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EMPIRICAL RESEARCH

The Role of Peer Stress and Pubertal Timing on Symptoms of Psychopathology During Early Adolescence

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Abstract Stress is known to amplify the link between pubertal timing and psychopathology. However, few studies have examined the role of peer stress as a context for this link. The present study examined the interaction between perceived pubertal timing and peer stress on symptoms of psychopathology in early adolescence. The sample consisted of 264 students (63% female; M_{age} = 12.40, SD = 1.00; 55% Caucasian, 23% African American, 7% Latino, 11% biracial and 4% other). Higher peer stress was associated with symptoms of anxiety/depression; this effect did not vary by timing or gender. However, early-maturing girls with high peer stress demonstrated higher rates of relational and overt aggression compared to other girls. Findings also suggested that late-maturing boys with high stress are at risk for aggression problems; however, due to the small number of boys, analyses were exploratory. Overall, results suggest that developmentally salient contexts as indicated by stressful peer experiences may pose unique threats to early maturing girls and possibly late-maturing boys.

Keywords Peer stress · Pubertal timing · Adolescence · Internalizing · Externalizing

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Introduction

Numerous studies have demonstrated a link between off-time pubertal maturation (i.e., experiencing puberty earlier or later than most of one's peers) and internalizing and externalizing problems during adolescence (e.g., Caspi et al. 1993; Ge et al. 2001; Graber et al. 1997; Weichold et al. 2003). While research for some behaviors has demonstrated robust effects across studies and methods, there is a continuing need to identify mechanisms and specificity for effects. For example, early maturation in girls has been associated with higher rates of subclinical depressive problems and externalizing problems, as well as higher rates of depressive disorder across the majority of studies (Graber 2008; Mendle et al. 2007). Moreover, recent research (Ge et al. 2001; Obeidallah et al. 2004; Rudolph and Troop-Gordon 2010; Silberg et al. 1999) suggests an interactive effect between pubertal timing and stress, such that the early timing effect on internalizing problems is exacerbated for adolescents with many stressful life experiences (i.e., contextual amplification; see Ge and Natsuaki 2009 for a review); findings have been most consistent for early-maturing girls. To date, only a handful of studies (Blumenthal et al. 2009; Conley and Rudolph 2009) have tested the stress-pubertal timing interaction focusing on specific types of stress thought to be highly relevant to changes in psychopathology in early to mid-adolescence, that is, *peer stress* (Deater-Deckard 2001; Rudolph 2002). Examples of peer stress can include being the victim of bullying or social exclusion, conflict within close friendships, and peer pressure. Additionally, virtually no studies have examined this model for externalizing problems, such as aggressive and/or delinquent behavior. Hence, the goal of the present study was to examine the interactive effect of pubertal timing and peer stress on internalizing and

externalizing symptoms in a sample of young adolescents in order to address the specificity versus breadth of this model in predicting which adolescents experience increased risk for problematic outcomes.

Pubertal Timing and Symptoms of Psychopathology

As indicated, pubertal timing has demonstrated links with a broad range of psychopathological symptoms and disorders during adolescence. In girls, early timing is associated with depressive disorders (e.g., Graber et al. 1997; Hayward et al. 1997), substance disorders (Graber et al. 1997), eating disorders (Stice et al. 2001) and comorbid depression and substance disorders (Stice et al. 2001) as well as a numerous associations with subclinical internalizing and externalizing symptoms (e.g., Mendle et al. 2007). Early maturation is also associated with elevated internalizing and externalizing symptoms (but not disorders) among boys (e.g., Ge et al. 2001; Graber et al. 1997; Susman and Dorn 2009). Most studies have focused on the impact of early maturation during early and mid-adolescence (see Foster et al. 2008; Graber et al. 2004, as exceptions). In contrast, for youth who mature later than peers, findings have been less consistent with some indications of elevated subclinical internalizing and externalizing symptoms during adolescence. For example, one study found that late-maturing girls had elevated depressive disorders during adolescence (Graber et al. 1997), but this effect did not persist over time (Graber et al. 2004). Among boys, whereas late maturation is associated with some symptomatology in adolescence, more serious problems, such as substance use and disruptive behavior disorders, emerge by late adolescence (Andersson and Magnusson 1990; Graber et al. 2004). Thus, effects differ by gender and period of adolescence.

Much of the current literature on timing effects (as outlined above) supports a gendered "deviation" pattern of pubertal timing effects, such that the most extreme timing groups are at greatest risk for symptoms of psychopathology. Because girls as a group tend to show outwardly visible signs of maturation a couple of years earlier than boys, early-maturing girls and late-maturing boys are most "deviant" compared to same age peers. A social processes framework of pubertal timing (Brooks-Gunn et al. 1994) suggests that social context (i.e., how an adolescent perceives his/her development relative to peers) plays a significant role in connecting pubertal timing and negative affect or behavior. Notably, the deviance experienced by early-maturing girls is quite different from that of late-maturing boys. The former are more likely to be perceived as older than they actually are. In particular, associations with deviant peers and less supportive peer (and other) relationships are salient factors in explaining why some early-maturing girls have greater internalizing and externalizing problems (e.g., Graber et al. 1997, 2004; Mendle et al. 2007). In contrast, late-maturing boys look less physically mature and may have social difficulties resulting from being left out of age normative interactions; thus far, very few studies have investigated or identified specific social mechanisms for the recent findings of substantial risk for externalizing problems and disorders among late-maturing boys (e.g., Graber et al. 2004).

Studies of depressive disorder find that early timing effects among girls are robust across measurement methods (i.e., perceived timing, age at menarche, and Tanner scores; Graber 2008). However, some studies have found perceived pubertal timing (i.e., adolescents' opinions regarding whether their maturation is early, about the same, or late compared to same-age, same gender peers) to be a stronger predictor of psychosocial problems, particularly in the context of interpersonal problems (e.g., Conley and Rudolph 2009), than timing based on child or parent reported Tanner scores. Although biological mechanisms likely play a role in the effects of off-time maturation on psychopathology (Ge and Natsuaki 2009), consistent with many researchers, we focus on timing as a social construct. Petersen and Taylor (1980) noted that puberty has a "social stimulus value" as several aspects of puberty are noticeable to peers as well as oneself. As such, puberty and its timing influence perceptions of what is normative in the peer group and have implications for peer interactions. Given that adolescence is characterized by substantial changes in social realms, such as increased focus on peers, more intimate peer relationships, and shifts in friendships and peer groups (Brown and Larson 2009), off-time maturation may be more challenging for young adolescents specifically because it is experienced in a social context. In turn, attention should be given to the interplay between pubertal timing and adolescents' peer experiences, as the interaction between these two developmental contexts may provide new insight into risks associated with off-time maturation.

Pubertal Timing and Peer Stress

Stressful life events are consistently identified as predictors of depressive symptoms and disorder (Cicchetti and Walker 2001). As noted, early maturation for girls, and to a lesser extent for boys, has also been identified as a predictor of higher rates of internalizing problems. From a diathesis-stress perspective, early maturation may be considered a vulnerability that interacts with stress to predict increases in depressive affect or disorder during adolescence. In fact, the effect of early timing on internalizing symptoms has been shown to be exacerbated by stressful life experiences (Ge et al. 2001; Rudolph and Troop-Gordon 2010; Silberg et al. 1999). In a 6 year longitudinal

study, Ge et al. (2001) found that early-maturing girls who experienced higher levels of stressful life events tended to report more depressive symptoms in the junior high and early high school years compared to other girls and boys. However, not all studies have shown a moderating effect of stress on the association between early timing and maladjustment. In a study investigating the interaction between puberty and maltreatment experience, Negriff et al. (2008) found that earlier pubertal timing was associated with elevated depressive symptoms and delinquency among boys and girls; however, a history of maltreatment did not moderate this association. This discrepancy highlights the need to consider contexts of stressful experiences independently, as not all stressors may function in the same manner.

Notably, adolescent psychopathology has been linked to stress in the peer realm (Deater-Deckard 2001; Rudolph 2002). It may be that stress resulting from peer interactions and relationships is more salient for adolescents who are also out of synch with peers in their pubertal development. Off-time maturation (i.e., being different from ones peers) may heighten adolescents' sensitivity to peer problems or prime them to interpret relatively benign peer problems as very stressful. Hence, peer stress specifically, rather than stressful experiences more generally, may be uniquely important for understanding timing effects on psychopathology. This effect may be particularly pronounced for early-maturing girls and late-maturing boys, as they are the most "deviant" from the rest of their peers. However, only a handful of studies has examined the interaction between timing and peer stress (Blumenthal et al. 2009; Conley and Rudolph 2009; Sontag et al. 2008). In a longitudinal study of 158 youth (ages 9.6–14.8 years), Conley and Rudolph (2009) found that early-maturing girls and late-maturing boys with high peer stress demonstrated greater concurrent and prospective depressive symptoms. In a cross-sectional study of adolescents (ages 10–17 years), Blumenthal et al. (2009) examined effects of early pubertal timing and peer problems on social anxiety. They found that early-maturing adolescents with greater peer problems reported the highest level of social anxiety symptoms. In contrast to findings of the Conley and Rudolph (2009) study, Blumenthal et al. found no effects for late maturation but did not investigate gender differences. In a study of 111 young adolescent girls ($M_{age} = 11.48$), Sontag et al. (2008) did not find that early-maturing girls experienced higher levels of stressful peer events overall. However, early-maturing girls were more likely than other girls to have experienced withdrawal of friendship by a peer, as well as feeling pressured by a peer to do something. Additionally, early maturation was associated with increased rates of aggression, whereas peer stress was associated with higher rates of internalizing symptoms (Sontag et al. 2008). Although findings varied, these studies highlight the importance of considering the role of peer stress and negative peer experiences in the association of pubertal timing and maladjustment. Overall, results from pubertal timing research suggest that the contextual role of peer stress may be most salient for early-maturing girls and late-maturing boys; however, further research is needed to examine consistency of effects among girls, as well as to consider whether peer stress is indeed a modifier of early versus late maturation effects among boys.

Goals and Hypotheses

The goal of the present study was to examine the interaction between pubertal timing and peer stress on internalizing and externalizing symptoms (i.e., anxiety/depression, relational aggression and overt aggression) in a sample of young adolescent girls and boys. Based on recent research on the interaction between pubertal timing and peer problems on internalizing symptoms (Blumenthal et al. 2009; Conley and Rudolph 2009), it was expected that early-maturing girls and late-maturing boys with high perceived peer stress would demonstrate greater symptoms of anxiety/depression compared to other adolescents. Although empirical work on the influence of pubertal timing and peer stress on externalizing problems is sparse, prior work on other stressors (Ge et al. 2001; Obeidallah et al. 2004; Silberg et al. 1999) as well as theoretical perspectives on timing effects (e.g., gendered-deviation hypothesis) suggested that both early-maturing girls and late-maturing boys would demonstrate higher levels of aggression (relational and overt) within the context of high levels of perceived peer stress.

Methods

Procedure

Data collection took place in two public middle schools in a small city in the Southeastern US during the 2006–2007 school year. Parental consent forms were distributed to students in homeroom classrooms by research team members. Each student who returned a form, regardless of consent decision, received a snack in class. Upon receipt of parental consent, data collectors returned to the schools to administer surveys during homeroom or lunch periods. Student surveys assessed psychosocial well-being, stressful peer experiences, and perceived pubertal development. Parents also consented to and participated in a brief phone interview that assessed family background characteristics. Procedures were approved by the institutional IRB.

Of the approximately 1,100 students eligible for participation in the study, 37% ($n = 412$) returned signed consent forms and 83.5% ($n = 344$) of those students received parental consent to participate in the study. Ultimately, 95% of students who brought back consent forms agreed to participate ($n = 327$). Examining participation rate by school, School 1 had a 56% participation rate versus a 23% participation rate for School 2. Although participation rates for School 2 were relatively low, this response rate falls within the typical range of studies utilizing active parental consent for risk behavior research (Tigges 2003). The gender and race/ethnicity distributions in the study reflect those typically seen in school-based or community based studies.

Participants

Two hundred sixty-four students (63% female; $M_{age} = 12.40$, SD = 1.00) were utilized in the current analyses. Participants were excluded if their data appeared falsified or if it was substantially incomplete ($n = 23$). Additionally, those participants who did not report perceived pubertal timing ($n = 40$) were not included. Participants who did or did not report pubertal timing varied only on report of social desirability bias, with participants not reporting pubertal timing having higher social desirability scores compared to other participants ($t = 2.74$, $p < .01$; $\Delta = 1.11$). Approximately 42% of students in the final sample were in the 6th grade, 34% in the 7th grade, and 24% in the 8th grade. The racial/ethnic breakdown of the sample was 55% Caucasian, 23% African American, 7% Latino, 11% biracial and 4% other, which was a close reflection of the larger school district's population.

Measures

Demographics

Adolescents reported their gender, race/ethnicity, and age. Additionally, parents reported on their own and their spouses' education, occupation, and employment status. Family socioeconomic status (SES) was scored using the standard protocol for the Hollingshead Four Factor Index of Social Status scale (Hollingshead 1975). This sample had an average SES score of 44.01 (SD = 13.87; range 8–66), which reflected some college or a bachelor's degree and employment as clerical/sales workers, owners of small businesses or semi-professionals.

Perceived Pubertal Timing

Participants' perceived pubertal timing was assessed with the question: "Compared to other [girls/boys] your age, is your pubertal development: earlier than others your age, about the same as others your age, or later than others your age?" The question was matched to the child's gender. Similar items have been used to assess perceived pubertal timing in other studies, and have demonstrated strong predictive validity in relation to psychosocial adjustment (e.g., Conley and Rudolph 2009; Graber et al. 1997, 2004).

Perceived Peer Stress

Participants completed a stressful events checklist as part of the Responses to Stress Questionnaire (RSQ; Connor-Smith et al. 2000). The negative peer events checklist asked participants to indicate if they had experienced each of nine events since the start of the school year (1 = yes, 0 = no; $\alpha = .78$). Example events included being teased or hassled by other kids, having someone stop being your friend, and being left out or rejected. For each item endorsed, participants responded to an appraisal item indicating how stressful each problem was (0 = not at all, to 3 = very). Total perceived peer stress was calculated as a sum of all appraisal items. Possible scores ranged from 0 to 27, with higher scores representing greater perceived peer stress.

Symptoms of Anxiety/Depression

The 12-item Anxious/Depressed subscale of the Youth Self Report (YSR; Achenbach 2001), an empirically based syndrome subscale, was used to assess symptoms of anxiety/depression in this study. Participants rated the occurrence of items in the past 6 months on a likert scale (0 = not true, to 2 = very true or often true). Items were summed such that higher scores indicated more symptoms of anxiety/depression ($\alpha = .84$).

Relational Aggression

Relational aggression was measured using 7 items from the Revised Peer Experiences Questionnaire (RPEQ; Prinstein et al. 2001) that assessed aggressive acts aimed at hurting others indirectly by damaging their social relationships or reputations. Participants were asked to indicate how often they had performed each aggressive act (0 = never to 4 = a few times a week). Items (e.g., "I said mean things about someone so that people would think he/she was a loser" and "I left someone out of an activity that he/she really wanted to be included in") were summed ($\alpha = .78$) with higher scores representing greater relational aggression.

Overt Aggression

Overt aggression was assessed using five items from the Reactive-Proactive Aggression Questionnaire (RPQ; Raine

et al. 2006) and three items from the RPEQ (Prinstein et al. 2001) that reflected physical aggression and threats of physical aggression; 8 items in total were used. Participants rated the frequency of engaging in each item in the past year. Because items from the RPQ used a response scale that differed from the RPEQ (0 = "never", 1 = "sometimes" and 2 = "often"), items from the RPEQ were recoded to 0 = "never," 1 = "once or twice to a few times," and 2 = "about once a week to a few times a week." Example items from the final scale ($\alpha = .73$) included "used physical force to get others to do what you want" and "hit, kicked, or pushed someone in a mean way." Items were summed with higher scores representing greater overt aggression.

Social Desirability

Due to its documented association with reporting bias of aggression and other problem behaviors (Nederhof 1985), social desirability was examined as a potential control variable in subsequent analyses. Social desirability was measured using the 10-item Version 2 short form of the Marlowe–Crowne Social Desirability Scale (Strahan and Gerbasi 1972); wording was adapted for use with young adolescents. The Marlowe Crowne Social Desirability Scale has been widely used in studies examining symptoms of psychopathology. Participants rated each item "true" or "false." An example item was "I am sometimes annoyed by people who ask favors of me." Sum scores were calculated (range 0–10), with higher scores representing an increased tendency to respond in the "socially desirable" manner ($\alpha = .52$). This measure includes forced response items measuring a variety of behaviors with a prominent social desirability component that represent a single proportion score. In turn, internal reliability scores below conventionally desirable levels of Chronbach's alpha are not unusual. Importantly, however, separate analyses demonstrated that social desirability was associated with psychosocial factors (e.g., temperament and behavioral problems) in the expected direction, suggesting the validity of its use (Sontag et al. 2010).

Analytic Plan

As indicated, the goal of the study was to examine the interaction between perceived pubertal timing (early, on-time, late) and perceived peer stress on symptoms of psychopathology (i.e., anxiety/depression, relational aggression, overt aggression) within gender. Typically, studies report 60–70% of youth as on-time maturers (Graber et al. 1996; Dorn et al. 2006). For example, in a large epidemiological study, early maturation was reported by 20% of girls and 14% of boys, whereas late maturation was reported by only 9% of girls and 16% of boys (Graber et al. 1997). The present study found comparable rates of off-time development; however, due to the smaller number of boys in the sample ($n = 98$) compared to girls ($n = 166$), cell sizes for the off-time groups were smaller than desired for boys. Preliminary analyses with boys and girls in the same model revealed that the direction of effects was primarily driven by the girls in the analyses. For these reasons, subsequent analyses examining the interaction between pubertal timing and perceived peer stress were conducted separately for boys and girls with the caveat that findings for boys should be interpreted with attention to this constraint.

Specifically, a series of hierarchical linear regression analyses were conducted, examining timing (early, late) as separate dummy coded variables in a single regression model; models were run separately for girls and boys. To assess the unique contribution of the variables, control variables were entered at step 1, main effects at step 2 as two dummy coded pubertal timing variables (early vs. other, and late vs. other) and perceived peer stress; and finally, centered interaction terms between the dummy coded pubertal timing variables and peer stress were entered at step 3.

Research investigating risk factors associated with symptoms of psychopathology (i.e., anxiety/depression and aggression) has traditionally examined demographic characteristics such as age, race/ethnicity, and SES as well as social desirability as potential control variables. According to Cohen and Cohen (1983), the relationship between any predictor and the outcome variable may be spurious due to one or more variables that are a cause of both; if a potential control variable is not associated with both the IV and DV, it will not account for confounding effects or spurious associations. Hence, only those variables with a significant association with both the predictors (pubertal timing, perceived peer stress) and outcomes (anxiety/depression, relational aggression, or overt aggression) were included in subsequent analyses as control variables.

Results

Descriptive and Covariate Analyses

Descriptive statistics and correlations for all key variables are shown in Table 1. Race/ethnicity differences in key variables were examined via independent samples t tests. Compared to Caucasian participants, non-Caucasian participants reported lower SES scores ($t = -5.19$, $p < .01$; $M_{\text{difference}} = 8.94$) and higher overt aggression ($t = 2.21$, $p < .05$; $M_{\text{difference}} = .64$). No other racial/ethnic differences were observed. Compared to girls, boys reported

Table 1 Intercorrelations among demographic information, perceived peer stress, and symptoms of psychopathology

	M (SD)	1	2	4	6	7	8	9
1. Age	12.92 (.95)	–						
2. SES	44.01 (13.87)	−0.19**	–					
4. Social desirability	5.19 (1.98)	−0.08	0.08	–				
6. Perceived peer stress	8.47 (6.43)	−0.01	−0.02	−0.20**	–			
7. Anxiety/depression	6.33 (4.61)	0.06	−0.09	−0.25**	0.34**	–		
8. Relational aggression	4.98 (3.91)	−0.03	−0.15*	−0.38**	0.23**	0.24**	–	
9. Overt aggression	1.97 (2.31)	0.10	−0.18**	−0.32**	0.11	0.15*	0.56**	–

Minority status = Caucasian (1) vs. other (0); Gender = girls (1) vs. boys (0)

* $p < 0.05$; ** $p < 0.01$

lower levels of anxiety/depression ($t = -2.91$, $p < .01$; $M_{\text{difference}} = 1.74$) and relational aggression ($t = -2.41$, $p < .05$; $M_{\text{difference}} = 1.27$), and higher levels of overt aggression ($t = 2.08$, $p < .05$; $M_{\text{difference}} = .64$). However, there were no gender differences in age, SES, social desirability bias, or perceived peer stress. Additionally, there were no gender differences [$\chi^2(2) = 2.58$, $p = .28$] or race/ethnicity differences [$\chi^2(2) = 1.62$, $p = .44$] in the distribution of pubertal timing groups, with approximately 15% of participants identifying themselves as early, 66% as on-time, and 19% as late maturers. Interestingly, a significant interaction effect between gender and pubertal timing emerged when examining reports of perceived peer stress [$F(2,256) = 3.88$, $p = .02$, $\eta^2 = .03$]. Contrary to expectation, late-maturing girls reported higher levels of perceived peer stress ($M = 11.43$, SD = 5.91) compared to early-maturing girls ($M = 7.88$, SD = 5.83) and on-time girls ($M = 8.11$, SD = 6.13). No difference in perceived peer stress was observed for boys ($M = 7.84$, SD = 6.85).

Additional correlation analyses were used to examine relationships between potential control variables (age, SES, and social desirability bias) and predictor (pubertal timing, perceived peer stress) and outcome variables (anxiety/depression, relational aggression, and overt aggression). Based on our inclusion criteria, only social desirability bias was identified as a control variable because of its association with perceived peer stress ($r = -.20$, $p < .01$) and all symptoms of psychopathology ($r = -.25$ to $-.28$, $p < .01$). Hence, subsequent analyses controlled for social desirability bias scores.

Pubertal Timing, Peer Stress, and Symptoms of Psychopathology

As noted, separate hierarchical linear regressions for girls and boys were used to test the interaction between pubertal timing (both the early timing and late timing effect) and perceived peer stress on symptoms of anxiety/depression, relational aggression and overt aggression. Results are presented in Tables 2 and 3.

Peer Stress and Timing Effects for Girls

As expected, results revealed a significant main effect of perceived peer stress on symptoms of anxiety/depression ($p < .01$) and relational aggression ($p < .01$) in girls; however, no main effects for perceived peer stress were found for overt aggression. Only one main effect of pubertal timing was observed, such that early pubertal timing was positively associated with overt aggression

Table 2 Perceived peer stress and pubertal timing predicting symptoms of psychopathology for girls ($n = 166$)

		Anxiety/depression		Relational aggression		Overt aggression	
		ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	Social desirability	.06	−.24**	.16	−.40**	.14	−.37**
Step 2	Peer stress	.09	.28**	.04	.22**	.05	.04
	Early timing		.11		.03		.22**
	Late timing		.08		−.02		.04
Step 3	Early × peer stress	.01	−.03	.03	.15*	.03	.17*
	Late × peer stress		.11		−.07		.03

β = standardized beta weight. Early timing was dummy coded (1 = early, 0 = not early); late timing was dummy coded (1 = late, 0 = not late)

† $p < 0.10$; * $p < 0.05$; ** $p < 001$

Table 3 Perceived peer stress and pubertal timing predicting symptoms of psychopathology for boys ($n = 98$)

		Anxiety/depression		Relational aggression		Overt aggression	
		ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	Social desirability	.06	−.24**	.12	−.35**	.06	−.25*
Step 2	Peer stress	.12	.27**	.02	.07	.03	.08
	Early timing		−.17		−.08		−.03
	Late timing		−.01		.09		−.15
Step 3	Early × peer stress	<.01	−.04	.04	.03	.03	<.01
	Late × peer stress		.03		.23†		.20

β = standardized beta weight. Early timing was dummy coded (1 = early, 0 = not early); late timing was dummy coded (1 = late, 0 = not late)

† $p < 0.10$; * $p < 0.05$; ** $p < 001$

($p < .05$). No significant main effects of pubertal timing (either early or late) on symptoms of anxiety/depression or relational aggression were observed for girls. For specific regression coefficients, see Table 2.

In addition, significant interaction effects between peer stress and early timing were observed for both relational aggression ($p < .05$) and overt aggression ($p < .05$) for girls. Follow-up analyses to explore the interaction effects were conducted. Controlling for social desirability, regression analyses examining peer stress on relational aggression and overt aggression were run separately for early maturers versus other girls. Follow-up analyses revealed that girls who identified themselves as early maturers had the strongest association between perceived peer stress and relational aggression compared to other girls, such that higher perceived peer stress was associated with greater relational aggression (Fig. 1a). Additionally, for early-maturing girls only, greater perceived peer stress was associated with greater overt aggression (Fig. 1b). These findings suggest that peer stress may be particularly important as a pathway for higher externalizing problems observed among early-maturing girls in this and prior studies (see Mendle et al. 2007 for a review). No significant interactions emerged for late pubertal timing and perceived peer stress for girls.

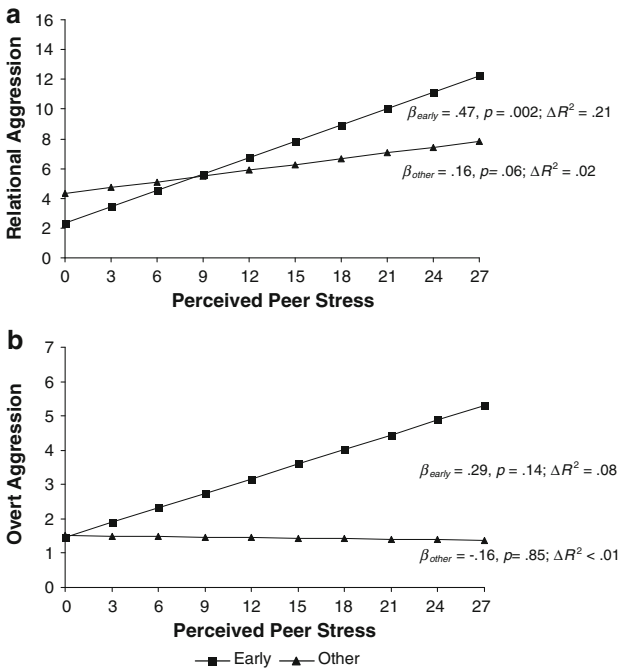

Fig. 1 Interaction between pubertal timing, perceived peer stress for girls ($n = 166$). This figure illustrates the peer stress by early pubertal timing interaction for relational aggression ($p = .05$; $\eta^2 = .03$) and overt aggression ($p = .03$; $\eta^2 = .03$). Regression lines for each group were fit at the sample mean for social desirability

Peer Stress and Timing Effects for Boys

As noted, because of the sample size, analyses for boys should be interpreted with caution. Similar to findings for the girls, results revealed a significant main effect of perceived peer stress on anxiety/depression ($p < .01$); however, no main effects of peer stress on relational or overt aggression were observed. Notably, no significant main effect of pubertal timing (early or late) was observed. See Table 3 for regression coefficients.

Regression analyses examining early timing and late timing effects did not reveal any significant interactions between pubertal timing and perceived peer stress on symptoms of psychopathology. However, a trend interaction between late timing and peer stress ($\beta = .23$, $p < .10$) on relational aggression was observed for boys. As with girls, follow-up regression analyses of the association between peer stress and relational aggression were run separately for late maturers versus other boys. As expected, late-maturing boys demonstrated the strongest association between perceived peer stress and relational aggression compared to other boys (Fig. 1a). In addition, although the interaction effect between late timing and peer stress on overt aggression did not reach significance, the effect size

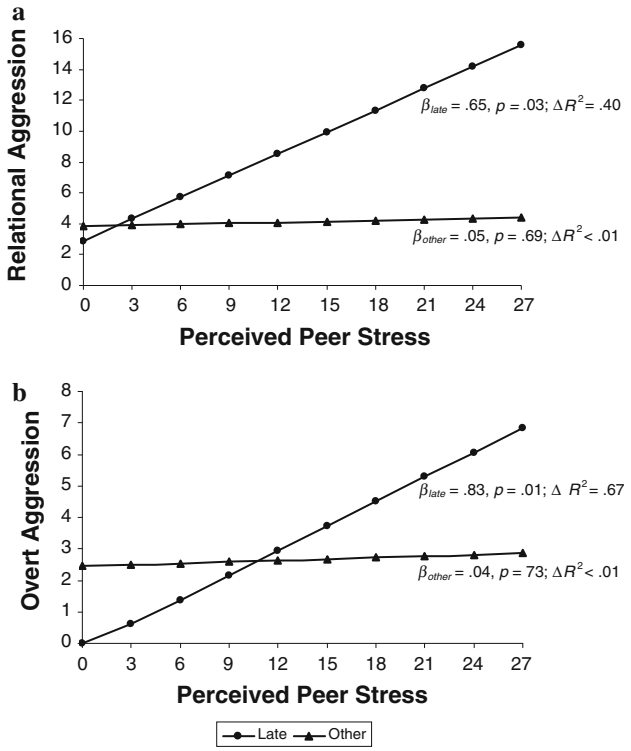

Fig. 2 Interaction between pubertal timing, perceived peer stress for boys ($n = 98$). This figure illustrates the peer stress by late pubertal timing interaction for relational aggression ($p = .07$; $\eta^2 = .03$) and overt aggression ($p = .14$; $\eta^2 = .03$). Regression lines for each group were fit at the sample mean for social desirability

($\eta^2 = .03$) was equivalent to the interaction between early-timing and peer stress for girls. This suggested the importance of examining the interaction effect for boys for exploratory purposes. Notably, follow-up analyses indicated that late-maturing boys had the strongest association between perceived peer stress and overt aggression compared to other boys, suggesting that high levels of perceived peer stress may be most problematic for late-maturing boys (Fig. 2b). Again, due to the smaller sample of boys, especially in the off-time groups (i.e., 14 early-maturing boys and 14 late-maturing boys), these findings should be interpreted with caution.

Discussion

Drawing from the contextual amplification hypothesis (e.g., Ge and Natsuaki 2009) and recent findings on the interaction between peer problems and pubertal timing (Blumenthal et al. 2009; Conley and Rudolph 2009), this study was the first to examine the interaction between pubertal timing and peer stress on self-reported internalizing *and* externalizing symptoms in a sample of young adolescent girls and boys. As anticipated, results from this study suggested that risks associated with early and late pubertal timing may be most pronounced under high levels of peer stress. Moreover, findings were consistent with a gendered-deviation hypothesis, such that early-maturing girls and late-maturing boys with high peer stress may be at greatest risk for maladjustment. Overall, findings suggest that the examination of developmentally salient contexts as indicated by stressful peer experiences may contribute to a greater understanding of why off-time maturation poses a threat to adjustment during early adolescence.

Consistent with prior research on pubertal timing in girls (Mendle et al. 2007), early maturation was associated with higher reports of overt aggression, both verbal threats and physical aggression. Interestingly, this effect was strongest for early-maturing girls who also reported higher levels of peer stress; this effect did not emerge for late maturation. Although the interactive effect between early maturation and peer stress in girls is consistent with prior studies examining internalizing symptoms (Blumenthal et al. 2009; Conley and Rudolph 2009), the mechanisms connecting early maturation, peer stress and aggression are what remain unclear. Given findings that sexual harassment increases with pubertal maturation and that cross-gender harassment increases as pubertal status increases (McMaster et al. 2002) it is possible that early-maturing girls experience more harassment than other peers; in turn, these girls react aggressively. However, a descriptive analysis on timing differences in peer stress indicated that late maturing girls, not early maturing girls, reported significantly higher levels of perceived peer stress. Alternatively, as peer relationships and concomitant peer stress become increasingly salient during early adolescence, particularly for adolescent girls (Rudolph 2002), it may be that dealing with concurrent stressors in the same domain (i.e., peer problems and early timing as social stressors) overwhelms the relatively undeveloped coping resources of young adolescents (Ge and Natsuaki 2009). Because of this, girls may be less equipped to manage negative emotions and cognitions related to such stress; in turn, they manifest impulsive or aggressive behavior.

Considering the developmental mismatch between early pubertal maturation and cognitive and emotion regulation skills (Ge and Natsuaki 2009), early maturing girls may be relying on a less diverse repertoire of coping skills to deal with psychosocial demands typically reserved for later adolescence. Recent studies examining pubertal timing and the role of coping and responses to stress (e.g., Rudolph and Troop-Gordon 2010; Sontag et al. in press) have found that early-maturing girls with less effective coping strategies and less advanced cognitive skills related to emotion regulation (i.e., executive functioning) demonstrated higher levels of internalizing and externalizing symptoms. It may

be that early maturing girls utilize less effective coping strategies; in turn, they behave more aggressively and elicit more problems among their peers. Importantly, we did include a measure of coping with peer stress (RSQ; Connor-Smith et al. 2000) as part of the larger study; however, preliminary analyses for the present investigation found no differences in coping strategies by timing group ($p > .10$ for all coping responses). Due to concerns about power, a more inclusive analysis of coping and peer stress was not included in the present investigation. (Analyses are available from the authors upon request.) However, it is noteworthy that young adolescents in our sample reported low-to-moderate use of adaptive coping skills such as engagement coping (Sontag and Graber 2010). Thus, it seems that at this age most young adolescents have some skills; but, young adolescents are perhaps not proficient at implementing these skills to the best effect (i.e., offsetting aggressive behavior). Further examination of the role of ineffective coping and emotion regulation skills on the associations among pubertal timing, stress, and psychopathology are needed.

As indicated, among girls, the interaction between perceived timing and peer stress on aggression was most salient for early-maturing girls. In contrast, among boys, *late*-maturing boys with higher levels of peer stress reported higher rates of aggression (relational and overt). The interaction effect between late timing and perceived peer stress for boys, while not statistically significant, illustrated comparable effect sizes to those found for early-maturing girls (see Tables 2, 3). Generally, late-maturing boys are smaller in physical stature and look more child-like compared to most other adolescents. It might be assumed that these boys would not aggress against peers who would typically be physically larger. At the same time, it may be that these late maturing boys are aggressing against younger or smaller peers; unfortunately, our measure of aggression did not assess whom participants aggressed against. However, this hypothesis is consistent with animal models of puberty and stress. For instance, Delville et al. (2003) found that subjugated hamsters in the early stages of puberty were more likely to attack smaller and younger individuals compared to subjugated hamsters in the later stages of puberty. Another explanation for these findings may relate to physical maturation and concern for social status. As suggested by the literature on bravado among African American male adolescents (Cunningham and Meunier 2004), late-maturing boys with high levels of peer stress may be aggressing against peers as a means of demonstrating social dominance. That is, some late-maturing boys may exhibit aggressive behaviors as a means of compensating for smaller stature and a younger appearance within the peer group.

Overall, these results are in line with research demonstrating elevated levels of externalizing problems in early adulthood for boys who were late maturers (e.g., Graber et al. 2004). Importantly, however, the experience of peer stress did not vary by timing group for boys in the present investigation. Late-maturing boys were not more likely to experience higher levels of stressful peer events but were more likely than other boys to demonstrate aggressive behavior if also experiencing higher levels of peer stress. In addition, late-maturing boys with *low* levels of peer stress reported the lowest levels of aggression compared to all participants. That is, when late maturing boys did not experience peer stress, they may not have felt the need to exert aggression to defend against assaults to their social status or bully younger peers as hypothesized above. This finding suggests that it is not exposure to stress alone that accounts for elevated levels of aggression, but rather the interaction between late timing and high peer stress. Of course, as noted, due to the smaller sample of boys especially in the off-time groups, our findings and discussion should be interpreted as exploratory; effects for late maturers and null effects for early-maturing boys warrant replication in future studies.

Contrary to prior research indicating that early maturation is associated with higher rates of internalizing problems for girls (Susman and Dorn 2009 for a review), perceived timing (both early and late) was unrelated to symptoms of anxiety/depression in this study. Although prior studies (Blumenthal et al. 2009; Conley and Rudolph 2009) have suggested that early maturing girls and late maturing boys with greater peer problems and stress are at greater risk for symptoms of anxiety and depression, our findings did not support this hypothesis; rather, the negative influence of peer stress was consistent across all timing groups. This discrepancy with prior research may be due to the age range of our sample. Some studies have demonstrated early timing effects with early adolescent samples (e.g., Conley and Rudolph 2009), whereas others (e.g., Ge et al. 1996) have found that the timing effect emerges most strongly in mid to late adolescence. Given that our sample was predominantly comprised of 6th and 7th graders, it may be that symptomatology as a result of timing differences have not yet emerged. Interestingly, as was true for girls, higher levels of peer stress were associated with more symptoms of anxiety/depression for boys. This effect did not vary by perceived timing and was comparable in effect size to that seen for girls ($\beta = .34$ for girls and $\beta = .30$ for boys). Thus, what is evident from our findings is that peer stress plays a role in girls' and boys' mood disturbances. Future studies are needed to replicate effects and test whether timing differences emerge at older ages.

Limitations

Despite the importance of our findings to understanding mechanisms for timing effects, especially for early maturation among girls, conclusions based upon this research are limited in several ways. First, some of the limitations due to the sample size for males in this study have been previously discussed (i.e., inability to test three-way interaction of pubertal timing × peer stress × gender). However, the smaller sample size in general also precludes the investigation of other potential three-way interactions that may be highly informative to the pubertal timing literature. As indicated, the literature suggests an interaction effect of gender and age on the link between pubertal timing and psychopathology; unfortunately, our sample characteristics (i.e., smaller number of early and late maturing boys, as well as the exclusive focus on early adolescence) precluded the investigation of such age-gender interactions. Future studies would greatly benefit from investigating the interaction among pubertal timing, peer stress and gender as a function of age across adolescence.

Second, the exclusive use of a measure of perceived pubertal timing, rather than in combination with a more biologically based index of pubertal development (i.e., Tanner stage or age at menarche), may have influenced our findings. For example, adolescents who perceive themselves as developmentally different from their peers may also be more likely to report higher levels of peer stress and symptoms of psychopathology. Researchers have argued that different measures of pubertal timing may align more clearly with different types of outcomes; that is, a self-rating of pubertal timing may be more salient when investigating variables rooted in social comparison, such as self-esteem, or in the case of this study, peer relationships (Dorn et al. 2006). Future studies may benefit from comparing the effects of different assessments of pubertal timing (e.g., Tanner staging by a trained health professional along with perceived timing).

Finally, the use of a cross-sectional design limits the interpretation of the directionality of results. For instance, it is feasible that aggressive adolescents facilitate or elicit negative or stressful peer experiences, which are in turn exacerbated by the experience of off-time maturation. That is, off-time maturation may intensify the adverse effects of aggressive behavior on interpersonal stress generation as Rudolph (2008) has reported for early-maturing girls. Similarly, early-maturing girls with more aggressive or delinquent tendencies may self-select into peer groups that foster such behaviors and bring with them more contentious peer relationships (Deater-Deckard 2001). Finally, prior studies have found that psychosocial stress, at least as experienced in the family context, alters the course of pubertal development (see Susman and Dorn 2009, for a recent review). As such, we were unable to consider how stress may have influenced timing itself in the present investigation. Notably, studies have not considered whether peer stress alters the timing of puberty and studies to date have found no or only very weak effects of family stressors on timing in boys (e.g., Belsky et al. 2007). Additional research is needed to extend our findings into mid and late adolescence, as some timing effects are known to emerge later in development.

Conclusions

Given that pubertal timing involves an emphasis on peer involvement and social comparison (Brooks-Gunn et al. 1994; Hayward 2003), our findings, along with other recent studies (e.g., Blumenthal et al. 2009; Conley and Rudolph 2009), support the hypothesis that problems experienced within the peer realm have unique value in understanding why off-time maturation leads to higher psychopathology for some youth. In particular, subgroups of early-maturing girls experiencing greater peer stress are exhibiting higher rates of aggression, suggesting that this group might benefit from preventive intervention targeting interpersonal skills and managing aggression. More broadly, the present research contributes to our growing understanding of variations in pubertal timing effects and suggests that future research should consider the contexts of stressful experiences independently, as different contexts may pose unique threats to adolescents experiencing off-time maturation.

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