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Disentangling the Effects of Boys' Pubertal Timing: The Importance of Social Context

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Abstract

Some prior studies have found that, for boys, earlier puberty is linked to higher crime and delinquency, while other studies have found that earlier puberty is associated with greater social competence and beneficial psychosocial development. The current study suggests that these seemingly contradictory results actually represent two divergent pathways by which earlier pubertal timing can affect adjustment. Which pathway boys take is highly dependent on psychosocial context. Using a sample of 310 African American boys and their primary caregivers tracked across three waves of data collection from ages 10.55 to 18.84 from the Family and Community Health Study (FACHS), the current study utilizes Latent Moderated Structural Equation Modeling (LMS) to analyze effects of interactions between pubertal timing and social contextual factors on criminal behavior and social competence. Results suggest that criminogenic effects of early puberty are contingent on deviant peer group, poor school experience, harsh parenting, and neighborhood disorganization, whereas the association between earlier puberty and social competence is attenuated by harsh parenting. Results suggest that modeling both positive and negative development outcomes together may give a clearer picture of the developmental

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Authors' Contributions

E.T.K. conceived of the study, participated in its design and coordination, conducted statistical analyses, and drafted the manuscript; T.E.S. participated in design of this study and assisted in drafting the manuscript; R.L.S. participated in the design and coordination of this study, and assisted in drafting the manuscript; L.G.S. participated in the design and coordination of this study, and assisted in drafting the manuscript.

Compliance with Ethical Standards

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

Standards of ethical responsibility have been followed. None of the findings in this paper have been published elsewhere. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Institutional Review Board of the University of Georgia approved the study and its informed consent procedures.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

consequences of pubertal timing for boys. Additionally, this study shows the importance of social context in shaping the meaning and consequences of biological variables like pubertal timing.

Keywords

antisocial behavior; delinquent behavior; adjustment; puberty; social competence

Introduction

A large body of research suggests that experiences during puberty can have long-lasting effects on youth development (Mendle, 2014b). There is substantial evidence that early or precocious pubertal development is associated with externalizing behavior in youth (Klopack, Simons, & Simons, 2018), especially for boys (Mendle & Ferrero, 2012). A recent meta-analysis found an effect size of 0.25 for the association between pubertal timing and externalizing behavior for boys (Dimler & Natsuaki, 2015). Unlike studies of girls which consistently find negative social, physical, and psychological consequences of earlier puberty (e.g., L. G. Simons, Sutton, Simons, Gibbons, & Murry, 2016), developmental studies of boys have also found that earlier puberty is linked to high self-esteem (Blyth, 1981), positive body image (Benjet & Hernandez-Guzman, 2002), and other prosocial and socially competent outcomes (Carlo, Crockett, Wolff, & Beal, 2012). The current study suggests that these seemingly disparate outcomes actually represent divergent pathways that can be explained in terms of social context. Specifically, social contextual factors, including parental and peer relationships, school experience, and neighborhood conditions will determine whether earlier puberty will be associated with delinquency or social competence for boys. In the current study, moderators were identified representing four important domains of youth experience—peer group, school, parenting, and neighborhood—that determine which pathway boys who experience earlier puberty take.

Early Puberty and Delinquency

Previous research has found that earlier pubertal development is directly associated with more delinquent and antisocial behavior (Path B in Figure 1). Past research has found evidence linking boys' earlier puberty with delinquent behavior (e.g., Chen & Raine, 2018), crime (Jackson, 2012), and other deviant behaviors like earlier and heavier alcohol use (Biehl, Natsuaki, & Ge, 2006) in US and international samples (Kweon, Yun, Park, & Kim, 2017). A number of explanations have been proffered to explain this association. Biosocial researchers have argued that higher testosterone is associated with risk-taking behaviors (Beaver & Wright, 2005). Because testosterone levels increase for boys in puberty, boys who develop earlier would be expected to engage in delinquency and other risk-taking behaviors earlier. This early delinquency continues across the life course as other prosocial avenues are closed off (Moffitt, 1993).

Another biosocial theory, life history theory, argues that children who grow up in harsher and more unpredictable environments develop faster and reach reproductive age more quickly so that they can reproduce before the environment can kill or disable them (Belsky, Schlomer, & Ellis, 2012). Life history researchers have noted that earlier puberty would

be an excellent indicator of faster development, and thus they argue that variation in pubertal timing can be explained by environmental harshness and unpredictability in youth (Belsky et al., 2012). These youth develop a suite of psychosocial dispositions that would make them better suited to survive in a harsh environment—e.g. preference for immediate gratification, hostile view of relationships (Ellis, Figueredo, Brumbach, & Schlomer, 2009). These dispositions make youth more likely to engage in risk-taking and delinquent behavior. Thus, puberty and externalizing behaviors are spuriously associated because they are both part of a reproductive strategy developed in response to a harsh, unpredictable environment.

However, others have disagreed with these biosocial explanations and have argued that the causes and consequences of pubertal timing are principally social. Social explanations of the antisocial effects of early puberty tend to emphasize role and social transitions inherent to maturation, including increased independence, orientation toward potential romantic partners, sexual involvement, and conflict with parents. When these transitions occur “off time”—that is, at a different time from most of a boy’s peers—these changes can become isolating and problematic (Waylen & Wolke, 2004). Following arguments made by Moffitt (1993), Felson and Haynie (2002) argue that boys who experience earlier pubertal timing experience a “maturity gap.” That is, boys who develop ahead of their peers reach biological maturity before they are regarded as adult by society. Adolescents attempt to bridge this gap by seeking greater autonomy and engaging in more pseudo-mature behaviors, including delinquency.

Similarly, others have argued that boys who experience puberty earlier will engage in behaviors appropriate for their level of development (e.g., independence seeking, orientation toward dating and sex). However, because their peers are not engaging in the same behaviors, these activities are viewed as deviant (Williams & Dunlop, 1999). Early maturing boys are thus labeled as deviants, potentially closing off non-delinquent life paths (Moffitt, 1993) and producing secondary deviance. Alternatively, the developmental stage termination hypothesis suggests that earlier maturation forces boys into roles they are not yet prepared for. This argument suggests that boys who develop slower have more time to acquire social and personal skills necessary for a successful transition to adolescence. Boys who experience earlier pubertal timing are less equipped to meet the expectations of someone of their physical maturity level (Williams & Dunlop, 1999). The stress and interpersonal conflict produced by the early termination of precociously developing boys’ childhood leads to deviant and delinquent behavior.

Early Puberty and Social Competence

In contrast to the antisocial effects of early puberty presented above, a large number of scholars have found that earlier pubertal timing is associated with prosocial outcomes and greater social competence (Path A in Figure 1), including greater confidence, self-image, and popularity (Benjet & Hernandez-Guzman, 2002; Blyth, 1981; Clausen, 1975). Explanations for this phenomenon tend to focus on gendered social roles that are highlighted by precocious development. Some scholars argue that puberty intensifies gender-related expectations, potentially increasing independence for boys who reach puberty earlier. According to this argument, in cultures that value displays of masculinity, boys who develop

earlier are more successful in performing masculinity, and thus are more socially successful (Hill & Lynch, 1938). Past research has found that puberty created a sense of agency for boys, and that boys typically looked forward to puberty (Martin, 1996). Unlike girls, who often experience more limited independence at puberty (Haynie, 2003), boys view as a positive period of greater independence.

The current study focuses on social competence as a positive socially oriented outcome. Social competence refers to the ability to act appropriately in social interactions and the ability to keep and maintain social relationships (Chen, Li, Li, Li, & Liu, 2000). Past research has shown that socially competent youth tend to excel in social and academic settings, have better psychological and social adjustment as they age, and tend to engage in fewer problem behaviors (see e.g., Najaka, Gottfredson, & Wilson, 2001). Social competence has also been shown to be associated with earlier pubertal timing in boys (Carlo et al., 2012) and may actually be a protective factor for youth experiencing earlier pubertal timing (Carter, Halawah, & Tirnh, 2018). The measure of social competence used here focuses on sociability, the ability to make and maintain friendships (Chen et al., 2000).

It is important to note that the studies finding an association between social competence and earlier pubertal timing for boys tend to be older. Several scholars have argued that the meaning of puberty has changed for boys over time (Mendle & Ferrero, 2012). Cross-cultural research on pubertal timing suggests that cultural attitudes toward gender roles have an important effect on the outcomes of youth who experience precocious pubertal development (Skoog, Stattin, Ruiselova, & Ozdemir, 2013). Thus, the seeming disparity in prosocial and antisocial effects of puberty may simply represent a cohort effect. If this is the case, it is expected that there will be no effect of puberty on social competence in this sample.

Early Puberty and Social Context

Several scholars have argued that earlier pubertal timing changes youth's social context (Klopack et al., 2018) (Path C in Figure 1). However, there is little research on the effects of earlier pubertal development on boys' social context. Most previous research on boys has focused on direct effects of puberty for boys, rather than the effects on social networks, parental relationships, school experience, and other social contextual factors.

Although most of the above discussion suggests that research finding associations between puberty and social competence and between puberty and delinquency are essentially incompatible, it may be that increased social competence, rather than being prosocial, is causally associated with delinquency and antisocial behavior (Path E in Figure 1). Some past studies (e.g., Chen et al., 2019) have found that more sociable youths also tend to engage in more delinquent behaviors. As discussed above youth tend to value some antisocial behaviors that signal maturity during adolescence (Moffit, 1993). At this point in the life course, aggression and delinquency may be a signal of "adult" behavior to other youth (Galambos & Tilton-Weaver, 2000). Aggression may also be used to distance oneself from less popular and less admired peers (Cillessen & Rose, 2005). Further, researchers have argued that high-status youth are especially likely to engage in behaviors that are

valued among peers to solidify their social standing (Choukas-Bradley, Giletta, Neblett, & Prinstein, 2015). Existing work supports the claim that popular youth also tend to engage in more aggressive and delinquent behavior than other youth (Becker & Luther, 2007). Although more work is needed, there is also some evidence that pubertal timing plays a role in this association. One study (Galambos & Tilton-Weaver, 2000) found that boys who had more advanced pubertal development also indicated greater social involvement with peers and engaged in more antisocial behaviors than other boys. However, consistent with the goals of this study, it may be that social context is important in delineating the effect of early puberty on boys' outcomes.

Contextual Moderation

A number of researchers have argued that pubertal timing interacts with social context to produce delinquent behavior (Paths D in Figure 1). Puberty is a sensitive period that can amplify the effect of criminogenic context (Mendle, 2014a). Puberty is an important life stage, during which youth are exposed to a wide variety of new experiences and behavioral options. Social context plays an important role in determining what opportunities and social expectations are available during this socially critical period (Ge & Natsuaki, 2009). Boys who experience puberty early may be at greater risk because they may find themselves labeled as deviant earlier or may have prosocial opportunities cut off earlier (Moffitt, 1993). Alternatively, some researchers have argued that social context may amplify the effects of pubertal timing discussed above (Ge & Natsuaki, 2009).

Studies addressing the contextual amplification of pubertal timing tend to focus exclusively on delinquent and antisocial outcomes. An important innovation of this study is the additional focus on social competence as a positive, prosocial developmental outcome of puberty that is dependent on social context. The current study is concerned with disentangling the seemingly divergent results of pubertal timing for boys; therefore, both delinquent behavior and social competence are modeled together. The principle argument forwarded here is that the inconsistent results indicating either more delinquency or greater social competence found in previous studies can be explained in terms of the social context experienced by boys who manifest precocious pubertal development. The concurrent modeling of delinquent behavior and social competence is utilized to show that boys are set on one pathway or the other depending on contextual factors.

The current study focuses on four domains—peer group, school, parenting, and neighborhood—that have been shown to be highly influential for boys' delinquency and social development. A very large body of research has shown that individuals are more likely to be delinquent when they associate with delinquent peers (Warr, 2002). More generally, social learning perspectives emphasize the way that various domains of adolescent life contribute to delinquency and other social behaviors (L. G. Simons, Sutton, Shannon, Berg, & Gibbons, 2017). School experiences, for example, have been shown to have important consequences for delinquency (Payne, 2009), and have been shown to interact with puberty to affect delinquent behavior (Park, Yun, & Walsh, 2017). Similarly, parenting has been a key factor in research on delinquency (e.g., Crosswhite & Kerpleman, 2009) and social development (e.g., L. G. Simons, Simons, Landor, Bryant, & Beach, 2014). Parenting

has been identified in past contextual amplification research as interacting with early puberty (e.g., Marceau, Abar, & Jackson, 2015). Finally, neighborhood conditions have been shown to impact various components of youth development (Sampson, 2012). Neighborhoods with greater collective efficacy tend to have fewer delinquent youth (Sampson, 2006). Additionally, prior research has reported that neighborhood disorder interacts with pubertal timing to affect developmental trajectories (Obeidallah, Brennan, Brooks-Gunn, & Earls, 2004).

This study builds on past research in the contextual moderation literature by including a variety of contextual factors. Past studies tend to focus on a single factor that interacts with pubertal timing like stressful life events (e.g., Jackson, 2012), parental monitoring (e.g., Marceau, Abar, & Jackson, 2015), school context (e.g., Park, Yun, & Walsh, 2017), or neighborhood disorder (Obeidallah et al., 2004). This study includes these factors in a single model, so that their relative contributions to the delinquent or socially competent effect of pubertal timing can be assessed. Additionally, a positive and negative developmental consequence of pubertal timing are included in a single model. Past research in the contextual moderation tradition has focused on negative consequences (e.g., substance use, delinquency). Focusing on only negative consequences may lead to true but under-contextualized results suggesting that early puberty is only a risk factor.

Current Study

Past research has found that earlier pubertal timing is associated with either more delinquent behavior or greater social competence. Thus, replicating past results, it is expected that earlier pubertal development will be associated with both social competence in late adolescence (Hypothesis 1) and/or more delinquent behavior in late adolescence (Hypothesis 2). The current study suggests that the seeming disparity in outcomes for boys' early pubertal timing can be explained in terms of contextual moderation. That is, the outcomes described above actually represent divergent pathways. Social context will interact with early pubertal development to determine whether early puberty will have socially competent or delinquent consequences in late adolescence (Hypothesis 3). Finally, as noted above, past research has suggested that more sociable youths may also engage in more delinquent behavior. According to this argument, social competence and delinquency are not divergent pathways determined by context but are causally related. This argument is an alternative to the principle explanation provided here and should therefore be assessed. If this alternative explanation is true, social competence and delinquent behavior will be positively associated in late adolescence (Hypothesis 4).

Methods

Participant and Procedures

These hypotheses are assessed using four waves of the Family and Community Health Study (FACHS). FACHS is a multisite longitudinal study of African American youth and their families. 10-year-old youth and their families were recruited from census tracts representing a wide variety of socioeconomic and racial backgrounds in Georgia and Iowa. In 1998, 897 (417 male) target youth were recruited into the study. As of Wave 4, 756 targets (84.28%

of the sample) including 341 males (81.77% of the male sample) remained in the study. Targets, primary caregivers (PCs), secondary caregivers, and siblings were interviewed using in-home computer-assisted interviews (CASI). For more information on the FACHS sample, see L. G. Simons et al. (2016). In the current study, data were utilized from male target interviews collected in 1998 (Wave 1), 2000 (Wave 2), 2002 (Wave 3), and 2005 (Wave 4), when targets' mean ages were 10.55, 12.65, 15.74, and 18.84 respectively as well as data from PC interviews collected in 2002.

Measures

Pubertal Timing.—The Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988) was used to assess pubertal timing at Wave 2. Respondents are considered to have experienced earlier pubertal timing if they have developed more (or have completed pubertal development) before their peers. The PDS is composed of six sex-specific questions assessing how much respondents' bodies have changed in regard to pubertal developments, including body hair, facial hair, skin changes, and deepening voice with responses ranging from (1) "not yet begun/not yet started" to (4) "seems complete/has been completed." Scores on this scale were standardized within age group. Thus, respondent scores are relative to other respondents their same age. Cronbach's α for this scale was 0.62.

Delinquency.—Delinquency is assessed using the conduct disorder subscale of the Diagnostic Interview Schedule for Children IV (DISC-IV), a variety scale of 13 unlawful behaviors including bullying and intimidation, assault, use of a weapon, robbery, and arson. Respondents were asked at Wave 4 whether they had engaged in any of these behaviors in the past 12 months. Items were summed to generate this variable.

Social Competence.—Social competence is assessed at Wave 4 using a 9-item scale developed for the FACHS study meant to assess a respondent's prosocial skills and ability to make and keep friends. Using a response format ranging from (1) "not very well" to (3) "very well", scale items include "how well can you make and keep friends of the same sex", "how well can you work in a group", "I find it hard to make friends (*reverse coded*)", and "I am a pretty important member of my group". Items were standardized and then averaged. Cronbach's α for this scale was 0.74.

Deviant Peers.—Deviant peers is measured at Wave 3 using a 12-item scale composed of questions asking in the past 12 months how many of the respondent's close friends engaged in various deviant behaviors including stealing something worth less than \$25, stealing something worth more than \$25, motor vehicle theft, assault, assault with a weapon, robbery, tobacco use, alcohol use, inhalant use, any drug use, binge drinking, becoming pregnant or impregnating someone. Possible responses are (1) none of them (2) some of them (3) all of them. Items were averaged to generate this scale with a Cronbach's α of 0.83.

Positive School Experience.—Positive school experience at Wave 3 was assessed using a 6-item scale developed by Conger and Elder (1994) for the Iowa Youth and Families Project designed to assess how positive a youth's experiences with school are. Items include "in general, you like school a lot," "you do not feel like you really belong at school (*reverse*

coded),” and “grades are very important to you,” with responses ranging from (1) “strongly disagree” to (4) “strongly agree.” Items were averaged, and Cronbach’s α for this scale was 0.69.

Harsh Parenting.—Harsh parenting was assessed at Wave 3 using a 14-item scale developed by Conger and Elder (1994) that focuses upon parental behavior during the previous 12 months. Items include “how often does your primary caregiver shout or yell at you” and “how often does your primary caregiver call you bad names,” with responses ranging from (1) “never” to (4) “always.” Cronbach’s α for this scale was 0.80.

Neighborhood Collective Efficacy.—Neighborhood collective efficacy was assessed using a 30-item scale combining three scales adapted from Sampson, Raudenbush, and Earls (1997) measuring community cohesion, collective socialization, and social disorder. At Wave 3, primary caregivers were reported on conditions in their neighborhoods. Sample items include “when there is a problem around here, the neighbors get together to deal with it,” “you can count on adults in your neighborhood to watch out that children are safe and don’t get in trouble” with responses (2) “true” or (1) “false” and in your neighborhood how big of a problem is “drinking in public,” “graffiti on buildings and walls,” and “gang violence” with responses ranging from (1) “a big problem” to (3) “not at all a problem.” Higher scores on this scale represent more collectively efficacious neighborhood context as reported by primary caregivers. Items were standardized and averaged to create individual scores. Cronbach’s α for this scale was 0.92.

Controls.—All models control for respondent age in years at Wave 2, parent SES (PC education in years and household income) at Wave 1 and prior criminal behavior (same as variable used from Wave 4) at Wave 1.

Plan of Analysis

To address the hypotheses described above, analyzed zero-order and multivariate associations among research variables were analyzed. For multivariate analysis, latent moderated structural equation models (LMS) in a structural equation modeling context was utilized (Cheung & Lau, 2017). LMS analyses were modeled using Mplus 7.4 (Muthén & Muthén, 1998–2015). Study variables were included in the model as reliability-corrected single-indicator latent factors. To ease estimation, control variables were entered as manifest variables. Outcome variables and mediators were freed to covary in all models. Interaction terms were estimated using the XWITH command in Mplus. Regression is typically used to assess interaction effects. However, measurement error introduces bias into interaction estimates and confidence intervals used to assess significance of these estimates. LMS uses latent variables and produces latent interaction terms that correct for this bias. Simulation studies have found that LMS produces more accurate interaction estimates and confidence intervals compared to regression.

Statistical significance of all model parameters was assessed using 90, 95, and 99% confidence intervals derived from a bias-corrected bootstrap procedure using 1000 draws (e.g. bias-corrected confidence intervals, BCCI). Bias-corrected bootstrapping allows for

nonparametric tests of significance that are appropriate for non-normally distributed data. This procedure is particularly important in the current study because interaction terms would not be expected to be normally distributed.

Model fit was assessed using model χ^2 , root mean square error of approximation (RMSEA), and comparative fit index (CFI) (Browne & Cudeck, 1993) in the first two models. LMS modeling does not allow for these fit indices to be calculated, so the fit of the model without interactions is used to assess all models (Cheung & Lau, 2017). Of the 354 boys who participated in Wave 2, 310 had complete information on parental SES and were included in the study. Missingness in this sample was handled using full information maximum likelihood estimation (FIML).

Results

Beginning with zero-order associations (shown in Table 1), pubertal timing was significantly associated with social competence ($r = .20, p < .01$) and marginally associated with delinquent behavior ($r = .11, p < .10$). Delinquent behavior and social competence were significantly negatively correlated ($r = -.16, p < .05$), suggesting negative evidence for Hypothesis 4 which asserted that delinquency and social competence would be positively related. As might be expected, delinquent behavior was significantly associated with deviant peers ($r = .19, p < .01$), positive school experience ($r = -.13, p < .05$), and harsh parenting ($r = .14, p < .05$), while social competence was negatively correlated with deviant peers ($r = -.13, p < .05$) and positively related to affirming school experiences ($r = .28, p < .001$). These associations are further explicated in multivariate analyses below.

Results of LMS models testing proposed hypotheses are shown in Table 2. In Model 1, delinquent behavior and social competence were regressed on pubertal timing and control variables. All fit indices indicated good or excellent fit. The χ^2 test was nonsignificant, the RMSEA was .05, and the CFI was .96. In all models shown in Table 2, delinquency and social competence were freed to covary. In this model, pubertal timing assessed at Wave 2 significantly predicted both delinquent behavior (95% BCCI = [0.01 – 0.31]) and social competence (95% BCCI = [0.07 – 0.48]) at Wave 4, providing evidence for Hypotheses 1 and 2. Delinquent behavior and social competence significantly negatively covaried (95% BCCI = [-0.12 – -0.02], further evidence against Hypothesis 4). In Model 2, potential mediators from Wave 3 of the associations between pubertal timing and delinquency and pubertal timing and social competence were included in the model. The χ^2 test was nonsignificant, the RMSEA was .03, and the CFI was 1.00. Associations between pubertal timing and delinquent behavior, pubertal timing and social competence, and delinquent behavior and social competence were largely unchanged. Positive school experience significantly predicted social competence (95% BCCI = [0.20 – 0.61]). Coefficients from paths for pubertal timing regressed on mediators are not shown in Table 2; however, none of these paths were significant.

In Models 3 through 6, potential moderators of the associations between pubertal timing and delinquency and between pubertal timing and social ability were included one at a time, testing whether these contextual factors influence the social competence or delinquency

of youths as predicted in Hypothesis 3. Model 3 shows the moderating effect of deviant peers. Results indicated that having more deviant peers amplified the delinquency producing effect of earlier pubertal timing (95% BCCI = [0.24 – 5.69]). Deviant peer group did not significantly moderate the association between pubertal timing and social competence. Model 4 shows the moderating effects of positive school experience. Having more positive school experience attenuated the association between pubertal timing and delinquent behavior (95% BCCI = [-9.18 – -2.20]) and amplified the association between pubertal timing and social competence (95% BCCI = [0.09 – 1.11]). In Model 5, harsh parenting amplified the delinquent consequences of earlier puberty (95% BCCI = [2.00 – 4.68]) and dampened the association between earlier pubertal timing and social competence (95% BCCI = [-1.98 – -0.36]). Results of Model 6 showed that greater collective efficacy in a youth's neighborhood weakened the association between pubertal timing and delinquent behavior (95% BCCI = [-6.20 – -0.01]) but did not moderate the association between pubertal timing and social competence. Finally, in Model 7, all moderators were entered together. In this model, the effect of deviant peers flipped direction. For boys with few deviant peers, earlier puberty was associated with more delinquent behavior (95% BCCI = [-9.15 – -0.28]). Harsh parenting (95% BCCI = [2.01 – 5.63]) and neighborhood context (95% BCCI = [-1.91 – -0.25]) still moderated the association between pubertal timing and delinquent behavior in the expected direction. Only harsh parenting still moderated the association between pubertal timing and social competence in this model (95% BCCI = [-2.34 – -0.33]).

Table 3 shows predicted effects of pubertal timing on delinquent behavior and social competence at specified levels of each moderator drawn from Model VII in Table 2. Results showed that at lower levels of deviant peers, earlier pubertal timing was associated with greater delinquent behavior. For a boy with a mean score on deviant friends, a one unit increase in pubertal timing was associated with .46 more delinquent acts; whereas, for a respondent with a deviant friends score two standard deviations below the mean, a one unit increase in pubertal timing was associated with about one more delinquent act. For respondents with deviant friends scores one and two standard deviations above the mean, pubertal timing was not associated with delinquent behavior.

A similar pattern held for positive school experience. Though the point estimate in Model VII in Table 3 was not significant, results in Table 3 showed some evidence that more negative school experience amplified the delinquent effect of earlier pubertal timing. Better school experience acted as a protective factor, as respondents who reported school experience one and two standard deviations above the mean showed no effect of pubertal timing on delinquent behavior.

Harsh parenting appeared to be particularly influential as a moderator of pubertal timing on delinquent behavior. Earlier pubertal timing had an increasingly positive effect on delinquent behavior for each additional standard deviation above the mean a youth scored on harsh parenting. For boys with harsh parenting scores one and two standard deviations below the mean, earlier pubertal timing was associated with fewer delinquent behaviors. Particularly low harsh parenting seemed to have a strong protective effect for boys who experienced puberty early.

Less collective efficacy in a youth's neighborhood also appeared to amplify the delinquent effects of earlier pubertal timing. For a boy whose primary caregiver reported a neighborhood context score at the mean, each unit increase in pubertal timing was associated with .46 more delinquent behaviors. For a boy whose primary caregiver reported a neighborhood context score two standard deviations below the mean, each unit increase in pubertal timing was associated with about one more delinquent behavior.

Finally, harsh parenting appeared to dampen the association between earlier pubertal timing and social competence. For youth with harsh parenting scores at the mean and one and two standard deviations above the mean on the harsh parenting, there was no significant association between pubertal timing and social competence. However, for boys who reported low levels of harsh parenting, earlier pubertal timing had an increasingly positive effect on social competence.

Supplemental Analyses

In the current study, four potential moderators of the associations between pubertal timing and delinquent behavior and between pubertal timing and social competence were identified. It is likely, however, that this list is not comprehensive and that there are additional contextual factors moderating these effects. In addition to the results shown here, a measure of neighborhood concentrated disadvantage drawn from census variables was analyzed (see, Sampson, Raudenbush, & Earls, 1997). This variable did not moderate either effect and was therefore excluded from this study. Additionally, boys in this study also reported on community disorder at Wave 3—though not community cohesion or collective socialization. This measure was used in place of the PC measure used above; again however, this variable did not significantly moderate either effect and was dropped from this study. It may be that the PC report better reflects actual neighborhood conditions compared to the target's report. Also, the more comprehensive measure used for the PC reported variable may capture important elements of community conditions that are critical to the moderating effect we find above. Further research is required to disentangle this effect.

Hypothesis 4 was assessed using only contemporaneous covariance between delinquent behavior and social competence. To conduct a more comprehensive test of this hypothesis, an autoregressive cross-lagged model was estimated by regressing delinquent behavior at Wave 4 on delinquent behavior and social competence at Wave 3 and regressing social competence at Wave 4 on social competence and delinquent behavior at Wave 3. All boys with data on exogenous variables were included in the model. All controls used in other models were included. The model was just identified and therefore had perfect model fit. This model is shown in Figure 2. This model provides further negative evidence for Hypothesis 4. Not only did social competence at Wave 3 not predict more delinquent behavior at Wave 4, social competence at Wave 3 was associated with less delinquency at Wave 4 ($\beta = -.16, p < .05$).

Discussion

The goal of the current study was to adjudicate between two literatures describing greater social competence and more delinquent behavior as outcomes for boys who

experience earlier pubertal timing. Thus, there is a substantial seeming inconsistency in the consequences of earlier pubertal timing for boys. The current study argued that this discrepancy is the consequence of diverging pathways for boys who experience earlier puberty. That is, boys are sorted into socially competent or delinquent pathways by social context, including peer group, school experience, parenting, and neighborhood conditions. To test this idea, interactions between pubertal timing and these contextual factors were estimated to assess the extent to which social context determined the socially competent or delinquent consequences of earlier puberty.

If there were indeed diverging pathways representing more socially competent versus delinquent outcomes of earlier puberty, pubertal timing should have been associated with both of these outcomes. Results indicated support for both Hypothesis 1, early pubertal development was associated with greater social competence in late adolescence, and Hypothesis 2, early pubertal development is associated with more delinquent behavior in late adolescence. In multivariate analyses pubertal timing predicted both more delinquency and greater social ability in late adolescence. Thus, the current study replicates results from both literatures discussed above. This study puts these past results in clearer conversation with one another. Rather than producing conflicting findings, these past studies identified processes that are occurring concurrently. The current study expands on these studies that were restricted to either negative (i.e., delinquency) or positive (i.e., social competence) consequences of earlier pubertal timing. Future studies should consider modeling both positive and negative developmental outcomes of pubertal timing; otherwise, they risk reaching correct but under-contextualized conclusions about the benefits or risks of pubertal timing.

The current study provides substantial evidence for Hypothesis 3 that social context interacts with early pubertal development to determine whether early puberty will predict greater social competence or more delinquent behavior in late adolescence. Thus, this study affirms and builds on past research in the contextual moderation tradition. Past research has shown that social context can amplify or attenuate the delinquent effects of earlier puberty. This study expands on that body of research by showing that social context also moderates the effect of pubertal timing on a positive developmental outcome (viz., social competence). Additionally, this study includes a wide range of potential moderators in a single model, clarifying the relative importance of these factors in determining the effects of pubertal timing for boys.

This study also helps to disentangle the conflicting results reported in prior research by examining which contextual factors push youth into either pathway. The results provided strong evidence that the association between pubertal timing and delinquency is moderated by deviant peer group, harsh parenting, and disorganized neighborhood conditions and weak evidence that positive school experience is a protective factor against delinquency. Lower levels of harsh parenting also amplified the social competence effects of earlier puberty in this study. There was also weak support for school experience as a moderator of the association between pubertal timing and social competence. This study contributes to the larger literature examining the social consequences of biological processes in youth development. Results indicate that the developmental consequences of this biological

process are highly dependent on social context. Future studies examining biological processes and variables should consider including social contextual factors to provide a more comprehensive understanding of the way that biology and society interact to shape development.

Finally, the current study finds negative support for Hypothesis 4 which posited that popularity and delinquency are positively associated in late adolescence. When a moderator affected whether boys who experienced earlier puberty went on to become delinquent or went on to have greater social ability, there was no association between delinquency and social ability in late adolescence. This indicates that the association between these two variables can be explained by the sorting of boys into prosocial and antisocial pathways. Thus, the current study does not support arguments that social competence will cause more delinquent behavior (e.g., Becker & Luther, 2007). There was no support for the idea of a causal link between social competence and delinquent behavior; rather, the results suggest that past seemingly dissonant findings regarding the effects of boy's early puberty can be harmonized by including social contextual factors.

The moderating effect of peer delinquency changes direction in Model VII. Because this model contains multiple interaction terms, the moderating effect of peer delinquency is, in part, dependent on the moderating effects of school experience, parenting, and neighborhood condition. It may be that for boys who have poor school experiences, experience harsh parenting, and live in a disorganized neighborhood, associating with delinquent peers may be normative and socially protective. Youth who experience poor school experiences, harsh parenting, and disorganized neighborhood conditions may be limited to a social network comprised of delinquent youth (Sampson & Wilson, 1995). Thus, sociable youth who got through these life experiences may have a greater proportion of delinquent youth with whom to associate. Further research is needed to clarify this association.

There are a number of important limitations to this study. To begin, it utilizes an all African American sample living in Georgia and Iowa at the beginning of the study. Previous research found that pubertal timing varies to some degree by racial group; however, these differences were largely accounted for by socioeconomic indicators controlled for in these models (Obeidallah, Brennan, Brooks-Gunn, Kindlon, & Earls, 2000). Similarly, the significance and roles associated with puberty may vary across cultures (Skoog et al., 2013). For example, research on young men of color in the United States indicates that they are labeled and treated as delinquent from an early age (see e.g., Rios, 2011), potentially affecting the influence of pubertal timing. Future studies should use more racially/ethnically and geographically diverse samples. However, it should be noted that participants lived in suburban, rural, and urban areas and that, over the waves of the study, participants have moved and now live throughout the United States.

These data are fairly old (Wave 4 was collected about 15 years ago), and it is possible that results would differ for a more contemporary sample. As noted above, some scholars have argued that the cultural meaning of puberty has changed over time (Mendle & Ferrero, 2012). Additional studies using more recent data are needed to fully assess this argument. Measures of social competence were not available in these data before Wave 3, thus it

was not possible to control for social competence prior to pubertal timing assessed at Wave 2. Future studies can better assess the causality of this pathway by measuring social competence before pubertal timing. It is also possible that important social contextual moderators may be missing from these analyses. Though four important domains for boys were selected, other factors may also sort precociously developing boys into these pathways (e.g., romantic partners, sexual debut, religiosity).

Conclusion

Puberty has been identified as a critical period for youth. Substantial past research has investigated the long term consequences of early pubertal timing and has found two seemingly contradictory findings for males—broadly antisocial outcomes, specifically greater delinquent behavior, and broadly positive developmental outcomes, including greater popularity and social competence. This seeming contradiction in past research represents an important gap in the developmental literature addressing the consequences of pubertal timing. Additionally, past research examining the contextual moderation of pubertal timing has typically focused on a single moderator and has examined only negative developmental outcomes, potentially producing under-contextualized conclusions. These gaps in the literature are addressed in the current study by utilizing LMS modeling and a panel study of African American boys and their families. Delinquent behavior and social competence were regressed on interactions between pubertal timing and multiple social contextual factors simultaneously to examine how social factors may shape the developmental consequences of earlier puberty for boys. Both negative (delinquent behavior) and positive (social competence) outcomes were modeled simultaneously to clarify the risk and/or protective effects of earlier pubertal timing.

Results of this study suggest that past findings represent diverging pathways determined by social contextual factors. Results indicate that pubertal timing interacts with deviant peer group, positive school experience, harsh parenting, and neighborhood collective efficacy to produce either more delinquent behavior or greater social competence. These results have important implications for the study of youth and development. First, an important innovation of the current study was the concurrent modeling of positive and negative developmental outcomes (viz., social competence and delinquency). Studies modeling one or the other may not reveal the full scope of the long-term effects of pubertal timing. This study also shows that social forces can be important in shaping the consequences of biological factors. Results here suggest that biological processes such as pubertal development may not directly shape social developmental outcomes, but are made meaningful by social context.

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Data Sharing Declaration

The datasets generated or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

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Age 12

Age 16

Age 18

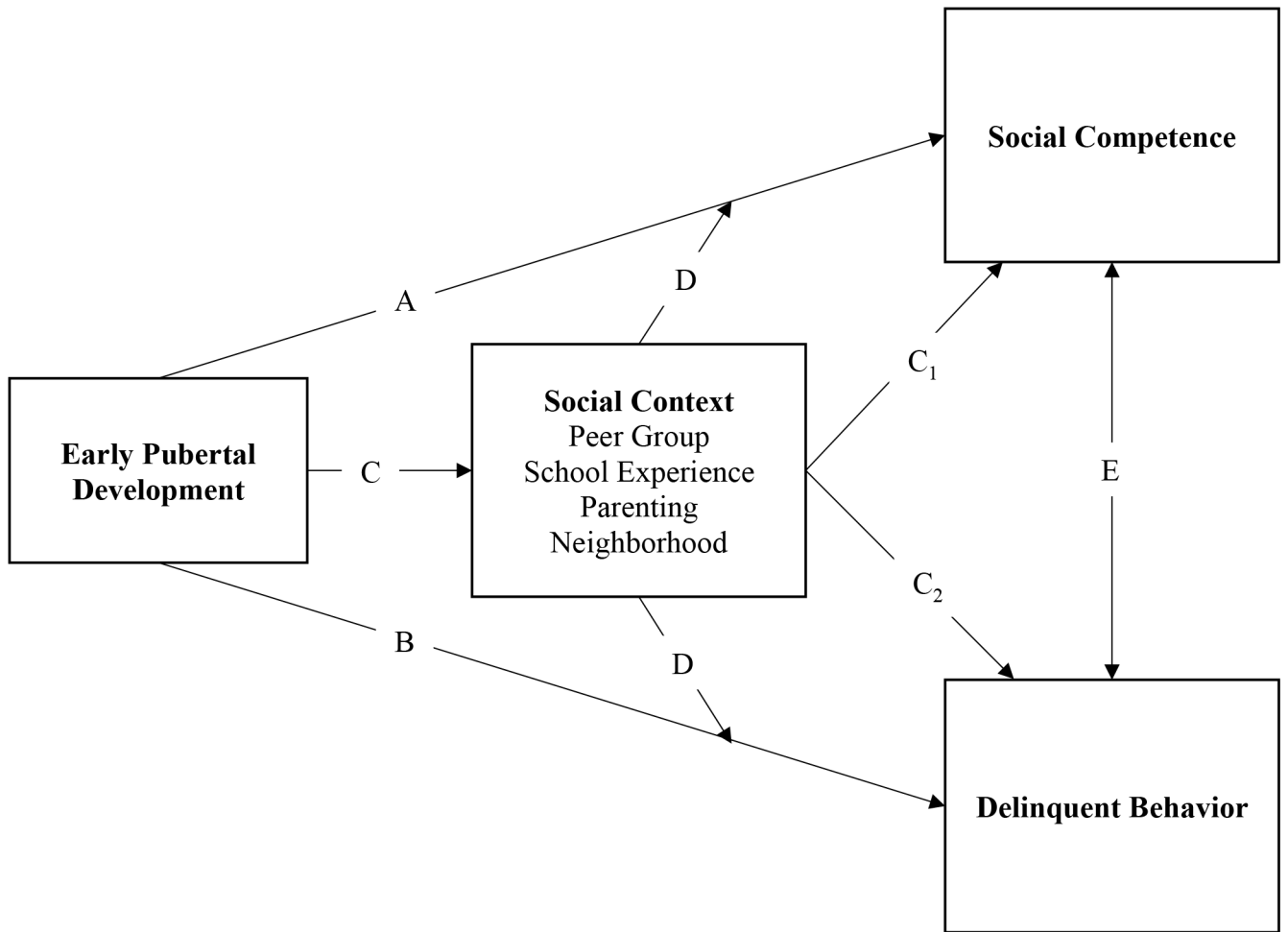
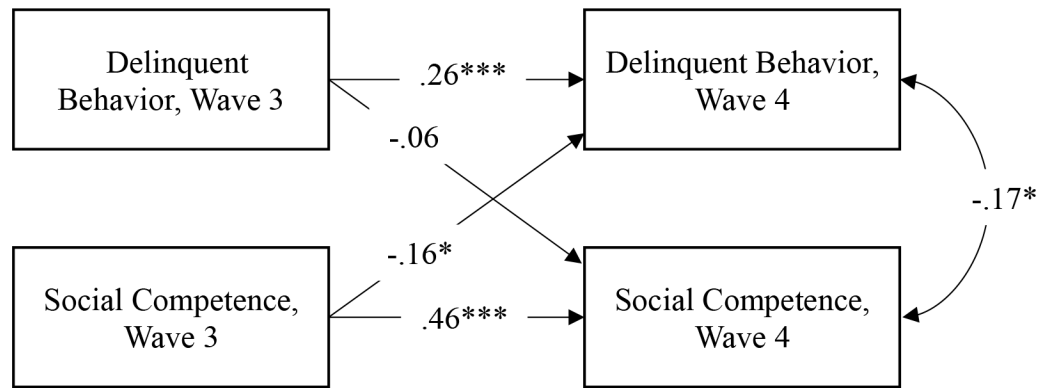


Figure 1.
Theoretical Model



Note: $N = 226$; standardized results shown.

* $p < .01$, *** $p < .001$

Figure 2.

Autoregressive Cross-lagged Association between Delinquent Behavior and Social Competence

Table 2.

LMS models	I	II	III	IV	V	VI	VII
Delinquent Behavior on							
Pubertal Timing	0.15*	0.16**	0.31**	0.30**	0.56**	0.40**	0.46**
Deviant Peers		0.14	0.18	0.03**	-0.03 [†]	0.07	-0.25*
PSE		-0.08	-0.09	-0.56**	-0.02**	-0.08	-0.05
Harsh Parenting		0.13	0.12	-0.02**	0.62**	0.17	0.64**
NCE		-0.11 [†]	-0.10 [†]	0.00	0.01**	-0.24**	-0.10**
PT X Deviant Peers			1.30*				-1.23**
PT X PSE				-3.74**			-0.23
PT X Harsh Parenting					2.84**		2.91**
PT X NCE						-0.87*	-0.46**
Social Competence on							
Pubertal Timing	0.28*	0.27*	0.25*	0.38	0.11	0.22	0.17
Deviant Peers		-0.33 [†]	-0.36*	-0.28	-0.18	-0.32	-0.08
PSE		0.42**	0.46**	0.75**	0.44**	0.47**	0.38**
Harsh Parenting		0.12	0.14	0.14	-0.14	0.13	-0.25 [†]
NCE		-0.05	-0.05	-0.06	-0.06	-0.03	-0.01
PT X Deviant Peers			-0.07				0.79
PT X PSE				0.55**			-0.27
PT X Harsh Parenting					-0.85**		-1.04*
PT X NCE						0.12	0.39 [†]
Delinquency with Social Ability	-0.06**	-0.05**	-0.05**	0.00	0.00	-0.05*	0.00

Note: N = 310; PT = Pubertal Timing, PSE = Positive School Experience, NCE = Neighborhood Collective Efficacy.

[†] 90% CI does not contain 0

* 95% CI does not contain 0

99% CI does not contain 0

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Table 3. Effect of Puberty on Delinquency and Social Ability at Specified Levels of Each Moderator

Delinquent Behavior on PT X Deviant Peers		Delinquent Behavior on PT X PSE		Delinquent Behavior on PT X Harsh Parenting		Delinquent Behavior on PT X NCE	
+ 2 S.D.	-0.16	+ 2 S.D.	0.29	+ 2 S.D.	2.02**	+ 2 S.D.	-0.01
+ 1 S.D.	0.15	+ 1 S.D.	0.38 [‡]	+ 1 S.D.	1.24**	+ 1 S.D.	0.23
Mean	0.46**	Mean	0.46**	Mean	0.46**	Mean	0.46**
- 1 S.D.	0.77**	- 1 S.D.	0.54**	- 1 S.D.	-0.32*	- 1 S.D.	0.69**
- 2 S.D.	1.07**	- 2 S.D.	0.63*	- 2 S.D.	-1.11**	- 2 S.D.	0.92**
Social Competence on PT X Deviant Peers		Social Competence on PT X PSE		Social Competence on PT X Harsh Parenting		Social Competence on PT X NCE	
+ 2 S.D.	0.56	+ 2 S.D.	-0.03	+ 2 S.D.	-0.39	+ 2 S.D.	0.56
+ 1 S.D.	0.36 [‡]	+ 1 S.D.	0.07	+ 1 S.D.	-0.11	+ 1 S.D.	0.36 [‡]
Mean	0.17	Mean	0.17	Mean	0.17	Mean	0.17
- 1 S.D.	-0.03	- 1 S.D.	0.26	- 1 S.D.	0.44*	- 1 S.D.	-0.03
- 2 S.D.	-0.23	- 2 S.D.	0.36	- 2 S.D.	0.72*	- 2 S.D.	-0.23

Note: Results from Model VII in Table 2. N = 305; S.D. = standard deviation; PT = Pubertal Timing, PSE = Positive School Experience, NCE = Neighborhood Collective Efficacy.

[‡] 90% CI does not contain 0

* 95% CI does not contain 0

** 99% CI does not contain 0