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Parents' Testosterone and Children's Perception of Parent-Child Relationship Quality

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Abstract

We examine the link between parental testosterone and children's perceptions of their relationship with their mother and father. Using data from 352 predominantly white working and middle class families, we find no direct link between mother's and father's testosterone and parent-child closeness. However, the association between mothers' testosterone and mother-child closeness appears to be influenced by the quality of two other family relationships. When father's marital satisfaction is low, mothers with high testosterone have a poorer relationship with their children. And, when fathers report low levels of intimacy with their children, high testosterone women have a poorer relationship with their children. No comparable associations were observed among fathers.

Keywords

mother testosterone; father testosterone; parent-child relationship quality; marital satisfaction

There is a growing literature on hormones and dyadic relationships within families. For example, hormones have become central in explaining parent-infant attachment (Fleming et

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al., 1997; Uvnas-Moberg, 1997), risk and resilience in early child development (Cairns et al., 1990; Gottlieb, 1992; Curtis and Cicchetti, 2003), and hormone related adolescent problem behavior moderated by parent-child closeness (Booth et al., 2003). These studies indicate that hormones and parent-child relations are linked at all stages of child development.

Although research on the link between parental hormones and parent child relationship quality is meager, existing studies suggest that the connection between the hormone testosterone and parent-child relationship quality is important to study for several reasons. For example, research on men has consistently found a link between concentrations of testosterone and behaviors that may influence family life. Specifically, high testosterone in adult males is associated with deviance (Booth and Osgood, 1993), depression (Booth et al., 2005), and spousal neglect and abuse (Booth and Dabbs, 1993), among other negative outcomes. Despite the fact that high testosterone is often tempered by social context, high testosterone in fathers remains a potential threat to parent-child relationship quality when the social conditions that moderate this behavior are not present. Because of this it is important to understand the extent to which children might be at risk for having poor relationships with their high testosterone fathers.

Furthermore, even though maternal testosterone does not have the same links to dominance as paternal testosterone (Booth et al., 2005) research has shown that women with high testosterone concentrations tend to exhibit a distinct repertoire of behaviors and attitudes that set them apart from women with low testosterone concentrations (Cashdan, 1995), and these differences may be directly related to family life (Udry et al., 1994). In a unique study of women's testosterone and family related behavior, Udry and colleagues (1994) found that high testosterone women had negative perceptions of family roles, including not marrying, assigning a lower priority to marrying, having fewer children, and finding little enjoyment in child care activities compared to low testosterone women. Notwithstanding these intriguing findings, researchers have not directly tested whether high levels of parental testosterone translate into differences in the quality of parent-child relationships for women who choose to marry and have children, or how testosterone may interact with other features of family life to influence parent-child intimacy.

Overall, the research linking men's and women's testosterone to parent-child relationship quality is limited, but it does suggest that high levels of testosterone may put parents at risk for having poorer relationships with their children. To test the idea we hypothesize:

H1: Parental testosterone levels are negatively associated with parent-child relationship quality.

Although it is reasonable to anticipate that parental testosterone will be negatively associated with a child's relationship with both parents, it is unclear whether the linkage is more important for fathers or mothers. On the one hand, studies have shown that the positive association between adolescent testosterone and externalizing behavior is moderated by the quality of parent-adolescent relationship, but more so for boys than girls (Booth et al., 2003). Other studies also suggest important gender differences in hormone-behavior links. For example, in marriages, husbands', but not wives', testosterone is positively related to marital quality when his role overload is low, but negatively related to marital quality when his role overload is high (Booth et al., 2005). Based on these studies, it is unclear whether father's or mother's testosterone's is more strongly linked to parent-child relationship quality.

In addition to drawing on hormone research to understand the link between testosterone and the parent-child bond, we call on family systems theory to explore the ways in which family

relationships—such as those between a parent and child or parent and parent—affect and are affected by one another (Cox and Paley, 1997). Because of overlapping and reciprocal ties between family members, the literature in this area suggests that the quality of a parent and child's relationship cannot be understood independent of the quality of other family bonds (Fincham, 1998). One of the primary mechanisms through which experiences in one of these family subsystems may influence the parent-child dyad is through a process of stress contagion called *spillover* (Bolger et al., 1989; White, 1999). Spillover occurs between family subsystems when the mood, affect, or behavior from one family grouping is transferred to another (Almeida et al., 1999), such as when a mother fights with her husband and then withdraws from both him and her child. The probability of spillover occurring is tied to both dynamic and stable family characteristics such as the salience of an unexpected stressor (e.g., a problem at work or school) as well as personal and familial attributes (e.g., maternal depression or family composition) (Almeida et al., 1999). We focus on within family processes such as the way particular family dyads, like the marital dyad, may affect the relationship between parents and their children or the way in which the father-child dyad affects the mother-child dyad.

Although each subsystem of the family is important in understanding the parent-child relationship, it has been suggested that the marital dyad may be the most influential because it sets the tone for all of the other relationships in the home by creating an environment that “facilitates or impedes effective parenting” (Fincham, 1998: 544). In a meta-analysis of 68 studies that examine the link between the marital dyad and parent-child relationships, Erel and Burman (1995) found that the quality of the marital relationship directly influenced the quality of the parent-child relationship. When couples have a positive marital relationship they report nearly one half of a standard deviation higher quality relationship with their child. Conversely, when couples have a poor marital relationship, mothers and fathers reported almost one half of a standard deviation lower parent-child relationship quality. The authors suggest that when parents have a conflictual relationship they are unable to provide the nurturing and warmth necessary to maintain a strong parent-child bond, and so the parent-child relationship suffers.

In light of research documenting direct effects of these family bonds on parent-child relationship quality, it is worth considering whether these dyads have a moderating effect on the association between testosterone and the child's relationship with their parent. For example, we expect high testosterone to have a negative average effect on parent-child relationship quality, albeit the negative effect may be stronger when other family subsystems are in crisis (such as when marital quality is low or the spouse has weak ties to the child) and attenuated when other family subsystems are strong (such as when marital quality is high or the spouse is close with the child). As a result, the importance of testosterone in understanding parent-child relationship quality may be partially driven by the contours of the family landscape, particularly as it relates to positive or negative functioning of other family dyads. Therefore, we propose our final two hypotheses:

H2: Marital satisfaction will moderate the relationship between high levels of parental testosterone and the quality of the parent-child relationship such that when parents have low marital satisfaction testosterone will have a negative effect on the parent-child relationship, but when parents have high marital satisfaction the negative effect of testosterone on the parent-child relationship will be attenuated or even disappear.

H3: Intimacy between the spouse and child will moderate the relationship between high levels of parental testosterone and the quality of the parent-child relationship such that when spouses are not close to their children, testosterone will have a negative effect on the parent-child relationship but when spouses are close to their

children the negative effect of testosterone on the parent-child relationship will be attenuated or even disappear.

As before, there may be important gender differences in how mothers and fathers respond to the moderating influences described in hypotheses two and three. And like before, it is unclear whether the results will support a stronger moderation for men or women. Research has consistently shown both men and women experience emotional transmission from one family relationship to another (White, 1999), though men appear to have larger declines than women in parent-child relationship quality when faced with other conflictual family relationships (Belskey et al., 1991; Osborne and Fincham, 1996). This may occur because “men’s role in the family is less scripted by social conventions, and, therefore, men’s relations to family members are more susceptible to outside influences” (Almedia et al., 1999: 51). However, no studies have considered whether a man’s or woman’s testosterone concentration might challenge these processes. In particular, it is unknown whether women with high levels of testosterone may be as effective at blocking the influence of spillover on their relationships with children as women who have low levels of testosterone, especially given consistent findings that high testosterone women often act in ways that are quite different from other women (Cashdan, 1995; Udry et al., 1994).

Methods

Participants

Data for the project came from a study of 400 families residing in central Pennsylvania, 203 of which had 2 preteen children and 197 of which had 2 adolescent children. The families were selected so that the gender composition of the offspring dyad was balanced; that is, there were approximately equal numbers of male-male pairs, female-female pairs, male-female pairs in which the male was older, and female-male pairs in which the female was older. This was an ideal sample for studying the influence of testosterone and family context on parent-child relationship quality because complete interview data and saliva samples were obtained from all four family members for the majority of families (88%).

Families were recruited to participate through 13 local school districts from students enrolled in either the fourth and fifth or the ninth and tenth grades. Each family with a child in those grades received a letter describing the study goals, the eligibility criteria (parents married and never divorced, both parents employed, and firstborn child with at least one sibling no more than 4 years younger), and the remuneration they would receive for participation. Eligible families were asked to return a postcard if they were interested in taking part. Over 90% of those families who returned the card and met the criteria agreed to participate. Analysis of census data along with school enrollment information from the area studied indicated that 11% of the school population met the study criteria. Dividing the number of families recruited by those estimated to be eligible yielded a response rate of 34% for the participation of four members of each family. This response rate is comparable to the National Survey of Families and Households rate of 37% for three family members.

Families participating in the study were middle-class or working-class and resided in rural areas, towns, or small cities. Median annual income for these predominantly dual earner families was \$35,000 for fathers and \$17,200 for mothers in 1996. Average educational attainment was 14.6 years. Ninety-seven percent of the participants were European American; the remaining 3% were Asian American and Latino American. Mean ages were 40.1 for mothers, 42.1 years for fathers, and 13.5 years (range= 6 to 18 years) for offspring. Parents had been married for an average of 17.5 years. With minor exceptions, the sample was representative of the population from which it was drawn. Parents were slightly older (2

years) than the population from which they came and were slightly more likely to have some post-high school education.

Data Collection

Data were collected using the following procedures. First, separate home interviews were conducted with mothers, fathers, and both first- and second-born offspring. During these interviews, family members reported on their family relationship experiences and individual well-being. Next, three saliva samples were obtained from parents and children, once during the home interview [collected for training purposes], and two more upon arising on two mornings following the interview. Participants were instructed to provide saliva before brushing teeth or eating the morning meal on each of the two mornings. They provided 5 ml of saliva using a short plastic straw and a 20 ml scintillation collection vial. Individuals who had a fever or problematic samples (i.e., discolored) were asked to provide saliva at a later date. Morning samples were used for the present analysis. The in-home collection served to train participants on how to collect, store, and express mail the morning samples. Someone, usually the mother, was given the responsibility for overseeing the morning saliva collection. A comparison of demographic and relationship characteristics of families who provided morning samples and those who did not revealed no systematic differences. Participants signed informed consent/assent statements for the interviews that were read to them prior to their participation. They signed separate consent/assent forms for the saliva samples and were told that saliva samples would be assayed for hormones. Families were given \$100 honorarium for the interview portion of the study and an additional \$25 if they provided saliva samples.

Saliva samples were assayed for testosterone using a double antibody radioimmunoassay for total serum testosterone (Diagnostic Systems Laboratories, Webster, TX) as modified by Granger et al. (1999) for use with saliva. Inter- and intra-assay coefficients of variation were less than 15%. In each assay, controls representing low and high salivary testosterone levels (Diagnostic Systems Laboratories) were included. The assays were conducted in duplicate, and the values of the two were averaged for a single measure. Samples with duplicate values that varied by more than 5% were subject to repeat testing.

When the testosterone assays were complete we checked a standard set of criteria to see whether the hormone levels might be influenced by factors found to distort analytic results in other samples. Items that have the potential for biasing the hormones include pregnancy, phase of the menstrual cycle, vigorous exercise, fasting, smoking, as well as prescription (e.g., birth control pills) and over-the-counter drugs (Booth et al., 1993; Campbell and Ellison, 1992). At the time the sample was collected, each individual was asked to complete a questionnaire on each of the factors that may influence hormone levels. None of the females were pregnant, and phase of menstrual cycle was controlled in all analyses. Those taking birth control pills (9%) were eliminated from the sample because of their potential to distort assay results for testosterone. None of the other factors had a significant influence on hormone levels. After removing the problematic cases described above, our final sample included 704 children from 352 families.

In a second stage of data preparation and adjustment we closely examined the distributions of hormone scores for mothers and fathers and checked all of the key variables for influential outliers with Cook's D and DFBETA estimates (Fox, 1991) computed in residual analyses of the regression equations. The findings from these tests indicated that the data and models were robust after a small number of extreme outliers at the high end of men's testosterone distribution ($n=3$) were recoded to lower values to bring them into the range of the rest of the sample.

Finally, a small number of missing values (less than five percent of observations for any specific measure) in the data set were imputed using the expectation maximization (EM) algorithm in the SPSS software package. Given the relatively small amount of missingness in this sample, single EM imputation was a reasonable choice to achieve appropriate point and standard error estimates (Allison, 2001). Only independent variables' values were imputed and all analyses were run with the imputed data.

Variables Used in the Analysis

The dependent variable used in this project is *parent—child relationship quality*. This was assessed from children's self-reports of their dyadic relationships with each parent. Every child in the sample completed two 8-item measures of parental acceptance and intimacy (adapted from Blyth et al., 1982), one regarding their feelings toward their mother-child relationship, and one about their father-child relationship. Each item was measured on a 5-point scale ranging from *not at all* to *very much*, and included the following questions: "How much do you share your inner feelings or secrets with him/her?", "How much does s/he understand what you are really like?", "How much does s/he come to your for advice or support?", "How important is s/he to you?", "How satisfied are you with the relationship you have with him/her?", "How much do you go to your mother/father for advice or support?", "How much do you want to be like her/him?", and "How much does s/he accept you no matter what you do?". Scores were summed across the eight items from 0–40 with higher scores indicating more intimacy. Cronbach's alpha coefficient for mothers and fathers was .77, suggesting that the measure works similarly well to assess mother's and father's relationships with their children, although differences in means (Table 1) indicate that mothers have slightly more intimate relationships with their children than fathers.

In addition to using child reports of relationship quality, we also examined *marital satisfaction* from the perspective of both mothers and fathers. Like parent-child closeness, marital closeness is well established as an important stressor (when it is low) and support (when it is high) in the family system. In this study, marital satisfaction is measured using an index in which spouses rated their satisfaction with marriage on seven domains using a nine point scale ranging from extremely dissatisfied to extremely satisfied (Huston et al., 1986). Items include: "How satisfied are you with how well the two of you talk over important and unimportant issues?", "How satisfied are you with how understanding your spouse is about your work situation either inside or outside the home?", "How satisfied are you with how the two of you divide housework such as cooking, cleaning, yard work, and so on?", "How satisfied are you with how the two of you divide the tasks of taking care of the children including getting them ready for school, helping with homework, etc.?", "How satisfied are you with your husband's fundamental principles about how to bring up children?", "How satisfied are you with the extent to which your husband supports your decisions about rules and discipline, makes you feel good about the kind of parent you are, etc.?", and "How satisfied are you with the way decisions in your family get made and the level of influence you have in those decisions?". Scores were summed across the seven items from 0–63 with higher scores denoting greater satisfaction. Cronbach's alpha was .85 for mothers and .88 for fathers. Overall, men reported slightly higher satisfaction with marriages, on average, than did their wives, although both groups were skewed toward positive assessments of their marital relationship. Note that we use mother, father, and child self-reports to test the tone of relationships in the family system. We do this rather than relying on a single respondent in an attempt to avoid same source response bias which plagues some of the work in this area (see Davis, 2009 for a discussion). By utilizing multiple reports from different family members we can offer a more stringent test of the spillover process among our families.

Parental Testosterone was measured as the mean of the saliva samples procured on two consecutive mornings. Although most participants in the study collected the saliva sample

early in the morning (modal time was around 7 am) there were a number of samples collected a few hours later. Because there is a decline in testosterone over the course of a day, especially for fathers, our measure of testosterone was adjusted to account for the number of hours of deviation from 7 am to account for the diurnal effect on hormonal levels. For example, a father who collected their sample at 3 in the afternoon would be 8 hours away from the modal collection time and would have 19.68 points added to his testosterone reading based on the formula ((number of hours deviating from 7 am *100) * (mean of regression coefficients from regression of T on time of day 1 and 2, or $-.0246$). Combining the two as we did increases that probability of obtaining a reliable baseline measure of each individual's testosterone when the hormone is typically at its highest level. The correlation between using our adjusted measure of testosterone and an unadjusted measure of testosterone that controls for time of day is .97 and there is no substantive difference in the findings when either measure is used in the final models.

In addition to the main dependent and independent variables, a number of covariates were included in the models that were thought to affect either parent-child relationship quality or hormone levels. In particular, research on mothers' and fathers' relationships with their sons and daughters indicates that parents have closer relationships with same gender offspring, particularly when they have both a daughter and a son, and that these gendered patterns become more pronounced as children age (Shanahan et al., 2007). Therefore, we controlled for *gender of offspring* (female=1), whether the *sibling pairs included an opposite sex child* (yes=1), and *child age* (in years). We also included in our models measures of *family income* (in dollars, ranging from 6,000–220,000 per year), *household size* (sum of the number of family members living in the home, ranging from 4–9), and *parental education* (in years, ranging from 8–20 with both parents having roughly equivalent levels of education which includes about 2 years of college) to account for the commonly reported link between parent-child relationship quality and the family's socioeconomic status (see for example Amato and Booth, 1997). *Parent's age* (in years, ranging from 30–68) was also incorporated because testosterone declines with age for men and women, and must therefore be accounted for in these models. Finally, in the mother-child analyses we controlled for *days since last menstrual cycle* began since testosterone has been found to vary across the course of the menstrual cycle.

Analytic Plan

Given our nested research design with two children and two parents from each family, we used hierarchical linear modeling to estimate two-level linear regression models for each child's relationship with their mother and father (Raudenbush and Bryk, 2002). Level 1 captured the within family variation and included information specific to each child, such as their age and gender, as well as the child's report of closeness to their other parent. Level 2 describes the between family variation, including factors common to both children in the home, such as the testosterone level of each parent, mother and father reports of marital satisfaction, household size, family income, parental age and education, and the sibling dyad sex constellation. Interaction terms were included at level two, except those involving the relationship quality of the child and the opposite sex parent, which was a cross-level interaction between the level 1 child report and the level 2 assessment of testosterone. These statistical models were designed to adjust the standard errors to reflect data clustering and account for the effects of child, parent, and family characteristics on parent-child relationships. Supplemental analyses were also conducted to test whether there was a difference in the link between parental testosterone and the quality of the parent-child relationship when child groupings were broken out by age and developmental stage, since half of the families in the sample had a middle child offspring and the other half had

adolescent children. Accounting for sample characteristics in this way did not affect the key findings and the supplementary results are not presented here due to space limitations.

Results

We began our evaluation of parent-child relationship quality with an examination of the pair-wise correlations among all key variables used in our models. See Table 2. Consistent with previous research, there was a significant positive relationship between father and mother testosterone, indicating that high testosterone women tend to be married to high testosterone men. Also consistent with previous research was the finding that both mothers and fathers reported being closer to their children when the children are younger or are the same sex as the parent, with mother-daughter pairs reporting the highest levels of intimacy, especially among younger rather than older children. There was no statistically significant bi-variate relationship between parental testosterone and parent-child relationship quality. There was a significant relationship, however, between father's testosterone and both the mother's and father's report of marital satisfaction, indicating that high testosterone men tend to view their marital relationships more positively—and have spouses who view their marital relationship more positively—than low testosterone men (Booth et al., 2005). In line with prior research (Booth and Osgood, 1993), there were significant negative bi-variate relationships between parents' testosterone level and the mothers' and fathers' education, and family income. Parental testosterone was not directly related to the strength of the parent-child bond.

The models presented below test our hypotheses regarding the link between parents' testosterone and parent-child relationship quality. Because of known variations in the outcomes by gender, the results are presented separately for fathers and mothers. For Tables 3 and 4, the models noted in the first row reflect a stepwise examination of the paper's three hypotheses. Model 1 assess whether there are net average effects of parent testosterone on parent-child relationship quality. Models 2 and 3 test whether the link between parental testosterone and parent-child relationship quality is affected by mother's (2) or father's (3) marital satisfaction. Model 4 assess whether the closeness of the spouse and child moderates the relationship between parental testosterone and parent-child intimacy. We first address the fathers' results (Table 3) and then the mothers' results (Table 4).

Father-Child Relationship Quality

Overall, there were consistent findings across models assessing father-child relationship quality, and these results were in the expected direction. For example, younger children reported more intimate relationships with their fathers compared with older children, and boys reported being closer to their fathers than girls. Furthermore, the amount of household income available to the family was a consistent and positive predictor of the strength of the father-child bond.

Although there is a clear connection between family context and father-child relationship quality, there was a lack of findings regarding the direct (Model 1) or moderating influence of testosterone on the father-child bond (Models 2, 3, 4). The father's testosterone level does not appear to influence his relationship with his offspring.

Mother-Child Relationship Quality

Similar to the findings presented in the fathers' models, there were no significant direct effects of mothers' testosterone on mother-child closeness (Model 1). However, when we considered whether the social context of family life influences the link between testosterone and mother-child relationship quality we find two significant interaction effects. First, the

association between mothers' testosterone and the quality of the mother-child bond is moderated by the father's marital satisfaction (Model 3) but not the mother's marital satisfaction. That is, when fathers are not satisfied with their marriage, mothers with high testosterone have a poor relationship with their offspring (Figure 1). The quality of the father's relationship is unrelated to the mother-child bond among women with low testosterone.

Second, the link between mothers' hormone and the bond she has with children is moderated by the quality of fathers' relationship with the children. If the relationship with his offspring is unrewarding, mothers with high testosterone have a very poor relationship with their offspring. The quality of the father's relationship is unrelated to the mother-child bond among women with low testosterone (Figure 2).

Discussion and Conclusions

This study is the first to examine the association between parental testosterone and parent-child relationship quality both directly and as it is moderated by spillover from other family relationships. The project has the advantage of using hormone information and measures of relationship quality from multiple family members, including mothers, fathers, and two children whose ages span middle childhood and early adolescence. Using data from 352 predominantly white, working and middle class families we test three hypotheses regarding the influence of parental testosterone on the parent-child bond. (1) High parental testosterone is associated with low parent-child relationship quality. (2) Marital satisfaction moderates the relationship between parental testosterone and the quality of parent child relationships. (3) Intimacy between the parent's spouse and the child moderates the relationship between parent testosterone and the quality of the parent-child relationship.

Neither maternal nor paternal testosterone was directly related to parent-child relationship quality. However, there were two interactions between the quality of father's family relationships and mother's testosterone that predicted the quality of her relationships with her children. When fathers are unhappy with their marriage, high testosterone mothers have poorer quality relationships with her children. When fathers report poor relationships with his children, high testosterone mothers report lower quality parent-child relationships. These findings suggest that high testosterone mothers are more likely to be influenced by their spouse's family relationships (i.e. low marital satisfaction and low father-child closeness) than high testosterone fathers.

Overall, the women's results provide the most support for family systems theory which suggests that family relationships can 'spillover' to influence the mother's intimacy with her child. Consistent with this notion are the findings that mothers with high levels of testosterone are less effective at maintaining boundaries between relationships and often fail to block the influence of either the marital or spouse-child dyad from influencing the quality of the relationship they have with their child. Conversely, low testosterone mothers are able to maintain strong bonds with their child even when faced with negative marital or father-child relationships. As a result, children with high testosterone mothers are more emotionally dependent on their fathers, in this case using them as a barometer to set the level of intimacy for the mother-child bond.

Though high testosterone women appear to be prone to men's emotional transmissions, they are not likely to have their own view of marital quality spillover to influence the mother child-bond. We suggest two reasons this may be happening. First, women may underreport problems with marriage and parenting because of social pressure to excel in these roles—a pressure not shared equally with men. If this is the case, then we would expect the father's

report of marital satisfaction to more accurately reflective problems in the relationship compared with the mother's report, making his assessment of the marriage a better indicator of the spillover that is occurring. Similarly, because women receive more social conditioning than men to portray the role of an ideal spouse they may work harder than men to hide their negative feelings from children. As a result the child who reports on parent-child closeness may be less informed of the problems the mother is having with the father, making the woman's perceptions of the marriage weakly correlated with the child's view.

The findings regarding women and spillover are intriguing because the distinctions between low and high testosterone mothers closely resemble the differences scholars have found between women and men in other studies of emotional transmission, with high testosterone women mirroring the expectations researchers usually reserve for men in families (e.g. Belskey et al. 1991). Taken together, this pattern of results is consistent with contemporary biosocial research that suggests the link between hormones and behavior is highly dependent on social context (see Booth et al., 2006 for review of such studies) and that women with high levels of testosterone concentrations often act in distinct ways from women with low or moderate levels of testosterone concentrations (Cashdan, 1995; Udry et al., 1994).

What is less clear from our models is why high testosterone men do not experience greater levels of spillover than low testosterone men. The gender distinctions in significant findings may be due to differences in the way testosterone operates in men's and women's bodies. Recall that high concentrations of testosterone in women are frequently associated with negative affect and low opinions of marriage and childbearing. These emotional attributes may make high testosterone women feel less capable in their motherly role and more vulnerable to outside influences—such as spillover—compared to low testosterone women. Conversely, high concentrations of testosterone in men are often associated with dominance behaviors and aggression, traits that may close men off from their families, reinforcing relationship barriers and decreasing the likelihood of emotional spillover. Future research should consider whether other hormone-linked traits affect the likelihood of men and women being differentially vulnerable to the spillover process.

We recognize that we might have detected more direct effects and perhaps more moderating influences if we had a larger and more diverse sample (Booth and Dabbs, 1993). If the study had included couples who were younger or had been married just a few years and had infants and preschool children, our finding may have been more extensive. Younger families are less stable (more likely to separate or divorce), have many more demands to cope with (infant and child care), and possess fewer resources (e.g. income and savings). Including such families would add much to our knowledge regarding hormones and parent-child relationship quality.

It would also be advantageous to consider these measures across a longer period of time to determine whether an alternate explanation is at work here—in particular whether the spillover identified was due to a stable or transient rise in testosterone among mothers. Unfortunately, our data do not allow us to identify long-term patterns in hormone levels. However, the finding that testosterone is linked to parent-child relationship quality, whether transient or stable, does support our hypotheses and helps to enlarge our understanding of the role of testosterone in developing strong family relationships.

In summary, neither maternal nor paternal testosterone had a net effect on parent-child relationship quality, although there were important interactions between the quality of other family relationships and the link between mothers' testosterone and the mother-child bond. These findings suggest that high testosterone women are more likely to be influenced by the quality of other family relationships than low testosterone women, and that testosterone may

be more detrimental to mother-child relationship quality when there is a lack of warmth in other family dyads. These findings are consistent with the biosocial perspective which suggests that the association between testosterone and behavior is highly dependent on the moderating influences found in one's environment, and that families are a crucial social context for understanding the link between hormones and behavior.

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Highlights

- We examine links between parent testosterone (T) and parent-child relationship.
- Sample is 352 intact families with two middle childhood or adolescent children.
- Parents and children interviewed in depth and provided three saliva samples.
- High T mothers not close to offspring when fathers dissatisfied with marriage.
- Low T mothers relations with children unaffected by father's dissatisfaction.

Figure 1.
Youth Report of Father's Marital Satisfaction as a Moderator of the Mother Testosterone - Mother-Child Closeness Linkages

Note: This figure was created in HLM with the Graph Equations command and is based on results from Table 4, Model 6. Graph specifications: (a) for the X focus at level 2, mother's testosterone was entered for entire range. (b) For the Z focus at level 2, father's marital satisfaction was entered for values equivalent to + and -1 standard deviation. The graphed relationship is significant at the less than $p < .05$ level.

Figure 2.
Youth Report of Father-Child Closeness as a Moderator of the Mother Testosterone -
Mother-Child Closeness Linkages

Note: This figure was created in HLM with the Graph Equations command and is based on results from Table 4, Model 7. Graph specifications: (a) for the X focus at level 2, mother's testosterone was entered for entire range. (b) For the Z focus at level 2, father-child intimacy was entered for values equivalent to + and -1 standard deviation. The graphed relationship is significant at the less than $p < .05$ level.

Table 1

Reports of Parent-Child Relationship Quality, Marital Satisfaction, Testosterone, and Demographic Variables: Descriptive Statistics (N = 709)

Variables	Respondent	Range	M	SD	α
Mother-Child Closeness ^a	Child report	10–40	29.85	4.79	.77
Father-Child Closeness ^a	Child report	11–40	27.95	5.16	.77
Mother Marital Satisfaction ^b	Mother report	0–63	46.64	9.86	.85
Father Marital Satisfaction ^b	Father report	0–63	48.66	8.50	.88
Mother Testosterone (ng/dl)	Mother saliva	4–90	21.95	11.07	na
Father Testosterone (ng/dl)	Father saliva	22–177	74.53	21.48	na
Child Gender (1= Female)	Mother report	0–1	.49	.50	na
Child Age, Years	Child report	6–16	11.60	2.55	na
Mother Education, Years	Mother report	11–20	14.53	2.15	na
Mother Age, Years	Mother report	30–52	40.10	4.10	na
Father Education, Years	Father report	8–20	14.48	2.35	na
Father Age, Years	Father report	30–68	42.26	4.89	na
Household Size	Mother report	4–9	4.61	.84	na
Family Income, Dollars ^c	Mother report	6–220	67.43	29.98	na

^aYouth report of closeness on 8 items which were summed across indicators with higher scores denoting greater intimacy.

^bParent report of satisfaction on 7 domains of marriage summed across indicators with higher scores denoting greater marital satisfaction.

^cReported in thousands.

Table 2

Observation of Parent-Child Closeness by Family Relationships, Testosterone, and Demographic Variables: Pairwise Correlations (N = 709)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Mother-Child Closeness ^a	–												
2. Father-Child Closeness ^a	0.55*	–											
3. Mother Marital Sat ^b	0.06	0.14*	–										
4. Father Marital Sat ^b	0.02	0.13*	0.28*	–									
5. Mother Testosterone	–0.05	0.03	0.06	0.05	–								
6. Father Testosterone	–0.03	0.01	0.09*	0.15*	0.15*	–							
7. Child Gender (1 = Female)	0.15*	–0.06	0.08*	0.05	–0.00	–0.03	–						
8. Child Age, Years	–0.20*	–0.27*	–0.08*	–0.05	0.05	0.02	–0.09*	–					
9. Mother Education, Years	0.06	0.02	0.07*	0.03	–0.15*	–0.10*	–0.04	–0.06	–				
10. Mother Age, Years	–0.04	–0.06	–0.03	–0.02	–0.10*	–0.08*	–0.08*	0.30*	0.34*	–			
11. Father Education, Years	0.05	0.03	0.13*	–0.08*	–0.11*	–0.10*	0.02	–0.08*	0.50*	0.38*	–		
12. Father Age, Years	–0.03	–0.02	–0.08*	–0.01	–0.08*	–0.12*	–0.08*	0.23*	0.25*	0.71*	0.26*	–	
13. Household Size	–0.02	0.02	–0.01	–0.07	–0.05	–0.16*	–0.01	0.03	0.07	–0.07	0.09*	–0.08*	–
14. Family Income, Dollars ^c	0.01	0.10*	0.01	0.08*	–0.13*	–0.12*	–0.02	0.02	0.39*	0.26*	0.39*	0.29*	0.04

^aYouth report of closeness on 8 items which were summed across indicators with higher scores denoting greater intimacy.

^bParent report of satisfaction on 7 domains of marriage summed across indicators with higher scores denoting greater marital satisfaction.

^cReported in thousands.

* $p < .05$.

Table 3

Summary of Multilevel Models with Robust Standard Errors Predicting Father-Child Relationship Quality^a (N = 709 Level One, N=352 Level Two)

Variable	Model 1			Model 2			Model 3			Model 4		
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Child Gender (1= Female)	-0.83**	0.35	-0.89**	0.35	-0.89**	0.35	-0.89**	0.35	-1.64***	0.29		
Child Age, Years	-0.52***	0.08	-0.51***	0.08	-0.52***	0.08	-0.52***	0.08	-0.34***	0.07		
Paternal Education, Years	-0.08	0.10	-0.04	0.10	-0.14	0.10	-0.14	0.10	-0.12	0.08		
Paternal Age, Years	0.02	0.05	0.02	0.04	0.03	0.05	0.03	0.05	-0.01	0.04		
Household Size	0.20	0.24	0.24	0.24	0.21	0.24	0.21	0.24	0.26	0.21		
Family Income, 10k Dollars	0.18**	0.09	0.15*	0.09	0.19**	0.09	0.19**	0.09	0.19**	0.08		
Paternal Testosterone (T)	-0.01	0.01	0.06	0.06	-0.05	0.04	-0.05	0.04	-0.04	0.05		
Father Marital Satisfaction ^b			0.15*	0.09								
Mother Marital Satisfaction ^b					-0.00	0.06						
Mother-Child Closeness ^d									0.47***	0.14		
Dad T * Dad Mar Sat			-0.00	0.00								
Dad T * Mom Mar Sat					0.00	0.01						
Dad T * M-C Closeness									0.00	0.00		
Intercept	32.25***	2.82	24.55***	5.14	32.96***	4.56	32.96***	4.56	17.02***	4.84		
<i>Variance Components</i>												
Within group variance (τ)	17.39		11.68		17.37		17.37		17.38			
Between group variance (u ₀)	7.19		5.42		6.93		6.93		6.76			

Note: Analyses conducted in HLM. Time since last menstrual cycle and the presence of opposite sex children were included as controls in each model. Child gender, child age, and mother-child closeness were entered uncentered at level one. All other variables were entered uncentered at level two.

^aYouth report of closeness on 8 items which were summed across indicators with higher scores denoting greater intimacy.

^bParent report of satisfaction on 7 domains of marriage summed across indicators with higher scores denoting greater marital satisfaction.

* p< .10

** p< .05.

*** p < .01, two tailed test.

Table 4

Summary of Multilevel Models with Robust Standard Errors Predicting Mother-Child Relationship Quality^a (N = 709 Level One, N=352 Level Two)

Variable	Model 1		Model 2		Model 3		Model 4	
	B	SE B	B	SE B	B	SE B	B	SE B
Child Gender (1= Female)	1.37***	0.35	1.36***	0.35	1.37***	0.35	1.83***	0.29
Child Age, Years	-0.33***	0.08	-0.32***	0.08	-0.32***	0.08	-0.03	0.06
Maternal Education, Years	0.12	0.10	0.11	0.10	0.13	0.10	0.19**	0.08
Maternal Age, Years	0.02	0.05	0.01	0.05	0.01	0.05	-0.01	0.04
Household Size	-0.11	0.19	-0.12	0.19	-0.14	0.19	-0.24	0.17
Family Income, 10k Dollars	-0.03	0.07	-0.03	0.07	-0.03	0.07	-0.12*	0.07
Maternal Testosterone (T)	-0.01	0.02	-0.15	0.10	-0.23**	0.11	-0.20**	0.08
Mother Marital Satisfaction ^b			-0.04	0.04				
Father Marital Satisfaction ^b					-0.09*	0.05		
Father-Child Closeness ^a							0.40***	0.07
Mom T * Mom Mar Sat			0.003	0.002				
Mom T * Dad Mar Sat					0.004**	0.002		
Mom T * F-C Closeness							0.010**	0.002
Intercept	31.57***	2.41	33.81***	3.53	36.48***	3.70	17.29***	2.62
<i>Variance Components</i>								
Within group variance (τ)	17.72		11.92		11.89		17.72	
Between group variance (u ₀)	4.09		3.14		3.04		4.10	

Note: Analyses conducted in HLM. Time since last menstrual cycle and the presence of opposite sex children were included as controls in each model. Child gender, child age, and mother-child closeness were entered uncentered at level one. All other variables were entered uncentered at level two.

^aYouth report of closeness on 8 items which were summed across indicators with higher scores denoting greater intimacy.

^bParent report of satisfaction on 7 domains of marriage summed across indicators with higher scores denoting greater marital satisfaction.

* p< 1.0

** p< .05.

$p < .01$, two tailed test.

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