This study examined whether stress within the context of other-sex relationships serves as one important difference in the way that boys and girls experience puberty that helps to explain the sex difference in depression. Specifically, we examined whether three indexes of puberty—pubertal status (absolute level of maturation), pubertal timing (level of maturation relative to one's peers), and age of menarche (an index of pubertal timing in girls) contribute to sex differences in depression through their impact on other-sex relationship stress.

Puberty is characterized by various unprecedented transitions within physical, psychological, and social contexts. Physical changes include alterations in body shape, fluctuating hormone levels, and a significant reorganization of the brain (Romeo, 2003). Psychological changes include maturation of executive functioning and shifts in cognitions associated with changing experiences (Blakemore & Choudhury, 2006; Mezulis, Hyde & Abramson, 2006). Social changes abound within the family and the peer group; for many youth, the adolescent transition is accompanied by entrance into middle school, which involves a new

level of autonomy, responsibility, and social disruption (Simmons, Burgeson, Carlton-Ford & Blyth, 1987).

It is clear that the pubertal transition represents a sensitive period in development when any number of the associated changes could lead to the destabilization that underlies susceptibility for depression. If boys and girls both face such vast changes at this stage, why is it that the onset of puberty is associated with higher levels of depression in girls but not in boys? Answering this question requires a consideration of the differences in the way that adolescents experience this transition. Some evidence suggests that varying characteristics of pubertal development make more advanced status or earlier timing a social disadvantage for girls but a social advantage for boys (Mendle, Turkheimer & Emery, 2006).

#### *Pubertal Status and Social Stress*

For girls, the onset of puberty is accompanied by increases in the hormone estrogen (which has on its own been posited to have a biochemical link to depression; Cutter, Norbury & Murphy, 2003), the emergence of secondary sex characteristics, and the onset of menstrual cycles. These physical transformations can manifest in the form of awkward personal discomfort, undesirable changes in body shape, and weight gain. Increased body fat can have an adverse effect on girls' self-image in societies where slenderness is idealized (Blyth, Simmons & Zakin, 1985), and researchers have found that more advanced pubertal maturation is associated with greater concerns about weight in girls (Compian, Gowen & Hayward, 2009). This and other physical-maturational changes also may lead to stressful social experiences such as teasing, harassment, or negative attention from same-sex and other-sex peers (Hyde, Mezulis, & Abramson, 2008). Indeed, McMaster, Connolly, Pepler and Craig (2002) found that same-sex

and other-sex sexual harassment was present during this developmental stage and that it was positively associated with advancing pubertal maturation.

For boys, on the other hand, advancing pubertal status is associated with some changes that may reduce social stress. In males, puberty is characterized by increases in testosterone, which, in turn, can result in increased height and muscle mass gain. These changes, in conjunction with the onset of secondary sex characteristics such as deepening voice and hair growth, can actually boost social status and self-esteem, perhaps due to increased athleticism and a more adult appearance. Muris, Meesters, van de Blom and Mayer (2005) found that adolescent boys made more attempts to become more muscular than girls, whereas adolescent girls made more attempts to lose weight than boys; for boys, more advanced status was associated with less social pressure to gain muscle mass.

#### *Pubertal Timing and Social Stress*

Beyond these effects of puberty itself, the timing of youths' maturation has been implicated as a contributor to depression. According to the stage-termination hypothesis (Petersen & Taylor, 1980), adolescents with earlier timing are insufficiently prepared and supported in the face of the cognitive and emotional demands of puberty. They are younger than average at the onset of puberty and they may not have had the opportunity to progress through prior developmental stages at a normal rate or in the normal order. Earlier-timers may also suffer somewhat as trailblazers who lack the support structures afforded to on-time peers. Of note, girls begin puberty earlier than do boys and they complete the transition more quickly (Parent et al., 2003). This means that, on average, girls exhibit more advanced pubertal status and earlier pubertal timing compared to boys of the same age, with a widening margin as girls advance more quickly. This also means that, on average, girls with earlier pubertal timing (compared to other

girls of the same age) experience the earliest timing overall, and boys with later timing (compared to boys of the same age) experience the latest timing overall. Thus, girls with earlier or even average (for a girl) timing may experience the most stress whereas boys with earlier timing may benefit from being one of the first members of their peer group to attain the socially desirable characteristics associated with advanced status in boys. Indeed, earlier pubertal timing (including earlier menarche) is linked to lower ratings for body image and self-esteem in girls (Williams & Currie, 2000) and predicts more positive social outcomes (marital success and satisfaction) into adulthood for boys (Taga, Markey & Friedman, 2006).

According to the risky social context hypothesis (Weichold, Silbereisen & Schmitt-Rodermund, 2003), earlier pubertal timing can also lead to affiliation with older peers, perhaps due to more mature appearance or interests. For girls, this tendency may spur earlier other-sex romantic relationships (Stroud & Davila, 2008). Not only are such affiliations (and their disintegration) likely to be fraught with psychological and social risk, but these stresses are experienced by girls with less developmental preparation than their on-time or late-timing peers.

#### *Other-Sex Stress and Depression*

In sum, the complex life transition of puberty is linked to stressful experiences in girls' but not boys' platonic and romantic relationships. Negative experiences with the other sex, such as teasing and difficult dating experiences, are in turn linked to depression (Compian, Gowen & Hayward, 2004; Rizzo, Daley & Gunderson, 2006). Compian et al. (2009) found that girls experiencing more relational victimization (from either sex) were at greater risk for depression when they were more physically mature, and Steinberg and Davila (2008) found that girls who reported more romantic experiences showed elevated depressive symptoms. This association between stress and depression may be especially pronounced for girls, who are particularly prone

to depression in the face of stressful interpersonal experiences during adolescence (Hankin, Mermelstein, & Roesch, 2007; Rudolph, Flynn, Abaied, Groot, & Thompson, 2009; Rudolph & Hammen, 1999). For girls, pubertal maturation may be related to more stressful experiences with the other sex; traversing this transition earlier than one's peers may accentuate the effect of puberty and associated stress on depression. For boys, advancing puberty may be characterized by fewer experiences of other-sex stress, and advancing earlier than one's peers may further reduce the chance of experiencing such stress (Natsuaki, Biehl & Ge, 2009). However, few studies directly examine the network of associations among puberty, other-sex stress, and depression, making it difficult to determine the precise role of other-sex stress.

### *Study Overview*

The goal of this study was to examine whether stress within other-sex relationships helps to account for sex differences in the link between puberty and depression. We investigated both platonic and romantic stressful experiences with members of the other sex. Specifically, we examined four hypotheses: (a) More advanced pubertal maturation and earlier pubertal timing would be associated with more depression in girls but with less depression in boys; (b) More advanced pubertal maturation and earlier pubertal timing would confer a social disadvantage upon girls (i.e., more stress in other-sex relationships) but a social advantage upon boys (i.e., less stress in other-sex relationships); (c) Both girls and boys who experienced more other-sex stress would show more depression, but this association would hold more strongly for girls than for boys; and (d) Other-sex stress would partly account for the puberty X sex contribution to depression (i.e., mediated moderation) and for the association between earlier age of menarche and depression in girls (i.e., simple mediation).



## Method

### *Participants*

Participants were 85 4<sup>th</sup> - 8<sup>th</sup> graders (51 girls, 34 boys;  $M$  age = 12.68,  $SD$  = 1.28) who were participating in a study of the adolescent transition. Participants were diverse in ethnicity (72.9% White, 17.7% African-American, 9.4% other) and socioeconomic background (annual family income < \$30,000 for 19.5% of the sample and > \$75,000 for 23.2% of the sample).

These youth were selected from a larger sample of 167 youth based on the availability of other-sex chronic stress data. Youth with and without the relevant data did not significantly differ in ethnicity [white vs. minority],  $\chi^2(1; N = 167) = 2.41, ns$ , income,  $t(160) = .38, ns$ , pubertal timing,  $t(156) = .23, ns$ , age of menarche,  $t(43) = .40, ns$ , or depression,  $t(165) = 1.08, ns$ .

Compared to youth without relevant data, those with data were more likely to be girls,  $\chi^2(1; N = 167) = 5.01, p < .05$ , older,  $t(165) = 3.03, p < .01$ , and more pubertally advanced,  $t(156) = 2.12, p < .05$ . These differences did not result from self-selection; rather availability of other-sex stress data was due to procedural issues (i.e., administration of this assessment began part way through the study). In no cases did youth decline completion of this interview.

Participants in the original sample of 167 were recruited based on school-wide screenings for depressive symptoms using the Children's Depression Inventory (CDI; Kovacs, 1992). We selected youth with a range of CDI scores, oversampling slightly for those with scores above 18. Participants and non-participants in the larger study did not differ in sex,  $\chi^2(1, N = 468) = .39, ns$ ; ethnicity,  $\chi^2(1, N = 468) = .02, ns$ ; or CDI scores,  $t(280) = 1.11, ns$ . Participants ( $M$  age = 12.41 years,  $SD$  = 1.19) were slightly younger than nonparticipants ( $M$  age = 12.65 years,  $SD$  = 0.89),  $t(275) = 2.28, p < .05$ .

## *Procedures*

Families were recruited through phone calls to the primary female caregivers. Interested families completed a three- to four-hour assessment during a laboratory visit. Caregivers provided written consent and youth provided written assent. Youth and caregivers then independently completed the puberty questionnaires and diagnostic interview, and youth completed the other-sex chronic stress interview. Caregivers were given a monetary reimbursement and youth were given a gift certificate.

To avoid contamination of the diagnostic and life stress information, two different staff members conducted these interviews. Diagnostic interviews were conducted by a faculty member in clinical psychology, psychology graduate students, or a post BA-level research assistant. Diagnoses were made through consultation with the clinical psychology faculty member. Life stress interviews were conducted by psychology graduate students, post BA-level research assistants, or advanced undergraduate students. Interviewers underwent extensive preliminary training that involved: (a) reviewing the interview protocols and diagnostic criteria, (b) listening to prior audio-taped interviews and making independent diagnoses, and (c) role-playing and feedback. They also received extensive feedback based on audiotapes of their interviews, as well as during consensual coding sessions. A best-estimate approach (Klein, Ouimette, Kelly, Ferro & Riso, 1994) was used to assign consensual diagnoses that combined information from the caregiver and youth.

## *Measures*

Table 1 presents descriptive information for girls and boys. A series of *t*-tests was conducted to provide descriptive information about sex differences in the variables. Based on the Pubertal Development Scale, girls were significantly more developed than were boys,  $t(83) = 2.63, p < .05$ . No other significant sex differences were found. The absence of a sex difference in

depression is likely due to the fact that this sex difference tends to emerge during middle adolescence (about age 13; e.g., Costello et al., 2003; Ge, Lorenz, Conger, Elder, & Simons, 1994), and about half (51.8%) of the present sample was younger than 13 years old.

*Pubertal development.* Two measures of pubertal status were collected. First, youth and caregivers completed the Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988). The PDS includes five questions that assess stage of growth spurt, body hair growth, skin changes, voice change and facial hair (for boys), and breast development and menarcheal status (for girls). Items were rated on a 4-point scale (1 = *No development*, 2 = *Development has just begun*, 3 = *Development is definitely underway*, 4 = *Development is complete*). The menarcheal status item was rated using a dichotomous response (1 = *No*, 4 = *Yes*). The PDS has been well validated across several studies (Brooks-Gunn, Warren, Rosso, & Garigiulo, 1987; Petersen et al., 1988). Scores on the PDS are moderately correlated with physician ratings of the Tanner stages (Brooks-Gunn et al., 1987). Because strong correlations were found between youth and caregiver reports in the overall sample [ $r(68) = .88, p < .001$ , for girls, and  $r(58) = .72, p < .001$  for boys], composites were formed for each of the five items by averaging across informants (within this subsample,  $\alpha = .89$  for girls and  $.80$  for boys). When information was available from only one informant, this information was used on its own.

Second, youth and caregivers rated youths' stage of development using the Udry Line Drawings of the five Tanner stages (Morris & Udry, 1980). The girls' drawings depict breast and pubic hair development, and the boys' drawings depict genital and pubic hair development. Caregivers and youth checked which of the drawings most closely matched youths' current stage of maturation. Validity of this measure has been established through significant associations with physician ratings on physical exams (Morris & Udry, 1980; Schlossberger, Turner, & Irwin, 1992).

In the overall sample, strong correlations were found between girls' and caregivers' reports [ $r(65) = .83, p < .001$ , for breast development;  $r(62) = .69, p < .001$ , for pubic hair development] and between boys' and caregivers' reports [ $r(40) = .47, p < .01$ , for genital development;  $r(37) = .65, p < .001$ , for pubic hair development]. Composites were formed for each of the two items by averaging across informants. When information was available from only one informant, this information was used on its own. Within this subsample, the two items were strongly correlated in girls,  $r(50) = .84, p < .001$ , and in boys,  $r(31) = .92, p < .001$ . Of the 85 youth, 32% were in Tanner stages 1 or 2 (less advanced), 23% were in Tanner stage 3 (average), and 45% were in Tanner stages 4 or 5 (more advanced), suggesting a reasonable distribution across pubertal stages.

Confirmatory factor analyses in this data set yielded well-fitting measurement models using the seven items (five PDS and two Tanner) as indicators for a latent variable (Conley & Rudolph, 2009). Thus, a composite score was created by averaging the seven items, standardized within sex. Composite scores were calculated for youth with at least five of the seven indicators. Because prior research has used the Tanner stages alone as an index of pubertal development (Dorn, Susman, Nottelmann, Inoff-Germain & Chrousos, 1990; Morris & Udry, 1980), scores also were calculated for youth with Tanner data only, or Tanner data plus one to two PDS items. Higher scores reflected *more advanced* pubertal status.

Two indexes of pubertal timing were used. First, residualized scores were computed separately for girls and boys by regressing pubertal status onto chronological age (Dorn, Susman, & Ponirakis, 2003). Higher scores reflected *earlier* maturation relative to one's agemates. Second, age of onset of menarche was used as an index of pubertal timing in girls who had reached menarche, averaging across youth and caregiver reports [ $n = 29, r(28) = .96, p < .001, M$  age of onset = 11.83 years]. To facilitate interpretation of effects involving this variable (i.e., to make the interpretation

parallel to that for the calculated pubertal timing variable), the effects are presented such that higher scores on this variable reflect earlier age of menarche.

*Other-sex stress.* The Youth Life Stress Interview (Rudolph & Flynn, 2007) was administered to youth to assess chronic stress within other-sex relationships. This semi-structured interview uses the contextual threat method (Brown & Harris, 1978) to assess the occurrence and severity of chronic stress experienced by youth in the previous year. The present study focused specifically on stress within other-sex relationships. Interviewers used specific probes to elicit information about youths' exposure to ongoing stressful experiences in the context of other-sex platonic relationships (e.g., teasing) and romantic relationships (e.g., conflict). Detailed follow-up questions were asked as needed to establish the overall severity of stress. The interviewer then created a narrative summary of the overall experience of other-sex chronic stress.

Interviewers presented the narrative summaries to a team of coders with no prior knowledge of youths' experience of depression or their subjective response to the chronic stress. Coders assigned an objective stress rating reflecting the degree of chronic stress experienced on a scale from 1 (*No Negative Stress*) to 5 (*Severe Negative Stress*). Because ratings for other-sex platonic and romantic stress were highly correlated ( $r = .72, p < .01$ ), a composite other-sex chronic stress index was created by averaging the two ratings.

*Depression.* Interviewers individually administered the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version-5 (K-SADS-E; Orvaschel, 1995) to youth and their caregivers to assess youth depression. Based on Diagnostic and Statistical Manual of Mental Disorders criteria (American Psychiatric Association, 1994) regarding the number, severity, frequency, and duration of symptoms and resulting impairment, ratings of depressive symptoms were assigned on a 5-point scale: 0 = *No symptoms*, 1 = *Mild symptoms*, 2 = *Moderate symptoms*

(consistent with a minor depressive episode), 3 = *Diagnosis with mild to moderate impairment*, and 4 = *Diagnosis with severe impairment*. Separate ratings were assigned for each category of depression (e.g., major depression, dysthymia) and each period of depression during the year preceding the interview, including the present. These ratings were then summed to create continuous depression scores. Higher ratings reflected more severe symptoms within a single diagnostic category, the presence of symptoms from multiple categories, and/or multiple episodes of depression (for similar rating approaches, see Davila, Hammen, Burge, Paley, & Daley, 1995; Hammen, Shih, Altman, & Brennan, 2003; Hammen, Shih, & Brennan, 2004; Rudolph et al., 2000). Thus, these scores represent composite indexes of several different markers of depression severity.

Providing evidence for concurrent validity, these scores were significantly correlated with scores on the CDI (Kovacs, 1992) and the Youth Depression Inventory (Rudolph, 2002) in the overall sample ( $r_s = .46 - .57, p_s < .01$ ). Consistent with the use of this continuous index, contemporary conceptualizations of depression, derived in part from taxometric analyses, have suggested that depression is best represented on a dimensional continuum rather than as a discrete category (Fergusson, Horwood, Ridder, & Beautrais, 2005; Hankin, Fraley, Lahey, & Waldman, 2005; Shih, Eberhart, Hammen, & Brennan, 2006). Based on independent coding of 25% of the original sample of the audio-taped interviews, strong reliability (one-way random-effects intraclass correlation coefficient [ICC] = .95) was found for the continuous depression scores. Of the 85 youth, 11.8% met diagnostic criteria for major depression or dysthymia within the past year (i.e., a rating of 3 or 4 for at least one episode). An additional 14.1% had subthreshold symptoms of major depression, dysthymia, or other depressive disorders within the past year (i.e., a rating of 1 or 2 for at least one episode).

## Results

### *Overview of Analytic Approach*

First, zero-order correlations were calculated separately in girls and boys for descriptive purposes to investigate the general pattern of associations among the variables. Second, regression analyses were conducted to investigate whether sex moderated the contribution of pubertal status and pubertal timing to depression. Third, regression analyses were conducted to examine whether other-sex stress mediated the Pubertal Development X Sex contributions to depression (i.e., tests of mediated moderation). Regression analyses also were conducted to examine whether other-sex stress mediated the association between age of menarche and depression in girls. In light of the fact that we had specific, theoretically driven directional hypotheses, one-tailed significance levels are reported (Rosnow, Rosenthal & Rubin, 2000).

### *Correlational Analyses*

Table 2 presents correlations among the variables. As expected, more advanced pubertal status, earlier pubertal timing, and earlier age of menarche were significantly positively associated with depression in girls, and more advanced pubertal status and earlier pubertal timing were significantly negatively associated with depression in boys. Comparison of the correlations using Fishers r-to-Z transformations revealed that the correlations between puberty and depression differed significantly between girls and boys,  $Z_s > 3.38$ ,  $p_s < .001$ . Also as expected, earlier age of menarche was significantly positively associated with other-sex stress in girls, and more advanced pubertal status was significantly negatively associated with other-sex stress in boys. Comparison of the correlations using Fishers r-to-Z transformations revealed that the correlation between pubertal status and other-sex stress differed significantly between girls and boys,  $Z = 2.26$ ,  $p < .05$ . Earlier pubertal timing was positively associated with other-sex stress in

girls and negatively associated with other-sex stress in boys; although the correlation was only marginally significant in boys, the two did significantly differ,  $Z = 1.82, p < .05$ . Other-sex stress was significantly correlated with heightened depression in girls and only marginally correlated in boys, but the difference was not significant,  $Z = 1.07, ns$ .

### *Regression Analysis of Sex Differences*

Separate hierarchical multiple regression analyses were conducted to examine sex differences in the contribution of pubertal status and timing to depression. Sex and the mean-centered main effects of puberty were entered in the first step, and the two-way interaction was entered in the second step. Significant interactions were interpreted and depicted by solving the regression equation in girls and in boys.

For pubertal status, analyses revealed nonsignificant main effects of pubertal status and sex but a significant Pubertal Status X Sex interaction (see Table 3). Decomposition of the interaction (see Figure 1a) revealed that more advanced pubertal status was significantly associated with more depression in girls ( $\beta = .36, p < .05$ ) and less depression in boys ( $\beta = -.38, p < .05$ ). For pubertal timing, analyses again revealed nonsignificant main effects of pubertal timing and sex but a significant Pubertal Timing X Sex interaction (see Table 3). Decomposition of the interaction (see Figure 1b) revealed that earlier pubertal timing was significantly associated with more depression in girls ( $\beta = .35, p < .01$ ) and less depression in boys ( $\beta = -.45, p < .01$ ).

### *Mediation by Other-Sex Stress: Pubertal Status and Pubertal Timing*

The next set of analyses examined whether the Pubertal Status X Sex and Pubertal Timing X Sex contributions to depression were accounted for by experiences of other-sex stress (i.e., tests of mediated moderation). Several conditions must be satisfied to demonstrate mediated



moderation (Muller, Judd, & Yzerbyt, 2005). Condition 1 requires that the magnitude of the overall effect of the independent variable (puberty) on the dependent variable (depression) depends on the moderator (sex); Condition 1 was previously satisfied for pubertal status and timing (see Table 3). Condition 2 requires that the mediator (other-sex stress) accounts for the overall moderation effect. For this to be the case, either the effect of puberty on other-sex stress depends on sex and the average partial effect of other-sex stress on depression is significant and/or the partial effect of other-sex stress on depression depends on sex and the average effect of puberty on other-sex stress is significant. As a result, the moderation of the residual direct effect of puberty on depression is reduced compared to the overall moderated effect (Muller et al., 2005). To investigate Condition 2 in the present analyses, two regression analyses were conducted. The first regression examined whether the path from puberty to other-sex stress was moderated by sex (Condition 2a). The second regression examined whether other-sex stress or the Other-sex Stress X Sex interaction predicted depression after adjusting for the main and interactive effects of puberty and sex (Condition 2b), and whether the overall interactive effect of puberty and sex on depression was reduced upon inclusion of other-sex stress and the Other-Sex Stress X Sex interaction (Condition 2c).

First, hierarchical multiple regression analyses were conducted to examine whether sex moderated the association between puberty and other-sex stress (Condition 2a). Sex and the mean-centered main effects of puberty (either status or timing) were entered in the first step; the Puberty X Sex interaction was entered in the second step. These analyses revealed nonsignificant main effects of sex and pubertal timing, but a marginally significant main effect of pubertal status. Specifically, more advanced pubertal status predicted less other-sex stress. These analyses also revealed significant Pubertal Status X Sex and Pubertal Timing X Sex interactions (see

Table 4). As displayed in Figure 2a, more advanced pubertal status was significantly associated with less other-sex stress in boys ( $\beta = -.47, p < .01$ ) but was not significantly associated with other-sex stress in girls ( $\beta = .01, ns$ ). Similarly, as displayed in Figure 2b, earlier pubertal timing was marginally associated with less other-sex stress in boys ( $\beta = -.28, p < .06$ ) but was not significantly associated with other-sex stress in girls ( $\beta = .13, ns$ ).

Next, hierarchical multiple regression analyses were conducted to examine whether other-sex stress or the Other-Sex Stress X Sex interaction predicted depression after adjusting for the main and interactive effects of puberty and sex (Condition 2b). Sex and the mean-centered main effects of puberty (status and timing) were entered in the first step; the Puberty X Sex interaction, the mean-centered main effect of other-sex stress, and the Other-Sex Stress X Sex interaction were entered in the second step.

*Pubertal status.* For pubertal status, analyses revealed a nonsignificant main effect of other-sex stress and a significant Other-Sex Stress X Sex interaction (see Tables 5). Decomposition of the interaction (see Figure 3a) revealed that higher levels of other-sex stress were significantly associated with more depression in girls ( $\beta = .48, p < .001$ ) and marginally associated with more depression in boys ( $\beta = .27, p < .07$ ). The residual effect of the Pubertal Status X Sex interaction on depression was slightly smaller than the overall moderated effect (see Table 3; Condition 2c) but remained significant after adjusting for other-sex stress and the Other-Sex Stress X Sex interaction (see Table 5), suggesting that other-sex stress may partially mediate the interactive contribution of pubertal status and sex to depression. We therefore examined whether other-sex stress mediated the association between pubertal status and depression in girls and in boys. We examined two indexes to quantify the strength of mediation: the size and significance of the indirect effect (IE ; Sobel, 1982; 1986) and the effect proportion (indirect

effect/total effect; Shrout & Bolger, 2002). In girls, we found a nonsignificant indirect effect ( $IE = .01$ ,  $Z = .07$ , *ns*) and a small effect proportion (other-sex stress accounted for 1.4% of the total effect of pubertal status on depression). In boys, we also found a nonsignificant indirect effect ( $IE = -.06$ ,  $Z = -.57$ , *ns*) and a small effect proportion (14.4%).

*Pubertal timing.* For pubertal timing, analyses revealed a nonsignificant main effect of other-sex stress and a significant Other-Sex Stress X Sex interaction (see Table 5).

Decomposition of the interaction (see Figure 3b) revealed that higher levels of other-sex stress were significantly associated with more depression in girls ( $\beta = .48$ ,  $p < .001$ ) and marginally associated with more depression in boys ( $\beta = .27$ ,  $p < .06$ ). The residual effect of the Pubertal Timing X Sex interaction on depression was smaller than the overall moderated effect (see Table 3; Condition 2c) but remained significant after adjusting for other-sex stress and the Other-Sex Stress X Sex interaction (see Table 5), suggesting that other-sex stress may partially mediate the interactive contribution of pubertal timing and sex to depression. Again, we examined whether other-sex stress mediated the association between pubertal timing and depression in girls and in boys. In girls, we found a nonsignificant indirect effect ( $IE = .06$ ,  $Z = .90$ , *ns*) and a small effect proportion (16.8%). In boys, we also found a nonsignificant indirect effect ( $IE = -.04$ ,  $Z = -.81$ , *ns*) and a small effect proportion (9.6%).

#### *Mediation by Other-Sex Stress: Age of Menarche*

Finally, we conducted a series of hierarchical multiple regression analyses to examine whether other-sex stress mediated the association between earlier age of menarche and depression in girls (Baron & Kenny, 1986; see Table 6). First, results revealed that the effect of earlier age of menarche on other-sex stress was significant. Second, results revealed that the effect of other-sex stress on depressive symptoms, after adjusting for age of menarche, was

significant. Consistent with partial mediation, the association between age of menarche and depressive symptoms was reduced to nonsignificance after including other-sex stress. In further support of partial mediation, the indirect effect of age of menarche on depressive symptoms was marginally significant ( $IE = .15$ ,  $Z = 1.60$ ,  $p < .07$ ). Finally, the effect proportion indicated that other-sex stress accounted for 35% of the total effect of age of menarche on depressive symptoms. Overall, these findings suggest that other-sex stress partially mediated the association between earlier age of menarche and depressive symptoms in girls.

## Discussion

This study examined the hypothesis that other-sex stress would partially account for the differential association between pubertal development and depression in girls and boys. Evidence was obtained for the anticipated moderating influence of sex on the association between puberty and depression, puberty and other-sex stress, and other-sex stress and depression. Other-sex stress did not significantly account for the contribution of pubertal status or timing to depression; however, other-sex stress partially accounted for the association between earlier age of menarche and depression in girls.

### *Pubertal Development and Depression*

As expected, more advanced status and earlier timing were associated with heightened depression in girls. This finding meshes with the relatively well-established effect of puberty on depression in girls (e.g., Angold et al., 1998, Ge, et al., 2001). Conversely, less advanced status and later timing were associated with more depression in boys. This finding is consistent with some prior research (Graber et al., 1997); however, findings are mixed with regard to the link between pubertal development and depression in boys. Indeed, some research indicates that earlier timing in boys is associated with more internalizing symptoms (DeRose, Wright & Brooks-Gunn, 2006). In one study (Conley & Rudolph, 2009) earlier pubertal timing in boys was associated with less depression concurrently but with more depression over time. In addition, earlier puberty in boys may lead to other kinds of negative developmental outcomes. For example, earlier maturation is linked to higher levels of aggression, conduct problems, and substance abuse problems in boys (Huddleston & Ge, 2003); Williams & Dunlop (1999) found that both earlier and later off-time boys were at greater risk for antisocial and delinquent behaviors. These discrepant findings may be accounted for by several factors. For example, it

may be that the detrimental effects of earlier timing manifest over longer time periods and are not captured in concurrent studies or studies of younger boys. Alternatively, the deviance hypothesis posits that simply being off-time (earlier or later compared to peers) may be a more important risk factor for psychological adjustment. Thus, earlier timing boys may not necessarily be as vulnerable to concurrent depression as girls, but this does not mean that the pubertal transition is without risk.

### *Pubertal Development and Other-Sex Stress*

Consistent with our expectations, our data showed that pubertal status was associated with less other-sex stress in boys. Earlier age of menarche was associated with more other-sex stress in girls, and earlier pubertal timing was positively, albeit nonsignificantly, correlated with other-sex stress. The fact that the associations between pubertal status and timing and other-sex stress were significantly different and in opposite directions between boys and girls further supports the premise that puberty is associated with differing sex-linked other-sex relationship experiences.

Given the evidence linking pubertal maturation to increased social stresses, it is unclear why more advanced pubertal status was not associated with more other-sex stress in girls. It may be that though some consequences of pubertal maturation are stressful for girls (e.g., dating older boys, teasing owing to changing appearance), those consequences may not always coincide with all forms of measured pubertal maturation, such as hair and skin changes and growth spurts. In the domain of other-sex stress, the onset of menarche may be a more salient sign of the entry into adolescence, and therefore may be more strongly associated with engagement in mature other-sex relationships that are likely to lead to stress. Also, the negative effects of advanced status and earlier timing may take time to develop and to manifest in measured forms of other-sex stress

and so would not have been captured in this concurrent study. The link between advanced pubertal status and reports of other-sex stress may be driven by relatively slowly accumulating changes in physical, emotional, and social development. A longitudinal examination of pubertal development and long-term trajectories of subsequent other-sex stress may elucidate these contributions in girls. Furthermore, it may be that pubertal status relative to peers (pubertal timing) is the most important factor for predicting peer stresses associated with pubertal development in girls. Though some characteristics of more advanced pubertal status (e.g., more adult/feminine appearance) could be socially desirable for girls, as they are for boys, these attributes may or may not be advantageous depending on the timing at which other-sex peers reach certain levels of maturity. In short, the effect of pubertal status on other-sex stress may be more context-specific for girls, such that advanced status is only associated with more other-sex stress at a certain time or under certain social conditions.

#### *Other-Sex Stress and Depression*

As anticipated, higher levels of other-sex stress were associated with more depression, and this association held more strongly for girls than it did for boys. The moderated associations between puberty and depression were not significantly mediated by other-sex stress, but the addition of other-sex stress to the statistical model did reduce the interactive effect of puberty and sex on depression. This suggests that other-sex stress may account for a small portion of this association. Further, other-sex stress did partly mediate the association between earlier age of menarche and depression, suggesting one process through which puberty is associated with vulnerability to depression for girls.

#### *Strengths and Limitations*

This is one of the first studies to investigate sex differences in the relationship between puberty and depression as mediated by other-sex stress. Beyond this novel conceptual contribution, this study also has several methodological strengths. First, life stress and depression were assessed with methodologically sophisticated, rigorous semi-structured interviews and coding systems to reduce the possibility of responder biases and to obtain nuanced and detailed descriptions of youths' experiences. Second, both parent and youth reports were used to assess depression and pubertal development, providing a more comprehensive, dual-informant perspective. Third, we assessed multiple indices of pubertal development, including absolute status, timing relative to peers, and age of menarche. However, the study was limited by a relatively small sample size, which reduced power to detect significant mediation, and by the fact that many girls in our cohort had not yet reached menarche at the time of data collection. Moreover, the age range of the participants, and boys in particular, may have limited our ability to detect certain effects. Although later pubertal timing may be an important source of vulnerability to both depression and other-sex stress, our sample of boys may not have been sufficiently old enough to capture the strongest negative effects of later timing. Future research in this area should endeavor to obtain data from a larger sample and a broader range of ages while maintaining methodological rigor.

Another notable limitation of this study was the concurrent design, which prevented us from detecting changes in other-sex stress and depression subsequent to the onset and progression of puberty. Pertinent to this, some researchers have speculated that stressful interpersonal experiences may themselves lead to earlier pubertal timing as an evolutionary strategy that takes advantage of extended childhood in supportive environments and accelerated maturation in stressful environments (Belsky, Steinberg & Draper, 1991). Indeed, Tither and



Ellis (2008) found that family disruption and paternal absence predict earlier age of menarche. For girls, this concept may manifest as a reciprocal relationship wherein interpersonal stress in the familial context may lead to earlier pubertal timing, which may, in turn, lead to still more interpersonal stress in other-sex relationships. Longitudinal examination of stress and puberty would be required to elucidate this potential cycle.

### *Conclusion*

Overall, this study contributes important information regarding the network of associations among puberty, other-sex stress, and depression. Though only modest evidence was found for mediation in this relatively small sample, the pattern of effects was consistent with our conceptual framework. Consistent with prior research, more advanced and earlier pubertal maturation was associated with heightened depression in girls but less depression in boys. As expected, puberty was differentially associated with other-sex stress across sex: It conferred an advantage for boys and (for earlier menarche) a disadvantage for girls. Also as expected, other-sex stress was associated with significantly more depression in girls than in boys. These findings support the premise that girls and boys face distinctly different experiences in the context of other-sex relationships as they progress through puberty and, in turn, these experiences confer distinctly different vulnerabilities to depression. The fact that girls, particularly those who mature earlier relative to their peers, begin to outnumber boys in their rates of depression during the pubertal transition may be due, in part, to their heightened vulnerability in other-sex relationships. Further evidence in this direction may have implications for preventative and ameliorative strategies targeted at improving mental health during this developmental stage.

## Tables and Figures

Table 1

*Descriptive Information*

Measures	Boys		Girls	
	Range	<i>M</i> ( <i>SD</i> )	Range	<i>M</i> ( <i>SD</i> )
Pubertal Development Scale	1.10 – 3.40	2.16 (.56)	1 – 3.80	2.56 (.84)
Udry Line Drawings	1 – 5	3.06 (1.13)	1 – 5	3.01 (1.29)
Age of Menarche	–	–	10.00 – 14.13	11.83 (1.05)
Other-sex Stress	1 – 4	2.13 (.69)	1 – 4.25	2.07 (.63)
Depression	0 - 8	.79 (1.67)	0 – 9	.82 (1.82)

Table 2

*Intercorrelations Among the Variables*

Measure	1	2	3	4	5
1. Pubertal Status	----	.71***	.25^	.01	.36**
2. Pubertal Timing	.76***	----	.51**	.13	.35**
3. Earlier Age of Menarche	----	----	----	.39*	.43*
4. Other-Sex Stress	-.47**	-.28^	----	----	.48***
5. Depression	-.38*	-.45**	----	.27^	----

^ $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

*Note.* Intercorrelations presented above the diagonal are for girls; intercorrelations presented below the diagonal are for boys.

Table 3

*Predicting Depression from Pubertal Development, Sex, and Pubertal Development x Sex Interactions*

Predictors	Status			Timing		
	$\beta$	$T$	$\Delta R^2$	$\beta$	$t$	$\Delta R^2$
Step 1						
Pubertal Development	.11	.97		.06	.50	
Sex	.02	.22		.01	.1	
Step 2						
Pubertal Development x Sex	.62	3.39***	.12	.62	3.72***	.15

$^{\wedge}p < .10$ .  $*p < .05$ .  $**p < .01$ .  $***p < .001$ .

*Note.*  $\beta$ s and  $t$ s represent standardized coefficients and  $t$  statistics at each step;  $\Delta R^2$  represents percent of variance accounted for at each step.

Table 4

*Predicting Other-Sex Stress from Pubertal Development, Sex, and Pubertal Development x Sex Interactions*

Predictors	Status			Timing		
	$\beta$	$T$	$\Delta R^2$	$\beta$	$t$	$\Delta R^2$
Step 1						
Pubertal Development	-.17	-1.58 <sup>^</sup>		-.04	-.33	
Sex	-.07	-.67		-.05	-.45	
Step 2						
Pubertal Development x Sex	.47	2.51**	.07	.34	1.90*	.04

<sup>^</sup> $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

*Note.*  $\beta$ s and  $t$ s represent standardized coefficients and  $t$  statistics at each step;  $\Delta R^2$  represents percent of variance accounted for at each step.

Table 5

*Tests of Mediated Moderation to Predict Depression: Pubertal Status and Timing*

Predictors	Status			Timing		
	$\beta$	$T$	$\Delta R^2$	$\beta$	$t$	$\Delta R^2$
Step 1						
Pubertal Development	.11	.97		.06	.50	
Sex	.02	.22		.01	.10	
Step 2						
Pubertal Development x Sex	.57	3.10**	.27	.54	3.38**	.28
Other-sex Stress	.10	.61		.14	.93	
Other-sex Stress x Sex	.31	2.02*		.25	1.73*	

$^{\wedge}p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

*Note.* Bs and ts represent standardized coefficients and  $t$  statistics at each step;  $\Delta R^2$  represents percent of variance accounted for at each step.

Table 6

*Test of Mediation: Age of Menarche*

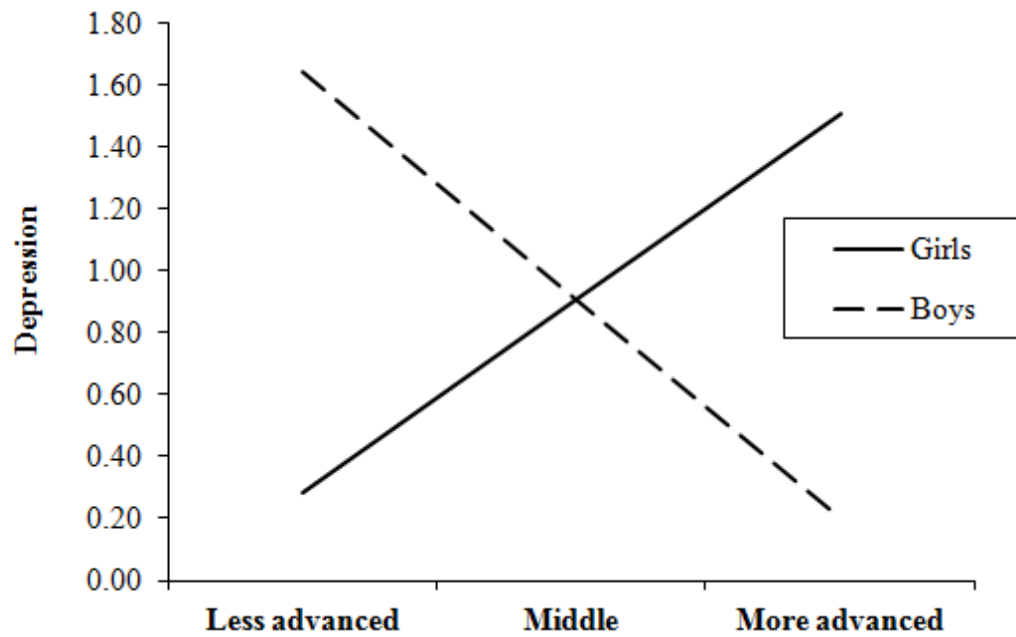
Predictors	Other-sex Stress			Depression		
	$\beta$	$T$	$\Delta R^2$	$\beta$	$t$	$\Delta R^2$
Step 1						
Earlier Age of Menarche	.39	2.22*	.15	.43	2.45*	.18
Step 2						
Earlier Age of Menarche				.28	1.56^	
Other-sex Stress				.39	2.22*	

^ $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

*Note.*  $\beta$ s and  $t$ s represent standardized coefficients and  $t$  statistics at each step;  $\Delta R^2$  represents percent of variance accounted for at each step.

Figure 1. Puberty  $\times$  sex contributions to depression for (a) pubertal status and (b) pubertal timing.

(a) Pubertal Status



(b) Pubertal Timing

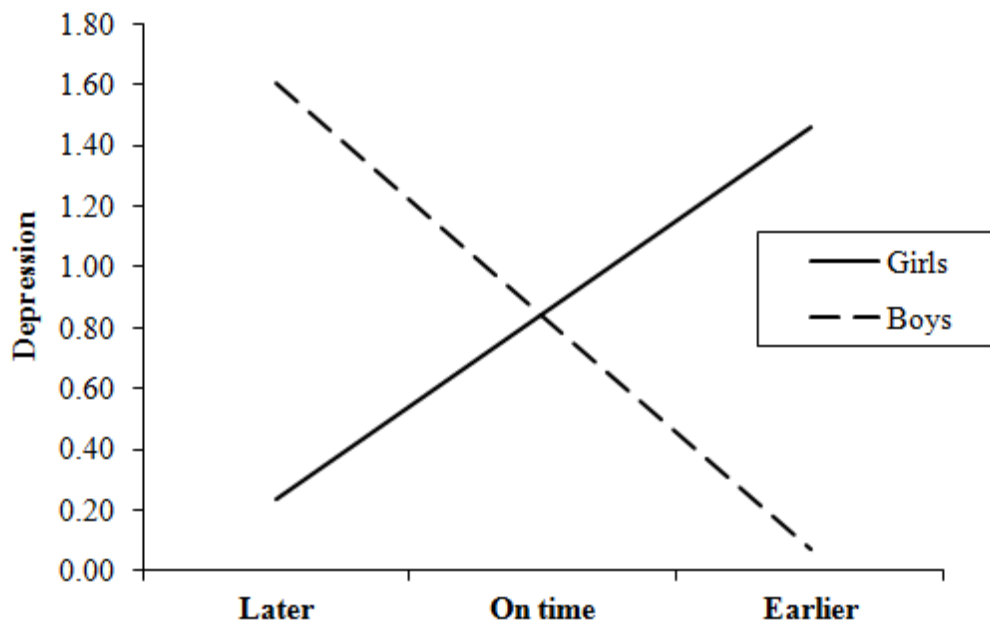
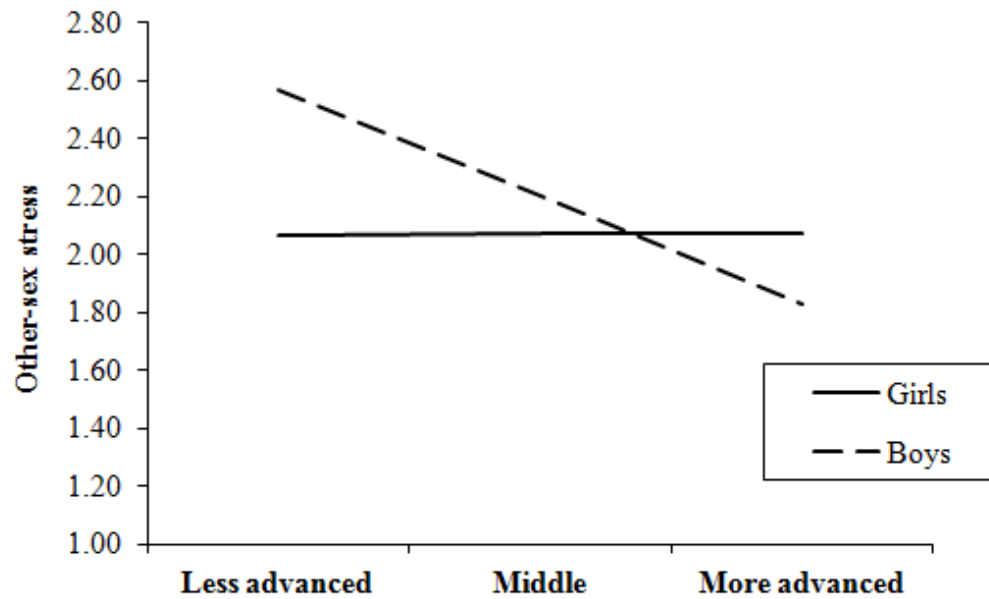




Figure 2. Puberty  $\times$  sex contributions to other-sex stress for (a) pubertal status and (b) pubertal timing.

(a) Pubertal Status



(b) Pubertal Timing

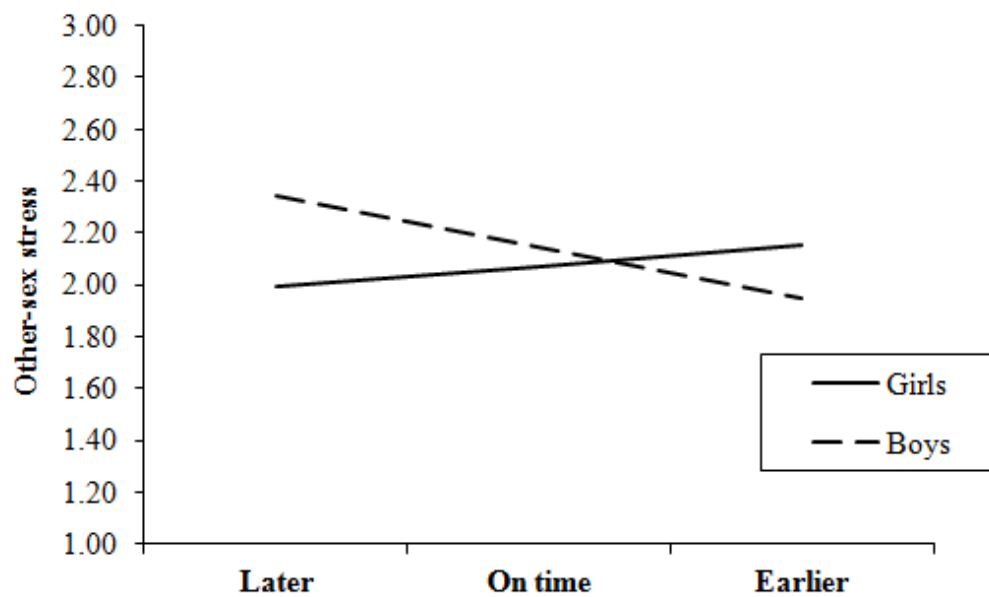
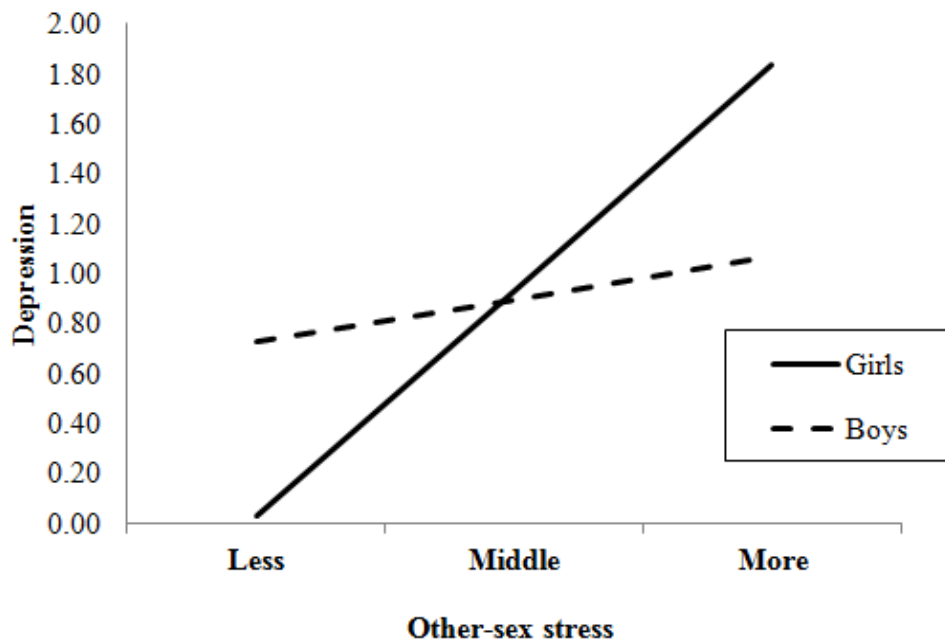
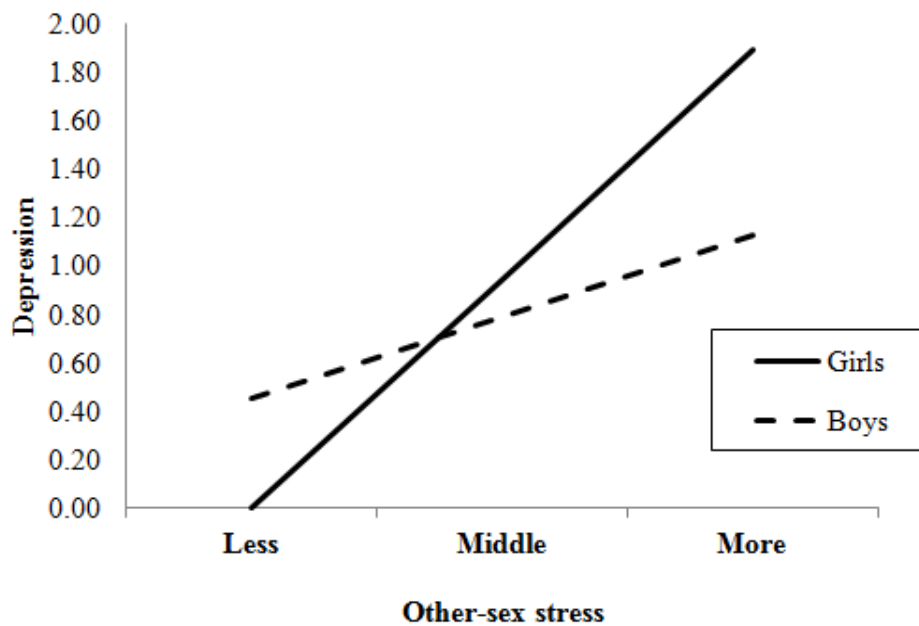


Figure 3. Other-sex stress  $\times$  sex contributions to depression for (a) pubertal status and (b) pubertal timing.

(a) Pubertal Status



(b) Pubertal Timing



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