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BRIEF REPORT

Peer Relationships and Depressive Symptomatology in Boys at Puberty

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The physical changes of puberty coincide with an increase in the salience of peer relationships and a growing risk for depression and other forms of psychopathology. Previously, we reported that *pubertal tempo*, defined as a child's rate of intraindividual change in pubertal status (measured using parent-reported Tanner stages; Marshall & Tanner, 1970), was associated with changes in boys'—but not girls'—depressive symptoms over and above effects explained by pubertal timing (Mendle, Harden, Brooks-Gunn, & Graber, 2010). The present study extends this previous research by examining changes in the quality of peer relationships in the association between individual differences in pubertal development and change in boys' depressive symptoms. Boys ($N = 128$, $M = 9.61$ years, $SD = 0.70$, at Time 1) were recruited from public schools and assessed annually for 4 years. Results from latent growth curve models indicated that earlier pubertal timing and more rapid pubertal tempo were associated with greater decrements in the quality of boys' peer relationships. After accounting for the association between change in peer relationships and depressive symptoms, the direct effects of pubertal timing and tempo on depressive symptoms were no longer significant. These results highlight a multifaceted approach to studying puberty and emphasize how social mechanisms may intersect with biological risk to produce psychological distress.

Keywords: pubertal timing, pubertal tempo, depression, peer relationships

Puberty represents a vital juncture for children's well-being and emotional stability. A marked surge of problem behaviors and clinical risks emerge during this critical developmental window and continue to evolve over the course of adolescence. Although puberty is a universal transition, there are notable fluctuations in development across children, and these differences serve as key predictors of subsequent well-being. To date, the majority of research on individual differences at puberty has centered on *pubertal timing,* or when children reach specific physical milestones relative to their same-age, same-gender peers (Ge & Natsuaki, 2009). Although pubertal timing is the most commonly investigated individual difference at puberty, it is not the only source of variability in development. Children differ not only in when they mature but also in how quickly they change (Marshall & Tanner, 1969, 1970; Susman et al., 2010). This rate of intraindividual maturation is known as *pubertal tempo.*

Recently, we reported that, in boys, both pubertal timing and tempo predicted changes in depressive symptoms in early adolescence (Mendle, Harden, Brooks-Gunn, & Graber, 2010). While most boys, on average, experienced a decrease in depressive symptoms during puberty, boys with rapid tempo and earlier timing actually increased in depressive symptoms. The effects of pubertal tempo were substantially stronger than those of pubertal timing, suggesting that, for boys, rapid pubertal change may be a more important mechanism of risk than simple timing of development. These findings implicate a new avenue for understanding the impact of individual differences in boys' psychopathology at puberty. This is particularly important given that the psychosocial adjustment of boys during puberty is a research area with notably mixed results (e.g., Conley & Rudolph, 2009; Ge et al., 2003; Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Huddleston & Ge, 2003; Kaltiala-Heino, Marttunen, Rantanen, & Rimpela, 2003; Zehr, Culbert, Sisk, & Klump, 2007), especially when compared with the consistency of findings regarding early puberty in girls (see Mendle, Turkheimer, & Emery, 2007, for review).

The present investigation examines the role of peer relationship quality in the association between pubertal development (both tempo and timing) and change in depressive symptoms for boys during early adolescence. The *maturation compression hypothesis* (Mendle et al., 2010) posits that a rapid developmental progression

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might demand a correspondingly quick adaptation to the new biological and social milestones that characterize puberty. The process can be exigent not only because a child must individually come to terms with staggering physical transformation but because others will also respond to this development—adapting their attitudes, behaviors, and expectations in response to a child's new developmental status. For this reason, the physical changes of puberty are generally accompanied by substantial and vital changes in social roles and relationships (e.g., Alsaker, 1995; Paikoff & Brooks-Gunn, 1991). Such changes are not instantaneous, however, but rather require time to come into full effect (Wentzel, 2003). Therefore, a rapid developmental tempo may mean that children would progress through puberty at a rate faster than the social environment can feasibly respond.

While puberty precipitates changes in multiple social domains, young adolescents may be particularly sensitive to changes in relationships with peers. In general, peer interactions take on a heightened importance during the pubertal period, supplanting previous reliance on parents (e.g., Connell & Dishion, 2006; Larson & Richards, 1991; Steinberg & Silverberg, 1986) and continuing to be a primary concern throughout adolescence (Brown, 2004; Prinstein & La Greca, 2002). It has been hypothesized that children have difficulties maintaining friendships with peers whose level of physical maturation differs from their own (Conley & Rudolph, 2009; Ge, Conger, & Elder, 1996; Petersen, Sarigiani, & Kennedy, 1991) and that they derive aspects of identity, self-concept, and self-awareness from the stability and quality of their peer interactions (Brown, 2004; Brown, Von Bank, & Steinberg, 2008). Problems getting along with peers (and sensitivity to peer rejection) are often critical antecedents of psychological distress, depression, and anxiety during early adolescence (e.g., McDonald, Bowker, Rubin, Laursen, & Duchene, 2010); of particular relevance for boys may be the emphasis on social dominance hierarchies during the middle school and early adolescent period, which may elicit increased concern over social standing and peer exclusion (Connell & Dishion, 2006; see also Rose & Rudolph, 2006, for a review).

The present study extends our previous research on the effects of pubertal timing and tempo on change in depressive symptoms during the transition to early adolescence among boys (Mendle et al., 2010). Using latent growth curve models, we previously showed that boys' initial levels of pubertal maturation relative to same-age peers (pubertal timing) and their rate of change in pubertal status between ages 8 and 13 (pubertal tempo) predicted changes in depressive symptoms (Mendle et al., 2010). As yet, no studies have targeted the psychosocial experiences that may explain these effects. In the current article, we address this by examining the role of changes in the quality of peer relationships. Specifically, we tested whether (1) earlier pubertal timing and more rapid pubertal tempo predict decrements in the quality of boys' peer relationships and (2) whether these changes in peer relationships account for the association between pubertal change and changes in depressive symptoms.

Method

Procedure and Participants

Participants were drawn from the Boys Health and Development Project (BHDP), a longitudinal study designed to examine the social and emotional correlates of biological development during late childhood and early puberty. The BHDP comprises a community sample of families from the New York City metropolitan area who were recruited in 2001–2002 using flyers distributed through public elementary schools. Schools were targeted for recruitment based on a high level of ethnic diversity and location in working- and middle-class neighborhoods in Brooklyn, Queens, and Yonkers. All assessments and procedures were approved by the Institutional Review Board (IRB) at Teachers College, Columbia University.

Parents who wished to participate were scheduled for a home visit. At the start of the home visit, mothers signed informed consent forms and children provided assent for their participation. During the home visit, mothers completed a structured interview; information on demographic variables was drawn from these interviews. Both mothers and children additionally completed a variety of standard, paper-and-pencil measures assessing psychological distress, problem behavior, and social functioning. Under the guidelines of the IRB, children who reported clinically significant levels on these measures were offered referrals for services. In addition, referrals were given to any parent interested in this information, regardless of child or parent survey reports. Children received a gift (e.g., T-shirt, miniature football) for their participation, and mothers were paid $75 for each year of their family's participation in the home visit and other study protocols.

Following the initial home visit, participants were asked to complete three subsequent annual assessments that included the same paper-and-pencil questionnaire items. Boys were 9.61 years of age on average at Wave 1 ($SD = 0.70$), with age ranging from 8.1 years to 12.0 years. Of the 128 boys, 40 (31%) were Caucasian, 55 (43%) were African American, and 33 (26%) were Hispanic/Latino. At Wave 1, 53.1% of boys lived in two-parent households. At successive assessments, 10%, 7%, and 9% of mothers, respectively, reported changes in their marital/significant partner status. The number of boys who participated at each time point was 128 (Wave 1), 103 (Wave 2), 91 (Wave 3), and 82 (Wave 4), corresponding to a loss of 35.9% of the sample. Boys who participated in all assessments did not significantly differ from boys who missed one or more assessments with regard to either baseline pubertal status or baseline depressive symptoms but were more likely to be nonwhite (15.2% European American vs. 40.2% non-European American for boys who participated in all assessments).[1]

Measures

Demographic data. During each follow-up assessment, mothers reported family characteristics, child ethnicity, their own education and occupation status, and the education and occupational status of any other parent/caregiver in the household. These responses were used to construct a measure of family socioeco-

[1] Because of the level of attrition in the sample, we conducted a series of Monte Carlo data simulations designed to test the extent to which missing data may have biased parameter estimates and/or compromised statistical power. Encouragingly, the Monte Carlo simulations suggested that parameter estimates were not substantially or systematically biased in either magnitude or direction by levels of missing data but that any null results should be interpreted cautiously. Results of the Monte Carlo simulations are available upon request.

nomic status (SES) using the Hollingshead Scale, with the standard scoring accounting for different household types (Hollingshead, 1975). The range of possible scores for family SES was 9–66 at Wave 1 ($M = 36.50$, $SD = 13.88$), which represents, on average, a high school diploma and employment as clerical workers, sales workers, or owners of small businesses. Hollingshead scores remained comparable across waves ($M = 38.24$ at Wave 2, $M = 36.59$ at Wave 3, and $M = 37.85$ at Wave 4).

Pubertal status. At each wave of data collection, mothers were provided with schematic drawings representing the five Tanner stages of genital development and asked to circle the figure that looked most like their child's (Morris & Udry, 1980). Tanner stage drawings range from Stage 1 (no visible signs of development) to Stage 5 (maturation consistent with adult status). If a mother indicated that she did not have sufficient knowledge of the child's current pubertal status, the child completed the pubertal ratings using the same line drawings as used by the mother. For boys at Wave 1, all ratings were completed by the mother. There were 13 boys who reported on their own pubertal status at Wave 2 (13%), 17 at Wave 3 (19.3%), and 8 at Wave 4 (17%). Boys' own ratings of level of pubertal development were strongly and positively correlated with their mothers' ratings at the previous assessment wave (polychoric $r = .63$ at Wave 3 and .59 at Wave 4). The distribution of Tanner stages at Waves 1–4 is shown in Table 1.

Pubertal timing and tempo. Pubertal timing was operationalized as a latent factor representing whether level of Tanner development was more or less advanced than that of other participants at the beginning of the study period. Therefore, children with a more advanced Tanner stage at the initiation of the study were the earliest maturing children. Pubertal tempo was operationalized as a latent factor representing how quickly a child progressed through Tanner stages over the study period. The latent factors representing pubertal timing and tempo are described in more detail later in the Analyses section.

Depressive symptoms. Boys completed the Children's Depression Inventory (CDI; Kovacs, 1985) at each wave. The CDI has been adapted from the Beck Depression Inventory for use with children ages 7–17. For each item on the CDI, three statements reflecting depressive symptoms are provided, and participants endorse the statement that best describes their current mood. Each statement is on a 0–2 scale, and items are summed, with higher scores indicating greater endorsement of depressive symptoms. In the present project, one item (pertaining to suicidality) was omitted, so only 26 items were completed at each time. The CDI demonstrated good reliability in the current sample (Cronbach's $\alpha = .82$ at Wave 1, .86 at Wave 2, .86 at Wave 3, and .87 at Wave 4). A score of 19 has typically been used to signify clinically relevant levels of depression, both in clinical and community populations (e.g., Timbremont, Braet, & Dreesen, 2004). Across the four waves, CDI scores ranged from 0 to 39 ($M = 6.40$, $SD = 5.65$), with the majority of participants reporting nonclinical levels of symptomatology; only 10% of the sample ($n = 13$ boys) reported clinical levels of depression during the study period.

Peer relationships. At each wave, boys completed the index for peer relations (IPR; Hudson, Nurius, Daley, & Newsome, 1990), a 25-item self-report measure of the quality of peer relationships, suitable for children and adults with a third-grade reading level. Items are rated on a 5-point Likert scale. In order to make the items more accessible for younger children, the current study used a novel modification, substituting the words *kids my age* for the word *peers.* Sample items included "I get along very well with kids my age," "I hate kids my age," and "I really feel left out from the group of kids my age." This modification did not affect the reliability of the IPR ($\alpha = .92$ at Waves 1–3 and .94 at Wave 4). The IPR produces scores on a scale from 0 to 100, with scores of 30 or above signifying relationship difficulties. In our sample, IPR scores ranged from 0 to 83 ($M = 21.22$, $SD = 16.39$).

Analyses

We utilized a latent growth curve (LGC) modeling framework (Meredith & Tisak, 1990), which allows one to characterize both inter- and intraindividual differences in change (McArdle & Nesselroade, 2002). Longitudinal measures of pubertal status were modeled with a latent factor representing initial level of development (i.e., the latent intercept) and a latent factor representing linear change in development (i.e., the latent slope). The intercept factor represents pubertal timing. Children with a higher latent intercept have higher pubertal status at the earliest age of observation (i.e., they are early maturing relative to their peers). The slope factor represents pubertal tempo; children with a higher latent slope are predicted to increase in pubertal status more quickly over time. (For complete results of the LGC modeling of pubertal development measures only, see Mendle et al., 2010.) Similarly, longitudinal change in depressive symptoms and peer relationship quality were modeled using linear growth models.

As depicted in Figure 1, our full model examines whether the effect of pubertal tempo on change in depressive symptoms in boys persisted even after accounting for changes in relationships with peers. In this model, the latent intercept and latent slope factors for depressive symptoms were regressed directly on the

Table 1
Number (and Percentage) of Boys at Each Tanner Stage in Waves 1–4

Tanner stage	Wave 1 ($M = 9.61$ yrs)	Wave 2 ($M = 11.13$ yrs)	Wave 3 ($M = 12.27$ yrs)	Wave 4 ($M = 13.14$ yrs)
1	59 (50)	24 (24)	2 (2)	0
2	38 (32)	39 (39)	21 (24)	8 (17)
3	17 (14)	23 (23)	35 (40)	13 (27)
4	5 (4)	13 (13)	26 (30)	18 (38)
5	0	1 (1)	4 (5)	8 (17)
Total *n*	119	100	88	47

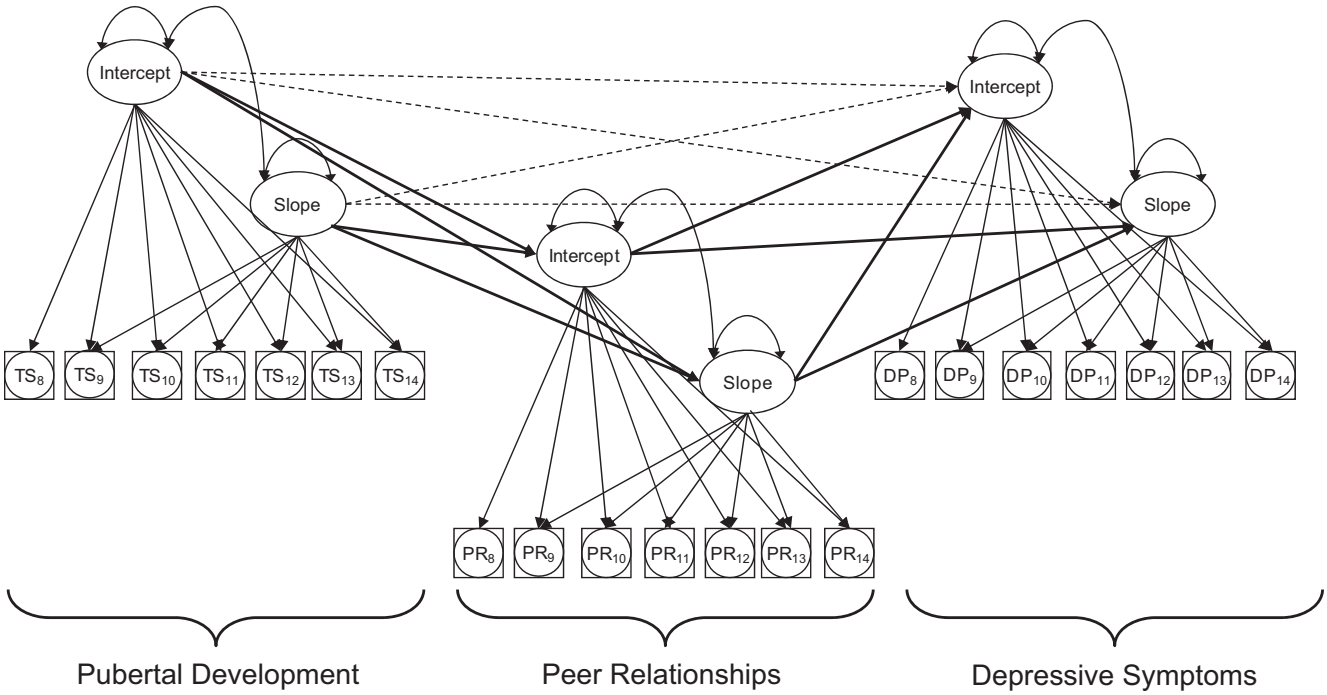

Figure 1. Latent growth model of pubertal development, peer relationship problems, and depressive symptoms in boys. Observed variables are depicted as circles within squares to indicate that children were not measured at every age (i.e., some data are missing by design at each age). Residual variances for observed variables were constrained to be equal across ages within construct. Basis coefficients are not labeled for illustrative clarity; all growth models were linear. Mean of the latent intercept factor for puberty was fixed to 0.0. Regressions of latent intercept and latent slope factors on dummy-coded race/ethnicity variables are not depicted. TS = Tanner stage; PR = peer relationship quality; DP = depressive symptoms.

latent intercept and latent slope factors for pubertal development (dashed lines in Figure 1). In addition, the growth factors for depressive symptoms were regressed on the growth factors for peer relationship problems, which were in turn regressed on the growth factors for pubertal development (bolded lines in Figure 1). In our previous study, we found that both pubertal timing and pubertal tempo significantly predicted change in depressive symptoms (Mendle et al., 2010). In the current study, the key parameters of interest were (a) whether change in peer relationship problems was significantly associated with change in depressive symptoms, after controlling for the direct effects of pubertal timing and pubertal tempo on change in depressive symptoms, and (b) whether the direct effect of pubertal tempo on change in depressive symptoms was reduced (or eliminated) after accounting for indirect effects on change in depressive symptoms via change in peer relationship problems. The logic of this model is similar to the *causal steps* logic of Baron and Kenny's (1986) classic mediation analyses, except that, rather than examining variables measured on a single occasion, we are examining relations among intraindividual changes in our constructs of interest.

All analyses were modeled using the software program Mplus (Muthén & Muthén, 1998–2009). Full information maximum likelihood was used to account for missing data. All models controlled for potential racial/ethnic differences in pubertal timing, pubertal tempo, and depressive symptoms by including two dummy-coded variables for African American race and Hispanic ethnicity as statistical covariates.

Results

Results from the full model are shown in Table 2. There were four main findings. First, boys who matured earlier demonstrated lower initial levels of peer relationship problems ($\beta = -.53$). Second, while the average change in peer relationship problems across all boys was negative (mean slope = –1.45), the effects of pubertal timing and pubertal tempo on change in peer relationship problems were positive ($\beta_{timing} = 0.67$, $\beta_{tempo} = 0.82$). This indicates that, on average, boys tended to experience fewer peer relationship problems over the transition to early adolescence, but early or rapid maturers actually experienced an increase in peer relationship problems over time. Third, change in peer relationship problems significantly predicted change in depressive symptoms ($\beta = 1.32$), with boys who experienced greater increases in peer relationship problems also showing greater increases in depressive symptoms across the transition to early adolescence. Fourth, there were no significant direct effects of either pubertal tempo or pubertal timing on average levels or change in depressive symptoms after controlling for peer relationship quality; rather, the effects of pubertal development were statistically accounted for by changes in the quality of peer relationships over time.

Growth factors for pubertal development accounted for 33.4% of the variance in initial level of peer relationship problems and 43.6% of the variance in change in peer relationships. As a comparison, we fit a nested model in which the effects of pubertal tempo on the growth factors of peer relationships were fixed to

Table 2
Standardized Parameter Estimates From the Latent Growth Curve Model of Pubertal Development, Peer Relationship Problems, and Depressive Symptoms

Model parameters	Estimate	95% CI
Growth factors		
Puberty		
Mean intercept	[0.00]	
Mean slope	1.06	[0.57, 1.56]
Intercept–slope correlation	–0.70	[–0.47, –0.83]
Depressive symptoms		
Mean intercept	2.34	[1.46, 3.23]
Mean slope	–0.47	[–1.55, 0.61]
Intercept–slope correlation	–0.56	[–0.12, –0.99]
Peer relationship problems		
Mean intercept	–0.04	[–1.71, 1.63]
Mean slope	–0.96	[–2.92, 1.01]
Intercept–slope correlation	[0.00]	
Effects		
On peer relationship level		
Puberty intercept	–0.53	[–0.97, –0.10]
Puberty slope	–0.72	[–1.14, –0.30]
On peer relationship change		
Puberty intercept	0.67	[0.10, 1.24]
Puberty slope	0.82	[0.24, 1.39]
On depressive symptom level		
Puberty intercept	0.32	[–0.45, 1.10]
Puberty slope	0.47	[–0.40, 1.34]
Peers intercept	0.89	[0.34, 1.44]
Peers slope	–0.28	[–1.09, 0.53]
On depressive symptom change		
Puberty intercept	–0.17	[–1.11, 0.77]
Puberty slope	–0.14	[–1.24, 0.96]
Peers intercept	0.35	[–0.44, 1.14]
Peers slope	1.32	[0.68, 1.97]

Note. CI = confidence interval.

zero. Pubertal timing alone, without the effects of pubertal tempo, accounted for only 6.8% of the variance in level of peer relationship problems and 12.9% of the variance in change in peer relationships. These estimates confirm that pubertal tempo substantially contributes to the prediction of peer relationship trajectories in boys, over and above what can be explained by pubertal timing.

The role of peer relationships in the effects of pubertal tempo is illustrated in Figure 2, which plots the standardized parameter estimates and 95% confidence intervals for the effects of pubertal development and peer relationships on initial level and change in depressive symptoms. Parameter estimates from the full model (summarized in Table 2) are plotted using black squares. For comparison, parameter estimates for the effects of pubertal timing and pubertal tempo from a model without peer relationships (previously reported in Mendle et al., 2010) are plotted using empty circles. Both pubertal timing and pubertal tempo had significant effects on change in depressive symptoms in the original model reported in Mendle et al. (2010). These direct effects were no longer significant in a model that included the effects of pubertal tempo and pubertal timing on change in peer relationships.

Discussion

Puberty represents not only a time of intense transformation but also a period of distinct risk for the emergence of clinical and subclinical symptomatology. Understanding which children are most vulnerable is critical for informing prevention and intervention efforts, and the study of individual differences in maturation has provided a key piece of the puzzle. Yet a primary challenge for this work is the nature of puberty itself, with its nexus of interrelated physical, social, and emotional changes.

The present project emphasizes the importance of social mechanisms in the association of puberty with depressive symptoms in boys. Both early maturing boys and rapidly maturing boys displayed decrements in the quality of their peer relationships as they moved out of childhood and into early adolescence, whereas boys with more typical developmental timing and tempo actually experienced improvements in peer relationships. After accounting for these changes in peer relationships, the direct effect of pubertal change on depressive symptoms was no longer evident. The transition from childhood to adolescence is normally characterized by a shift from relying on parents to a growing dependency on peers (e.g., Steinberg & Silverberg, 1986). These findings suggest that navigating the transition in peer relationships may be especially

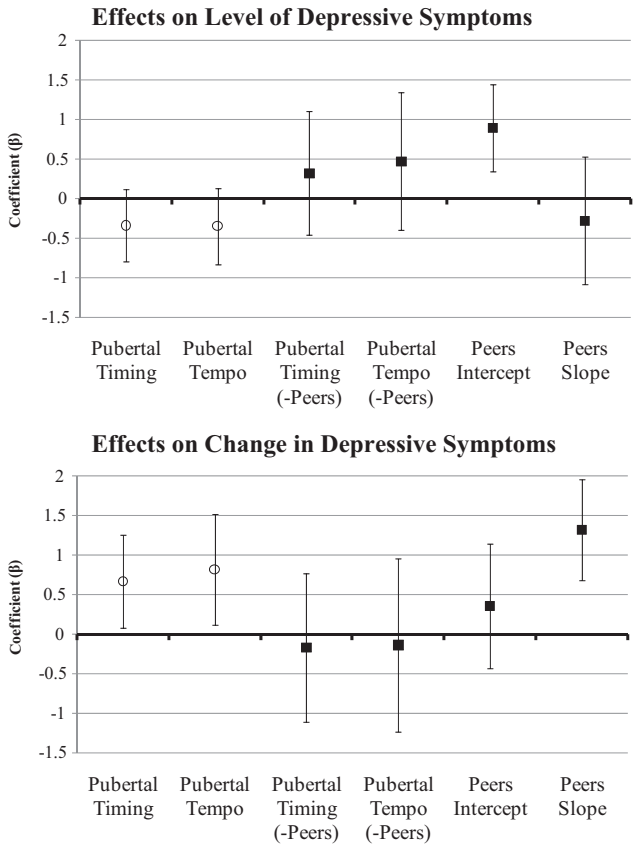

Figure 2. Comparison of the effects of pubertal timing, pubertal tempo, and peer relationships. Black squares represent standardized coefficients from the full model (including peer relationships). Direct effects of pubertal timing, "Puberty Intercept (-Peers)," and pubertal tempo, "Puberty Slope (-Peers)," are estimated controlling for effects of changes in peer relationship quality. Empty circles represent standardized coefficients from the model not including effects of peer relationships (reported in Mendle et al., 2010). Bars around parameter estimates show 95% confidence intervals.

challenging for boys whose pattern of maturation diverges from that of others of their age. In the case of early pubertal timing, it may be that children who mature ahead of their peers may lose a sense of identification with friends whose level of maturation fails to match their own (e.g., Ge et al., 1996). With regard to pubertal tempo, it is worth noting that the changes in social roles accompanying physical development take time to evolve, since early adolescent social hierarchies can be relatively inflexible (Martin, 2009). For children with a rapid pubertal tempo, it may be that physical maturation moves more rapidly than the intense social environment—rife with its past histories and complexities—can respond. Rapid developers' desire for a different sort of peer interaction may therefore potentially trigger difficulties in relationships with children of the same age and amplify feelings of distress.

The LGC approach employed in our study has been described as "better suited [than cross-lagged analyses] for studying individual differences in development and change" (Curran, 2000, pp. 3–4). Most important, it captures the dynamic nature of the pubertal tempo construct, by modeling the rapidity of within-person change in pubertal status as a random effect. However, it is important to note that this model is formally ambiguous regarding the direction of causation between change in the quality of peer relationships and change in depressive symptoms. Thus, results are best conceptualized as evidence for concurrent, correlated changes: The individuals who increase in peer relationship problems across the transition to adolescence are, at the same time, showing the greatest within-person changes in depressive symptoms. Given previous evidence on bidirectional effects between children's peer relationships and internalizing problems (e.g., Deater-Deckard, 2001), we suspect that these correlated changes represent a mutually reinforcing and reciprocal process.

Our study is one of the few to examine pubertal tempo and the only study to examine potential mechanisms for the effects of tempo on depressive symptoms. Yet there are limitations worth considering. These include a small sample of male participants, high attrition, and data collection that ended comparatively early in adolescence. The level of depressive symptoms in our participants, moreover, reflected the nonclinical population from which it was drawn. Because of the nature of our sample, we therefore can make no predictions about long-term effects beyond early adolescence, and our results cannot be assumed to generalize to girls as well as to boys. In addition, we utilized parent reports of Tanner stages, which can vary in accuracy compared with reports of development determined during a physical exam (Dorn, Dahl, Woodward, & Biro, 2006). Finally, we tested the additive effects of pubertal timing and tempo, but these may interact with each other, such that rapidly developing boys are most at risk when maturation occurs earlier than in peers, compared with boys whose rapid development allows them to "catch up" with earlier or on-time maturing peers. Given the current sample size, we were unable to test such latent variable interactions.

We believe these limitations are counterbalanced by the strengths of our study, most notably its focus on boys; inclusion of multiple sources of variability in development; and consideration of physical, social, and emotional change. There has been a dearth of research on boys' puberty to date. Most studies focus exclusively on girls, and even those that include boys tend to conceptualize hypotheses and interpret findings in terms of the dominant theories of puberty and psychosocial adjustment, which were all developed based on data from girls (Ge & Natsuaki, 2009). Moreover, because of the infrequent use of multiwave assessments of puberty, prior studies have emphasized the importance of pubertal timing in the absence of examination of tempo. This literature, however, has yielded inconsistent results. The current project contributes to a growing awareness that research that integrates multiple aspects of puberty may better reflect the challenges faced by boys during this dramatic transition.

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