The Role of Family Relationship Quality and Testosterone Levels in Adolescents’ Peer Experiences: A Biosocial Analysis

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Grounded in a biosocial model, this study examines the interaction between adolescents’ testosterone levels and qualities of the parent–adolescent and sibling–adolescent relationship in adolescents’ peer experiences and contributes to empirical research on the role of biological factors and family socialization processes in adolescents’ peer competence and involvement. Participants included 331 adolescents (M = 14.68 years of age, SD = 1.53) and their mothers and fathers in 173 families. During home visits, data were collected from family members regarding adolescents’ family relationships, peer relationships, and psychosocial adjustment; daily time-use data were gathered during a series of 7 nightly phone interviews; and testosterone levels were assessed through saliva samples. Hierarchical regression results revealed that when boys had close relationships with mothers and sisters, testosterone was positively associated with their peer competence and involvement. Discussion focuses on the value of exploring biosocial interactions and highlights the particular importance of boys’ relationships with opposite-sex family members in efforts to understand their peer experiences.

Keywords: parent–adolescent and sibling relationships, hormone levels, peer experiences

Peers figure prominently in adolescents’ daily lives as their most frequent companions outside of school (Larson & Richards, 1991). Interactions with peers primarily involve
first to examine how the links between testosterone and indicators of adolescents’ peer competence and involvement are moderated by family relationship experiences. Previous research, in contrast, has focused primarily on biosocial models of adolescents’ problematic and risk-taking behavior (e.g., Booth, Johnson, Granger, Crouter, & McHale, 2003; Udry, 1988).

Testosterone and Peer Relationships

Our first step was to explore the links between testosterone and peer relationships, focusing on the activational (or direct and contemporaneous) role of testosterone (Buchanan, Eccles, & Becker, 1992). In adolescence, researchers have focused primarily on the links between boys’ testosterone levels and their physical aggression and social dominance with peers. The emerging picture suggests that testosterone is not consistently linked to aggression in nonclinical samples (e.g., Schaal, Tremblay, Soussignan, & Susman, 1996) but to socially appropriate dominance behaviors in male peer interactions (e.g., Tremblay et al., 1998). In late adolescence and young adulthood, links between testosterone and indicators of interpersonal competence have been documented. For example, testosterone has been linked to being helpful, engaging, and outgoing (Dabbs & Ruback, 1988) and to being involved in traditionally masculine and competitive activities in adult men (Mazure & Booth, 1998). In adult women, prenatal androgen exposure and adult testosterone level (as well as their interaction) have been linked to masculine behavior (Udry, Morris, & Kovenock, 1995). Together these studies, although generally involving small, nonrepresentative samples, suggest a pattern linking testosterone to competition and traditionally masculine social behaviors. Given that males’ interactions are characterized by competition and dominance (Maccoby, 1998), we anticipated that boys’ testosterone levels would be linked to greater perceived competence and to higher levels of involvement in activities with other boys. We explored the possibility that similar associations may emerge for girls. However, considering that there is less variability in girls’ versus boys’ testosterone levels, associations may be more difficult to detect for girls.

Testosterone also has been related to sexual behavior in adolescence. Biological models propose that hormonal changes in puberty result in increased sexual interest. Longitudinal changes in boys’ testosterone are associated with increased frequency of sexual behaviors with opposite-sex peers (Halpern, Udry, & Suchindran, 1998), and girls’ average testosterone levels, as well as increases in testosterone over time, predict the timing of first intercourse (Halpern, Udry, & Suchindran, 1997; but see Halpern, Udry, Campbell, & Suchindran, 1993, for null effects). Given the pattern of extant findings, we assessed whether testosterone was positively related to perceived competence in romantic relationships, time spent alone with an opposite-sex peer and time spent with mixed-sex peer groups, each of which may precede sexual involvement.

The proposed linear associations between testosterone and girls’ and boys’ peer competence and involvement were examined as an initial step in this study. We anticipated, however, that links between adolescents’ testosterone levels and peer experiences would be moderated by family characteristics. Although there is a general pattern indicating that testosterone is associated with markers of interpersonal competence, some evidence also exists showing that testosterone is associated with problematic social behavior (e.g., antisocial behavior, depression) in adulthood (e.g., Booth & Osgood, 1993) and poor psychosocial adjustment in adolescence (e.g., Angold, Costello, Erkanli, & Worthman, 1999).

Thus, it is important to consider whether there are conditions under which associations between testosterone and competent versus problematic social interactions emerge. Family relationships may serve as protective factors in the links between testosterone and adjustment. Booth and colleagues (2003), for example, showed that boys’ testosterone levels were associated with depressive symptoms only when boys had poor relationships with their mothers.

A Biosocial Model

Our primary purpose was to test a biosocial model, that warmth and support in adolescents’ relationships with mothers, fathers, and siblings moderated connections between testosterone levels and peer competence and involvement. Studies of adolescent problem behavior highlight the importance of considering interactions between hormonal and social factors (e.g., Booth et al., 2003; Udry, 1988). Drawing on a social control perspective, Udry (1988), for example, explored the additive and interactive effects of hormones and social controls (e.g., family structure) on adolescents’ sexual behavior. For girls, a positive association between testosterone and sexual behavior was present only when girls did not participate in sports or did not have a father present in the household.

In the present study, we hypothesized that the potential links between testosterone and adolescents’ peer experiences depend on the degree of warmth/acceptance and emotional support in adolescents’ family relationships. A warm and supportive relationship with a parent or caring individual has been consistently associated with children’s social competence (Patterson, Cohn, & Kao, 1989). From a social learning perspective, close and supportive relationships with family members set the stage for girls and boys to develop skills and behaviors that are associated with peer competence and acceptance (Parke & Buriel, 1998). Risk and resilience research highlights the degree of warmth and closeness in the parent–child relationship as an important protective factor and as a positive influence on social and emotional development (Patterson et al., 1989). Drawing on these two perspectives, we predicted that high levels of testosterone in combination with a supportive family relationship context would be associated with peer competence and involvement.

The present study builds on extant work in this area by considering the role of fathers and siblings in addition to mothers, who have been a primary focus of research on family peer linkages. Interactions with fathers appear to offer opportunities to develop a distinct set of skills than
those adolescents learn from mothers (Parke & Buriel, 1998). Thus, we considered both mothers’ and fathers’ reports of parental warmth/acceptance as moderators of the links between testosterone and peer experiences. There also is evidence that adolescents’ relationships with their siblings may matter (e.g., Buhrmester, 1992). Given that adolescence is a time when sibling relationships become more egalitarian and similar in structure to peer relationships, girls and boys may learn interpersonal skills with siblings that they can apply with peers (e.g., Buhrmester, 1992). In addition, as adolescents become interested in developing romantic relationships, having an opposite-sex sibling may offer opportunities for interaction that are less common in the sex-segregated world of peers in early adolescence (e.g., Ickes & Turner, 1983).

Sex Differences

There are several reasons to expect different patterns of moderation for boys versus girls. First, boys’ testosterone levels increase at a significantly higher rate and are significantly more variable during adolescence than are girls’ levels (Shirtcliff, Granger, & Likos, 2002). Therefore, the predictive strength of testosterone may differ for girls versus boys both as a main effect and in interaction with family relationship quality. Second, there is evidence that the connections between family and peer experiences and between hormones and peer experiences differ for girls and boys (e.g., Udry, 1988; Updegraff, Madden-Derdich, Estrada, Sales, & Leonard, 2002). Analyzing boys and girls together may mask these potentially different patterns.

Method

Participants

Complete data were collected from 331 adolescents ($M = 14.68$; $SD = 1.53$) and their parents in 173 families as part of a larger study ($N = 197$ families) of family relationships and adolescent development (Crouter, Bumpus, Head, & McHale, 2001; McHale, Updegraff, Tucker, & Crouter, 2000). Participants were recruited via letters sent to families of students in 13 school districts in central Pennsylvania. In the letters, we described the study and requested that eligible parents return postcards to express their interest in the project. Eligible families included nondivorced couples with at least two adolescents, the oldest in the eighth through tenth grade and the secondborn 1 to 3 years younger. With one exception, both parents were in the paid labor force. Families were middle- and working-class and resided in rural areas, towns, and small cities. Reflecting the demographics of the region, 99% of the participants were European American and the remaining 3% were Asian. Average annual incomes for mothers and fathers were $21,683 and $40,701, respectively, and both parents had completed an average of 2 years of education beyond high school.

Our response rate of 34% for participation by four members of each family, estimated using census data for families that fit our sampling criteria, is comparable with the National Survey of Families and Households rate of 37% for only three members of a family. Further, analyses revealed no differences between families who did ($n = 173$) and did not ($n = 24$) provide complete information for this study on demographic variables and measures used in this study.

Procedure

The Institutional Review Board approved the following procedures. Eligible families were enrolled in the project and scheduled for a home interview, the first of three data collection procedures. At the onset of the home interview, the purpose of the study was described, informed consent was obtained, and families were paid a $125 honorarium. Separate interviews were then completed with adolescents and their mothers and fathers to assess family relationships and peer experiences. The second procedure involved collecting saliva during the home interview as well as upon rising on the two mornings following the interview. Averages of the two morning samples were used for these analyses, because early morning samples are less likely to be influenced by intra-individual differences in daily experience on testosterone levels (Granger, Shirtcliff, Booth, Kivlighan, & Schwartz, 2004). Samples were refrigerated until all samples were collected and then were sent by 2-day mail to the laboratory, where they were stored at $-80^\circ C$ until assayed. Research shows that saliva maintains its integrity for purposes of testosterone assays for up to 7 days at room temperature (Dabbs, 1991).

Third, in the 3 weeks following the home visit, daily time-use data were collected from adolescents during a series of seven nightly phone calls (five weekdays, two weekend nights). These calls were designed to gather information about adolescents’ daily home and personal activities. Using a cue-recall strategy (McHale, Crouter, & Barko, 1992), adolescents reported on 63 daily activities, including how long each event lasted and who else participated.

Measures

Testosterone. Saliva was assayed using a double antibody radioimmunoassay for total serum testosterone (Diagnostic Systems Laboratories, Webster, TX) as modified by Granger, Schwartz, Booth, and Arentz (1999) for use with saliva. Inter- and intra-assay coefficients of variation were less than 15%. We checked for influential outliers with Cook’s $D$ and DFBETA estimates (Fox, 1991), computed in residual analyses of the regression equations. We assessed whether or not testosterone was influenced by pregnancy, phase of the menstrual cycle, vigorous exercise, smoking, fasting, or use of anabolic steroids. None of the females were pregnant, no one reported anabolic steroid use, and the other factors had no influence on morning hormone levels.

Pubertal development. Adolescents rated their pubertal development using the 5-item Petersen Pubertal Development Scale (Petersen, Crockett, Richards, & Boxer, 1988). Summary scores were computed with higher scores indicating more advanced development, with Cronbach’s alphas .80 for this sample.

Parent-adolescent warmth/acceptance. Mothers and fathers completed the 24-item Warmth/Acceptance subscale of the parent version of the Children’s Report of Parental Behavior Inventory (Schwartz, Barton-Henry, & Pruzinsky, 1985) separately for each adolescent in the study. Higher scores reflected greater warmth and acceptance. Cronbach’s alphas were above .93 for mothers’ and fathers’ reports for both adolescents in this sample.

Sibling intimacy. The Sibling Intimacy Scale (Blyth & Foster-Clark, 1987) includes eight items that assess the degree to which adolescents perceive their relationship with their sister or brother as a source of emotional closeness and support. Higher scores reflect greater perceived intimacy. Cronbach’s alpha was .85 for this sample.

Peer relationship measures. Our peer relationship measures were designed to capture adolescents’ experiences in dyadic rela-
tionships and groups, as these represent different ways that girls and boys are involved with peers (Ruble & Martin, 1998). First, adolescents rated the popularity of their best friend on a 3-point scale, ranging from “Not at all popular” to “Very popular with other kids.” Adolescents’ perceived competence in romantic relationships was assessed with Harter’s (1988) Self Perception Profile for Adolescents. Higher scores on this 5-item scale indicate greater perceived romantic competence. Alphas in this sample were .74.

Peer involvement was calculated by summing the number of minutes spent in activities (e.g., hangout, play sports), across the seven phone calls, in each of four social contexts: (a) time with a single female peer, (b) time with a single male peer, (c) time with a same-sex peer group, and (d) time with a mixed-sex peer group. We were unable to establish a direct estimate of reliability of adolescents’ reports of their time spent with their peers; however, the correlation between the two siblings’ independent reports of their shared time in this study was $r = .88$, $p < .01$, providing strong evidence of the interreporter reliability of adolescents’ time estimates.

Results

Overview and Preliminary Analyses

Our goals were to examine the associations between testosterone levels and adolescents’ peer experiences and to test whether warmth/acceptance with mothers and fathers and intimacy with a sister or brother moderated these relations. We treated the 331 adolescent siblings (in 173 families) as individual units of analysis to increase statistical power, because biosocial interactions are generally small and difficult to detect (Raine, 2002), particularly in a homogeneous sample. Treating two adolescents from each family as individuals violates the ordinary-least-squares assumption of independent observations, thus biasing the significance tests and estimates of the standard errors. We therefore used the SVYREG procedure in Stata statistical software (StataCorp, 2003) to adjust for the effects of correlated observations (i.e., two adolescents from the same family). The procedure used in SVYREG can be applied to a wide variety of designs that involve correlated data (StataCorp, 2003). The estimated standard errors fall between the sizes of the standard errors estimated when the degrees of freedom represent the total number of respondents and the sizes estimated when the degrees of freedom represent the number of families in the study. The design effects (Johnson & Elliott, 1998) introduced by the correlated observations for the key effects in our regression models ranged from 0.98 to 1.08, which suggest little or no effects of correlated data. These minimal effects were adjusted using the statistical procedures used in SVYREG.

Analyses were conducted separately for boys and girls given the potential for different patterns of association. Testosterone levels were significantly higher for boys, $F(1, 329) = 292.98$, $p < .01$, $d = 2.13$, and there was greater variability in boys’ than girls’ testosterone levels, $F(175, 154) = 7.58$, $p < .001$. Because of the age range in our sample (i.e., 10.0 to 16.5 years) and developmental changes that occur in testosterone during this period (Booth et al., 2003), we needed to control either for age or pubertal development. We chose to control for age as a marker of the multiple changes that occur in adolescence. Controlling for both was not necessary given their multicollinearity ($r = .68$ for girls and $r = .58$ for boys).

Associations Between Testosterone and Peer Experiences

We computed partial correlations (controlling for age) separately for boys and girls (see Table 1). Boys’ (but not girls’) testosterone levels were positively related to their perceived romantic competence and to time spent alone with a female peer.

Testing a Biosocial Perspective

The series of regression models, performed separately for girls and boys, included two steps. For the analyses testing parental acceptance as a moderator, the first step included age (as a control variable), testosterone levels, and either maternal or paternal acceptance. The second step included the interaction between testosterone level and acceptance. The models testing sibling intimacy as a moderator included age, sibling gender, testosterone level, and sibling intimacy in the first step, and the two-way and three-way interaction terms in the second step (i.e., Testosterone $\times$ Sibling Gen-

<table>
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<th>Variable</th>
<th>1</th>
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<th>3</th>
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<th>6</th>
<th>7</th>
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<td>.06</td>
<td>.07</td>
<td>.02</td>
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<td>—</td>
<td>.42***</td>
<td>.30***</td>
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<td>.11</td>
<td>—</td>
<td>.09</td>
<td>.02</td>
<td>.16*</td>
<td>.05</td>
<td>.07</td>
<td>.14†</td>
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<td>.09</td>
<td>.05</td>
<td>.27***</td>
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<td>.14</td>
<td>.06</td>
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<td>.06</td>
<td>.04</td>
<td>.08</td>
<td>.03</td>
<td>—</td>
<td>.03</td>
<td>.06</td>
<td>.22*</td>
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<td>—</td>
<td>.17*</td>
<td>.02</td>
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<td>.16*</td>
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<td>9. Time with same-sex peers</td>
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<td>.06</td>
<td>.03</td>
<td>.01</td>
<td>—</td>
<td>.06</td>
<td>.11</td>
<td>.01</td>
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<tr>
<td>10. Time with mixed-sex peers</td>
<td>.06</td>
<td>.05</td>
<td>.05</td>
<td>.07</td>
<td>—</td>
<td>.07</td>
<td>.13†</td>
<td>.06</td>
<td>.09</td>
<td>—</td>
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</table>

*p < .05. **p < .01. ***p < .001. †p < .10.
Sibling Intimacy, Sibling Gender × Sibling Intimacy, and Testosterone × Sibling Gender × Sibling Intimacy). Variables were centered to reduce multicollinearity before interaction terms were created. Unless otherwise noted, the second step in each model represents a significant increase in the variance explained. The significance level was set at $p < .01$.

**Moderating role of maternal acceptance.** Our first set of analyses examined the moderating role of maternal acceptance separately for boys and girls. Beginning with the findings for boys, in the first step in the model predicting best friends’ popularity, testosterone and maternal acceptance were positive predictors, $F(3, 125) = 4.94$, $p < .01$, $R^2 = .08$. Testosterone (at the trend level) and the maternal acceptance by testosterone interaction were significant predictors in the final model, $F(4, 124) = 5.04$, $p < .01$, $R^2 = .11$ (see Table 2). To follow up, we plotted the regression lines representing the relation between testosterone and best friends’ popularity separately for boys whose mothers reported high (one standard deviation above the mean) versus low levels (one standard deviation below the mean) of acceptance. As shown in Figure 1, testosterone was significantly and positively related to perceptions of best friends’ popularity only when maternal acceptance was high.

The first step in the model with maternal acceptance and testosterone predicting boys’ romantic competence revealed that testosterone and maternal acceptance were positively associated with romantic competence, $F(3, 126) = 6.56$, $p < .01$, $R^2 = .09$. Testosterone and the interaction were significant in the second step, $F(4, 125) = 9.29$, $p < .01$, $R^2 = .12$ (see Table 2). Similar to the pattern that emerged in Figure 1, testosterone was significantly related to romantic competence only when maternal acceptance was high, $\beta = .53$, $p < .01$. For boys’ time alone with a female peer, the first step including maternal acceptance revealed a positive relationship between testosterone and time spent alone with a female peer, $F(3, 126) = 6.60$, $p < .01$, $R^2 = .12$ (see Table 2). No new predictors emerged in the second step.

Maternal acceptance did not moderate the associations between testosterone levels and boys’ time with a same-sex peer or group of peers or a mixed-sex peer group. No significant findings emerged in the models testing maternal acceptance as a moderator of girls’ peer experiences.

**Moderating role of father acceptance.** For boys, the model predicting best friends’ popularity was not significant and including fathers’ warmth/acceptance to predict romantic competence revealed only that testosterone was positively related to boys’ romantic competence, $\beta = .35$, $p < .01$, accounting for 8% of the variance, $F(4, 125) = 4.75$, $p < .01$. In the model including fathers’ warmth/acceptance to predict boys’ time alone with a female peer, testosterone was positively related and fathers’ acceptance was negatively related (at the trend level) to time alone with a female, $F(3, 126) = 6.87$, $p < .01$, $R^2 = .14$. Testosterone, paternal acceptance, and the interaction term (at the trend level) were significant in the second step, $F(4, 125) = 5.84$, $p < .01$, $R^2 = .18$ (see Table 3). Because the second step represented an increase in the variance explained, we followed up on the interaction term. Contrary to our expectations, the interaction revealed a stronger positive relationship between testosterone and time spent alone with a female peer when fathers reported low compared with high acceptance, $\beta = .48$, $p < .08$. No significant moderation was found in predicting boys’ time spent with male peers or time spent in a mixed-sex peer group. The regression models for girls were not significant.

**Moderating role of sibling intimacy.** For boys, the model predicting best friends’ popularity was not significant. The final step in the model predicting boys’ romantic competence was significant, with higher levels of testosterone and sibling intimacy related to greater perceived romantic competence in boys’ romantic relationships, $\beta = .26$, $p < .05$, and $\beta = .25$, $p < .01$, for testosterone and sibling intimacy, respectively, $F(4, 125) = 4.72$, $p < .01$, $R^2 = .15$. Turning to boys’ time alone with a female peer, in the first step of the model, testosterone was positively related to time

| Table 2 |

| Boys’ Perceived Peer Popularity, Romantic Competence, and Time Alone With a Female Peer Predicted by Testosterone and Maternal Acceptance |

<table>
<thead>
<tr>
<th>Regression models</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
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<td>0.04</td>
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<td>.08*</td>
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<td>0.00</td>
<td>.18*</td>
<td>.11*</td>
<td>.03*</td>
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<td>Romantic competence</td>
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<td>Testosterone × Maternal Acceptance</td>
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<td>0.00</td>
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<td>0.70</td>
<td>−.02</td>
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Note. Standardized betas represent final models.

* $p < .05$. ** $p < .01$. † $p < .10$. 


spent alone with a female peer, $F(4, 125) = 5.34, p < .01$, $R^2 = .12$. Testosterone and the Testosterone × Sibling Gender × Sibling Intimacy interaction were significant in the second step, $F(8, 121) = 3.62, p < .01$, $R^2 = .17$ (see Table 3). To follow up on this interaction, we tested for the interaction between testosterone and sibling intimacy separately for boys with sisters versus boys with brothers. The Testosterone × Sibling Intimacy interaction was significant at the trend level for boys with sisters, $β = .26, p < .10$, with the overall model accounting for 19% of the variance, $F(4, 77) = 2.95, p < .05$ (see Figure 2). The model for boys with brothers was significant, but the two-way interaction was not. Finally, the models predicting time spent with male peers and in a mixed-sex peer group were not significant, and no significant moderation emerged for girls.

### Additional Analyses

We conducted two additional sets of analyses. First, we conducted the analyses a second time, controlling for pubertal development rather than age, and the pattern of findings remained the same. Second, because hormonal changes are linked to the emergence of secondary sex characteristics, which in turn may elicit socialization responses and corre-

<table>
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<th>ΔR²</th>
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<td>−.19†</td>
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<tr>
<td>Testosterone</td>
<td></td>
<td>1.49</td>
<td>0.67</td>
<td>.31**</td>
<td></td>
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<tr>
<td>Sibling gender</td>
<td></td>
<td>8.30</td>
<td>16.92</td>
<td>.03</td>
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<tr>
<td>Sibling intimacy</td>
<td></td>
<td>0.02</td>
<td>3.29</td>
<td>.00</td>
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</tr>
<tr>
<td>Sibling Intimacy × Sibling Gender</td>
<td></td>
<td>−0.53</td>
<td>3.80</td>
<td>−.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testosterone × Sibling Gender</td>
<td></td>
<td>−0.13</td>
<td>0.66</td>
<td>−.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testosterone × Sibling Intimacy</td>
<td></td>
<td>0.20</td>
<td>0.12</td>
<td>.25</td>
<td>.12**</td>
<td></td>
</tr>
<tr>
<td>Testosterone × Sibling Gender × Sibling Intimacy</td>
<td></td>
<td>−0.36</td>
<td>0.16</td>
<td>−.27*</td>
<td>.17**</td>
<td>.05*</td>
</tr>
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</table>

*Note. Standardized betas represent final models.
* $p < .05$. ** $p < .01$. † $p < .10$. **
sponding changes in adolescent behavior (e.g., Halpern et al., 1993), we substituted pubertal development for testosterone. No significant findings emerged in this set of analyses.

**Discussion**

This study tested a biosocial model of the interactive role of family relationship qualities and testosterone levels in predicting adolescents’ peer experiences. Using a multi-method, multi-informant approach, we drew on self-report data from adolescents and their mothers and fathers, daily time-use data gathered through a series of nightly phone interviews with youth, and biological markers of testosterone levels collected through saliva samples. The use of multiple sources of data and multiple informants reduced concerns about shared variance and increased our confidence in the modest associations found in this study. It is important to note, however, that it is not possible to draw conclusions about direction of effects with the cross-sectional design. It will be important to extend this work using longitudinal designs. Although a study of more than 4,000 men revealed few ethnic differences in average levels of testosterone or in the connections between testosterone levels and marital quality (Booth & Dabbs, 1993), cross-cultural differences in peer relationships have been documented (e.g., Updegraff et al., 2002). Thus, these connections should be examined in youth from different cultural backgrounds.

Our main purpose was to explore whether considering both familial and biological factors increases our understanding of adolescents’ peer relationships. We found evidence that testosterone was positively associated with boys’ peer popularity and romantic competence when mothers reported high but not low levels of maternal acceptance, supporting our moderation hypotheses. Consistent with social learning and risk and resilience perspectives, when boys have close and supportive relationships with their mothers they may be able to develop interpersonal skills that are essential for competent interactions with peers (Parke & Buriel, 1998; Patterson et al., 1989). This relationship context, in turn, may underlie the positive association between testosterone and boys’ competence with peers. There are at least two possible reasons why relationships with mothers may be important. First, consistent with attachment theory, it may be that boys’ relationships with their primary caregivers are most significant in the development of social competence. Second, it may be that having a warm and supportive relationship with a female is important for boys as they develop relationships outside the family in adolescence, particularly with opposite-sex youth. Because mothers still assume responsibility for caregiving in the majority of families today (Parke & Buriel, 1998), it is difficult to disentangle which aspect of boys’ relationships with their mothers—the fact that they are primary caregivers or that they are females—is more important in the development of their peer relationships. Regardless of the underlying mechanism, adult females who are significant members of boys’ lives may provide important models for the acquisition of skills that promote social interactions during adolescence.

It is also important to consider that boys’ close ties with their mothers may reflect the nature of their interpersonal skills, given that the direction of effects cannot be determined from these data. The pattern of correlations between family members’ warmth/support and indicators of peer competence and involvement do not provide strong support for this alternative explanation, however. Future longitudi-
nal designs will be an important step toward exploring the bidirectionality of these relationships.

When boys described an emotionally supportive relationship with a sister, testosterone was positively associated with the time they spent alone with a female peer; in contrast, there was no association between testosterone and time spent alone with a female for boys whose relationships with their sisters were not emotionally close or for boys who had brothers. Having an intimate relationship with a sister may represent an important opportunity to develop interpersonal skills and confidence, both of which facilitate boys’ involvement with the opposite sex (Ickes & Turner, 1983). The moderating role of both maternal acceptance and emotional intimacy with sisters highlights the potential benefits of boys’ interactions with female family members in adolescence. The limited nature of boys’ interactions with females outside of the family prior to adolescence (Maccoby, 1998) suggests that opportunities to interact with mothers and sisters may be developmentally significant.

The pattern of moderation for paternal acceptance was inconsistent with our expectation. When fathers reported low levels of warmth/acceptance with their sons, there was a stronger positive association between testosterone and time spent alone with a female than when fathers were more accepting of their sons. Boys with high testosterone may turn to female companions when they do not have close relationships with their fathers. Caution is warranted in generalizing from this finding, however; although the step in the model including the interaction term reflected a significant increase in the variance, the interaction term only reached trend level.

The findings for girls revealed no support for the hypothesized associations between testosterone and peer experiences or that family relationship qualities would interact with hormone levels to predict girls’ perceived competence or involvement with peers. One possibility is that lower mean levels and variability in testosterone levels in girls (compared with boys) may reduce testosterone’s predictive ability (Shirtcliff et al., 2002). Another possibility is that socialization factors operate differently for girls versus boys. This study explored how family relationships may afford the expression of social competencies. Other work highlights factors that constrain the expression of hormone–behavior relationships in girls (e.g., Udry, 1988), suggesting that there may be gender differences in biosocial processes involving testosterone.

Our findings emerged in the context of a relatively homogenous sample (i.e., adolescents from two-parent working and middle-class families), with limited power. A stronger pattern may emerge in a larger and more heterogeneous sample. It is also important to note that biosocial interactions are generally small and difficult to detect (Raine, 2002). In fact, previous research suggests that Type II errors are of greater concern than Type I errors in tests of biosocial interactions (Raine, 2002). Thus, our modest results suggest that the exploration of biosocial interactions to understand adolescents’ positive psychosocial functioning may be a fruitful line of inquiry.

Interventions to enhance adolescents’ social relationships do not typically include multidimensional family components (e.g., program components targeting parents and siblings or extended family members). As adolescents begin to expand their social worlds, it may be important to adapt intervention programs to include individuals who may serve as important role models for the acquisition of a broad range of social skills, particularly for boys. More generally, our findings highlight the complexities of understanding adolescents’ social relationships and suggest future research and policy in this area should promote consideration of both biological and social processes.

This study breaks new ground in several ways. First, this study brings together research on family socialization processes and biological factors to understand adolescents’ peer competence and involvement. Although a body of research documents the connections between parent–child and peer relationship quality (Parke & Buriel, 1998), research from a biosocial perspective has focused almost exclusively on problematic peer behavior. Second, the consideration of both mothers and fathers and sisters and brothers is a unique feature of this research. The role of siblings, in particular, has been ignored in biosocial models incorporating family processes. Finally, we consider both affective (e.g., support) and quantitative dimensions (e.g., temporal involvement) of adolescents’ relationships. It will be important to explore how multiple dimensions of adolescents’ relationships interact with biological factors in future research to identify the conditions under which biosocial interactions offer the most complete picture of adolescents’ psychosocial functioning.

References


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