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Quality of Early Family Relationships and Individual Differences in the Timing of Pubertal Maturation in Girls: A Longitudinal Test of an Evolutionary Model

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Abstract

In an 8-year prospective study of 173 girls and their families, the authors tested predictions from J. Belsky, L. Steinberg, and P. Draper's (1991) evolutionary model of individual differences in pubertal timing. This model suggests that more negative–coercive (or less positive–harmonious) family relationships in early childhood provoke earlier reproductive development in adolescence. Consistent with the model, fathers' presence in the home, more time spent by fathers in child care, greater supportiveness in the parental dyad, more father–daughter affection, and more mother–daughter affection, as assessed prior to kindergarten, each predicted later pubertal timing by daughters in 7th grade, The positive dimension of family relationships, rather than the negative dimension, accounted for these relations. In total, the quality of fathers' investment in the family emerged as the most important feature of the proximal family environment relative to daughters' pubertal timing.

The onset of pubertal development has typically been viewed as an important marker of the transition into adolescence and is accompanied by major social and cognitive changes (J. J. Conger, 1984; Feldman & Elliot, 1990). Variations in the timing of pubertal maturation—in levels of physical and sexual development of adolescents compared with their same-age peers—have received considerable research attention. The most consistent finding to emerge from the literature is that early onset of puberty in girls is associated with negative health and psychosocial outcomes. In particular, early maturing girls are at greater risk later in life for breast cancer (e.g., Kampert, Whittemore, & Paffenbarger, 1988; Vihko & Apter, 1986) and unhealthy weight gain (e.g., Ness, 1991; Wellens et al., 1992); have higher rates of teenage pregnancy (e.g., Manlove, 1997; Udry & Cliquet, 1982); are more likely to have low-birthweight babies (Scholl et al., 1989); and tend to show more disturbances in body image, to report more emotional problems such as depression and anxiety, and to engage in more problem behaviors such as alcohol consumption and sexual promiscuity (e.g., Caspi & Moffitt,

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1991; Flannery, Rowe, & Gulley, 1993; Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Mezzich et al., 1997; Susman, Nottleman, Inoff-Germain, Loriaux, & Chrousos, 1985).

Although a good deal is now known about the sequelae of variations in pubertal timing in girls, relatively little is known about the social and psychological antecedents of this variation. Recent theory and data (e.g., Belsky, Steinberg, & Draper, 1991; Graber, Brooks-Gunn, & Warren, 1995) have suggested that an individual's experiences during childhood may influence the physiological mechanisms that initiate and control pubertal development. In this article, we examine antecedents of pubertal timing in adolescent girls in a community sample that has been followed prospectively from preschool through adolescence. We tested predictions from an evolution-based theory of the development of female reproductive strategies. These predictions concern the relation between the quality of early family relationships and individual differences in the timing of pubertal maturation.

Sources of Variation in Pubertal Timing

Individual differences in the timing of pubertal maturation are influenced by both genes and environment. Genetic studies using twin designs have suggested that genotypic effects account for most of the variation in menarcheal timing and that the remaining variance is attributable to nonshared environmental effects (Kaprio et al., 1995; Treloar & Martin, 1990). Given the apparent absence of shared environmental effects on menarcheal timing, one might ask, is a psychosocial model of the phenomenon necessarily wrong?

We believe that the answer to this question is no, for several reasons. First, both Kaprio et al. (1995) and Treloar and Martin (1990) found that at least half of the genetic variance in age of menarche was nonadditive, As Meyer, Eaves, Heath, and Martin (1991) pointed out, this nonadditivity would tend to obscure any possible shared environmental variance in menarcheal timing. Meyer et al. suggested that alternatives to traditional twin designs (e.g., studies of unrelated girls reared together) are needed to detect effects of shared environment. Second, alternative methods have produced evidence of shared environmental influence on age of menarche. Specifically, Farber (1981) reported that monozygotic twins reared together were most similar in menarcheal age (*M* difference = 2.8 months), followed by monozygotic twins reared apart (*M* difference = 9.3 months), followed by dizygotic twins reared together (*M* difference = 12.0 months). That monozygotic twins reared apart were most similar in menarcheal timing to dizygotic twins reared together suggests that individual differences in age of menarche may be influenced by the degree to which girls share common environments (as well as common genes). Third, the types of environmental influences posited by the present psychosocial model of pubertal timing are likely to be nonshared. This is because a shared environmental effect in a behavior genetic design, by definition, has to be one in which the environmental factor is proportionally equivalent across siblings in the same home (Perusse & Boulerice, 1998). Parent–child processes, which are central to the current model, vary substantially across siblings (e.g., Sulloway, 1996). Finally, it has been well documented in past research that the timing of pubertal maturation in girls is sensitive to a variety of external factors, such as exercise and nutrition (reviewed in Graber et al., 1995).

In sum, behavior genetic theory and data do not preclude the possibility of psychosocial influences on girls' pubertal timing. These influences may include such factors as stressful family relationships, father absence, and exposure to unrelated adult males (see, e.g., Belsky et al., 1991; Ellis & Garber, in press; Graber et al., 1995). The present article specifically focuses on psychosocial antecedents of variation in pubertal timing in young adolescent girls.

Draper and Harpending's (1982, 1988) Evolutionary Theory of Father Absence and the Development of Female Reproductive Strategies

Draper and Harpending (1982, 1988) proposed an evolutionary theory of the role of father absence in the development of female reproductive strategies. This theory formed the foundation of Belsky et al.'s (1991) model of psychosocial factors in the onset of puberty. Draper and Harpending (1982, 1988) posited that individuals have evolved to be sensitive to specific features of their early childhood environments and that exposure to different environments biases individuals toward acquisition of different reproductive strategies. Specifically, Draper and Harpending (1982, 1988) proposed that an important function of early experience (during approximately the first 5 years of life) is to induce in girls an understanding of the quality of male–female relationships and the father's investment in the family. According to the theory, this understanding has the effect of canalizing a developmental track, which has predictable outcomes for girls' reproductive behavior at maturity. Girls whose early family experiences are characterized by discordant male–female relationships and relatively low paternal investment (e.g., divorce, unreliable provisioning or child care by the father, and “male bashing” by the mother) perceive that male parental investment is not crucial to reproduction; these girls are hypothesized to develop in a manner that accelerates onset of sexual activity and reproduction, reduces reticence in forming sexual relationships, and orients the individual toward relatively unstable pair-bonds. In contrast, girls whose early family experiences are characterized by more harmonious male–female relationships and relatively high paternal investment (e.g., marital stability, marital satisfaction, reliable provisioning by the father, and involvement by the father in child care) perceive that male parental investment is important to reproduction; these girls are hypothesized to develop in a manner that slows onset of sexual activity and reproduction and increases reticence in forming sexual relationships, facilitating the formation of relatively long-term pair-bonds with reliable and nurturant mates (Draper & Harpending, 1982, 1988). Either way, the girl “chooses” a developmental track that—in the adult social environment into which she is born—would have been likely to promote reproductive success during human evolutionary history.

The data on father absence and the development of female reproductive strategies are largely consistent with Draper and Harpending's (1982,1988) theory. Specifically, adolescent girls in father-absent homes tend to show precocious sexual interest in boys, to express negative attitudes toward males and masculinity, and to show relatively little interest in maintaining sexual and emotional ties to one male (Belsky et al., 1991; Bereczkei & Csanaky, 1996; Draper & Harpending, 1982; Flinn, 1988; Hetherington, 1972).

Belsky et al.'s (1991) Evolutionary Theory of Family Ecology and the Development of Female Reproductive Strategies

Belsky et al. (1991; see also Draper & Belsky, 1990) made two relevant additions to Draper and Harpending's (1982, 1988) developmental theory of female reproductive strategies, First, Belsky et al. broadened the scope of the predictor variables. Whereas Draper and Harpending (1982, 1988) emphasized that children experienced early socialization with their “antennae” tuned to the quality of male–female relationships and paternal investment, Belsky et al. expanded this conceptualization to include more generally the availability and predictability of resources in the environment, the trustworthiness of and treatment by significant others, and the enduringness of close interpersonal relationships. The revised theory now focused on the general conditions that stressed children, such as poverty, single parenthood, marital discord, and harsh, rejecting, inconsistent parenting (whether from the father or mother). Belsky et al. ordered these stressors in a causal chain: Within the general ecology of the family, contextual stressors (e.g., low socioeconomic status (SES), single parenthood, and stressful life events)

were hypothesized to foster more negative and coercive family relationships, which in turn were hypothesized to provoke a more precocious and promiscuous reproductive strategy. Conversely, more supportive ecological contexts were hypothesized to foster more positive and harmonious family relationships, which in turn were hypothesized to promote a later developing and more monogamous reproductive strategy.

Second, Belsky et al. (1991) added a new outcome variable to the theory: puberty. Whereas Draper and Harpending (1982, 1988) focused only on predicting psychological and behavioral development, Belsky et al. (see also Surbey, 1990) extended the cast of the theoretical net to include physical development. Specifically, they conceptualized early pubertal maturation, precocious sexuality, and unstable pair-bonds as integrated components of an underlying reproductive strategy that functioned to promote reproduction at a relatively early age, without the expectation that paternal investment in child rearing would be forthcoming and without the precondition of a close, enduring romantic relationship. The revised theory now included the novel prediction that girls whose early experiences in and around their family of origin are characterized by relatively high levels of stress (or low levels of support) will develop in a manner that accelerates pubertal maturation within the individual's range of plasticity.

Quality of Family Relationships and the Timing of Pubertal Maturation in Girls

Our study centered on the hypothesized relation between quality of family relationships and girls' pubertal timing. Past research on this topic has focused largely on the relation between pubertal timing and either (a) the dimensional quality of family relationships or (b) the social address of father absence.

Quality of Family Relationships

Do relatively high levels of family stress (or low levels of family support) accelerate pubertal development in girls? To adequately address this question, one must assess the quality of family relationships prior to adolescence, followed by assessment of pubertal timing during adolescence.[1] Moffitt, Caspi, Belsky, and Silva (1992) used this design in their longitudinal study of New Zealand girls and found a significant correlation between mothers' reports of conflictual family interactions, assessed when daughters were age 7, and daughters' reports of menarcheal age, obtained at age 15. Consistent with Belsky et al. (1991), Moffitt et al. found that greater early family conflict predicted earlier menarche.

Other longitudinal research has assessed levels of conflict and cohesion among family members after the daughters were already at least 10 years old and then prospectively studied its relation with later pubertal timing (Ellis & Garber, in press; Graber et al., 1995; Steinberg, 1988; Wierson, Long, & Forehend, 1993). These studies must be interpreted with caution, however, because by age 10 the hormonal changes that underlie pubertal development have already begun (McClintock & Herdt, 1996); thus, it is possible that these hormonal changes are causing increased distance or conflict in family relationships, rather than vice versa. Nevertheless, Steinberg (1988) found that greater distance in the mother–daughter relationship accelerated the speed of daughters' pubertal maturation. Similarly, both Ellis and Garber (in press) and Graber et al. (1995) found that greater family dysfunction was associated with earlier pubertal timing in daughters. Furthermore, Wierson et al. (1993) found that greater frequency of conflict between parents was associated with earlier menarcheal age in daughters.

In sum, most research has supported Belsky et al.'s (1991) hypothesis that greater stress in the family environment is associated with earlier pubertal timing in girls. Only one study, however, has used the kind of long-term, prospective design (following individuals from early childhood

[1]Of course, not even this longitudinal design can truly answer the question because it cannot rule out gene effects.

to adolescence) that is really needed to test the theory (Moffitt et al., 1992). The absence of long-term studies is especially problematic because Belsky et al. specified the first 5–7 years of life as the time of sensitive-period learning of reproductive strategies. In addition, previous research has relied on questionnaire measures of the quality of family relationships. This is problematic because the relation between quality of parental caregiving and child outcomes tends to emerge most strongly when parental caregiving is assessed through interviews or observations, rather than through questionnaires (Rothbaum & Weisz, 1994). Given these limitations, *the first goal of the present study was to test the family stress hypothesis in a long-term, prospective design using both interview-based and behavioral observation measures of the quality of family environment in the first 5 years of girls' lives*. Following Belsky et al.'s (1991) causal model, we tested the hypothesis that contextual family stressors (i.e., single parenthood, low SES, and stressful life events) result in more negative and coercive (or less positive and harmonious) relationships among family members, which in turn provoke earlier pubertal timing in daughters.

In theorizing about relationships among family members, Belsky et al. (1991) did not distinguish between positive and negative dimensions of these relationships; that is, positive–harmonious relationships were treated as the opposite of negative–coercive relationships. Although family relationships have often been conceptualized in this unidimensional manner, recent research has suggested that family relationships have fairly independent positive and negative dimensions (e.g., Ellis & Malamuth, in press; Hetherington & Clingempeel, 1992; Pettit, Bates, & Dodge, 1997) and that each of these dimensions often accounts for unique variance in child outcomes (e.g., Belsky, Hsieh, & Crnic, 1998; Hetherington & Clingempeel, 1992; Pettit & Bates, 1989). Accordingly, variations in positive–harmonious family relationships may influence timing of pubertal maturation, independent of variations in negative–coercive family relationships (and vice versa). To address this issue, *the second goal of this study was to assess both positive and negative dimensions of family relationships in early childhood and to examine the effects of each of these dimensions on daughters' pubertal timing in adolescence*. This was the first long-term prospective study of pubertal timing to include both positive and negative indices of the quality of family relationships.

The Social Address of Father Absence

Do girls raised in homes with their biological father absent experience sexual maturation earlier than girls raised with their biological father present? Most research on this topic suggests that girls reared in father-absent homes reach menarche several months earlier than their peers reared in father-present homes (Jones, Leeton, McLeod, & Wood, 1972; Moffitt et al., 1992; Surbey, 1990; Wierson et al., 1993). Moreover, some of these studies have found that the longer the period of father absence, the earlier the onset of daughters' menstruation (Moffitt et al., 1992; Surbey, 1990).[2]

Although there is reasonable evidence to support the father-absence hypothesis, there is almost no research on the relation between quality or extent of paternal caregiving and timing of daughters' pubertal development. The one study on this topic (Steinberg, 1988) did not find an accelerating effect of father-daughter distance on speed of daughters' pubertal maturation. The results of this study should be considered tentative, however, because it included fewer than 50 father–daughter dyads, examined father–daughter relationships only in homes where fathers and daughters were coresident (thus greatly restricting the range of father involvement), relied on questionnaire measures of the quality of father–daughter relationships, and began data collection after girls were already in early adolescence.

[2]Not all studies (see Campbell & Udry, 1995) have found an accelerating effect for years of father absence on menarcheal age. Further, Ellis and Garber (in press) found that years of stepfather presence, rather than years of biological father absence, best accounted for girls' pubertal timing.

The overall absence of information about the relation between quality of father–daughter relationships measured dimensionally and daughters' pubertal timing, together with the dichotomous classification in past studies of fathers into present versus absent categories, is especially problematic because the theory (Belsky et al., 1991) conceptualizes parental influences as a continuum. The development of girls' reproductive strategies should be shaped not simply by whether the biological father is present or absent in the home but by the extent of his involvement in the daughter's life. An implication of Belsky et al.'s model is that it is not only within father-absent homes, but also within dysfunctional father-present homes, girls should develop in a manner that accelerates pubertal maturation. Thus, *the third goal of this study was to test the hypothesis that low-quality paternal investment in early childhood is associated with earlier pubertal timing in daughters*. The present study was the first to test this hypothesis in a long-term, prospective design using multiple measures (both interview based and home observation) of the quality of early father–daughter relationships. To provide a stringent test of this hypothesis, we examined whether quality of paternal investment predicts daughters' pubertal timing within father-present families.

Finally, we examined the issue of mother-effects versus father-effects on daughters' pubertal timing. Draper and Harpending's (1982, 1988) father-based theory of the development of female reproductive strategies and Belsky et al.'s (1991) family ecology-based theory of the development of female reproductive strategies offer somewhat different perspectives on this issue. Draper and Harpending's (1982, 1988) model implies that variations in fathers' investment in the family, more than mothers' investment in the family, will influence daughters' reproductive development. An implication of this type of father-based model is that father-effects will contribute uniquely to the prediction of daughters' pubertal timing, whereas mother-effects, if they occur, will be redundant with father effects. By contrast, Belsky et al. were silent on the issue of mothers vs. fathers. Belsky et al. emphasized parent–child relationships and other family processes more generally and did not distinguish between the effects of mothers and fathers on pubertal timing. To address this issue, *the fourth goal of this study was to assess the quality of both maternal caregiving and paternal caregiving received by daughters in early childhood and to compare the effects of these two sources of caregiving on daughters' pubertal timing*. The present study was the first to compare mother-effects and father-effects on pubertal timing in a long-term, prospective design.

Method

Participants

The data presented in this report were collected as part of the ongoing Child Development Project, a multisite, longitudinal study of socialization factors in children's and adolescents' adjustment (see Dodge, Bates, & Pettit, 1990; Pettit et al., 1997). Participating families were initially recruited from three geographical areas (Nashville and Knoxville, Tennessee, and Bloomington, Indiana). At the time of kindergarten preregistration in the summers of 1987 and 1988, parents of matriculating children were solicited at random (in person at the child's school or by mail) to become involved in the study. About 70% agreed to participate. Data on contextual family stressors (i.e., single parenthood, SES, and family life stress) and quality of family relationships (i.e., mother–child, father–child, and mother–father relationships) were collected at this time (Year 1) while the daughters were in preschool (4 to 5 years old). A total of 585 families agreed to participate in the study. Of these 585 families, 281 of the children were girls. The analyses reported in this article were based on this female subsample, which was demographically diverse and representative of the geographic regions (81% Caucasian, 18% African American, 1% “other”; 28% lived with a single mother in Year 1). The Hollingshead (1975) Four-Factor Index of Social Status was computed from demographic information provided by the parents of the girls. The mean family score on the index was 38.85

(*SD* = 14.0), indicating a predominantly lower middle to middle-class sample. The data on pubertal timing were collected in Year 8 of the study when the girls were in seventh grade (12 to 13 years old). Of the original 285 girls, 217 (76%) participated in the Year 8 interview. This subset is generally representative of the original sample (14% African American, mean SES = 39.88). Other analyses have shown that attrition has not biased the sample on any family socialization variables (Dodge, Pettit, Bates, & Valente, 1995).

Year 1 Maternal Interview

Following recruitment, mothers were interviewed at home in the summer prior to daughters' entry into kindergarten. The 90-min audiorecorded interview included both open-ended and structured questions about each of two eras in the child's life (a period from age 12 months to 12 months ago and from the past 12 months to the present). The open-ended format was designed to be culturally sensitive and to enable parents to explain their responses in their own words. Questions concerned the child's development and child-care history, family stressors, parental behavior, exposure to socializing factors, and current functioning. Interviewer training occurred over a 4-week time period and consisted of reading a procedure manual, observing other interviews, and conducting interviews with a supervisor present. Interviewers were trained to a reliability of 80% or higher (based on percentage of agreement across all items, using the supervisor's scores as the criterion) prior to conducting any real interviews. Reliability of actual scores was assessed through independent ratings of 41 randomly selected families made by a second coder who sat in with the interviewer. From the maternal interview, several measures of contextual family stressors and quality of family relationships were derived, as follows.

Contextual Family Stressors

Following Belsky et al. (1991), we assessed contextual family stressors in terms of the major social address variables that are associated with increased risk for low-quality parenting: having low SES, being raised in a single-parent household, and experiencing family stress. Ineffective parenting is more common in families experiencing each of these three types of contextual stressors (Bank, Forgatch, Patterson, & Fetrow, 1993; R. D. Conger et al., 1992; Hetherington & Martin, 1986).

SES—SES was computed on the basis of mothers' and fathers' occupations and years of education (Hollingshead, 1975). As recommended by Hollingshead, when fathers (or adult male partners) did not reside in the home, the mothers' scores were double weighted.

Father absence and single-parent status—The theoretical perspectives of Draper and Harpending (1982, 1988) and Belsky et al. (1991) are somewhat different in their approach to the question of father absence and single parenthood. Whereas Draper and Harpending (1982, 1988) focused on the presence versus absence of the biological father, Belsky et al. focused on the presence of one parent versus two parents. To accommodate both approaches, we created two different measures: biological father absence and single-parent status, The father-absence measure contrasted girls who were living with both biological parents (63% = father present) with girls who were living in single-mother households (28% = father absent) at Time 1. This measure classified as “missing” those girls who were living with a mother and stepfather (6%) or in various other arrangements (3%). The measure of single-parent status contrasted girls who were living with their biological mother plus either the biological father or stepfather (69% = two-parent status) with girls who were living in single mother households (28% = single-parent status) at Time 1.

Family life stress—Family life stress was assessed during the interview. Mothers were asked to recall each era and to answer these questions: “What changes or adjustments occurred during

this time [prompting from a list including 10 major stressors such as death, divorce, and legal problems]?" "How did these changes affect your child?" Following these questions, the interviewer completed one rating of the extent of stressful, challenging events faced by the child and family. The ratings were made on a 5-point scale ranging from 1 (*minimum challenge*) to 5 (*severe frequent challenges*). The ratings from the two eras were averaged to yield a score for family-life stressors ($M = 3.04$, $SD = 0.94$; alpha across the two ratings = .64; correlation between independent raters = .79).

Quality of Relationships Among Family Members

Harshness of discipline—Mothers were asked to respond open-endedly to each of these questions for each era: "Who usually disciplined your child?" "How?" "Was your child ever physically punished?" "How often?" "If physical punishment had been used, how did adults usually spank your child?" "Do you remember any times when your child was disciplined severely enough to be hurt or to require medical attention?" Following these questions, the interviewer paused and privately completed two ratings on 5-point scales. The first rating assessed the degree of restrictive discipline received by the child; the scale ranged from 1 (*nonrestrictive, mostly prosocial guidance*) to 5 (*severe, strict, often physical*). The second scale assessed the interviewer's impression about whether the target child had been severely harmed, with points ranging from 1 (*definitely not*) to 5 (*authorities involved*). These four ratings (two ratings for each of two life eras) were averaged to derive the harshness-of-discipline score ($M = 2.05$, $SD = 0.67$; alpha across the four ratings = .81; interrater $r = .78$).

Severity of conflict in the parental dyad—Mothers were asked to recall each era and to answer this question: "All families have conflicts, parents and kids. What kinds of family strife and violence was your child exposed to during this time" (e.g., shouting, physical fights, pushing—parent–parent or parent–child)?" If necessary, interviewers probed for description of arguments and for any agency involvement. Following this question, the interviewer completed one rating of the severity of conflict within the parental dyad (this included the biological mother and the male partner [either husband or boyfriend] living in the home) on a 5-point scale ranging from 1 (*rarely even shout*) to 5 (*physical fights, more than once*). The ratings from the two eras were averaged to yield a score for severity of conflict within the parental dyad ($M = 2.19$, $SD = 1.03$; alpha across the two ratings = .74; interrater $r = .80$). Twenty-three mothers (8%) had missing data on this variable (i.e., they had no male partner in the home over either of the two time periods).

Levels of supportiveness in the parental dyad—Mothers were asked to recall each era and to answer these questions: "In what ways was your spouse helpful to you during this time?" "In what ways were you helpful to your spouse?" (The term *spouse* was used broadly to include either husband or male partner living in the home.) If necessary, interviewers probed for helpfulness and emotional support. Following each of these questions, the interviewer completed two ratings on 5-point scales. The first assessed helpfulness (0 = *no partner;* 1 = *none, minimal;* 2 = *when asked;* 3 = *did own chores;* 4 = *pitched in spontaneously*). The second assessed emotional supportiveness (0 = *no partner;* 1 = *none;* 2 = *minimal, tolerant;* 3 = *moderate;* 4 = *good, strong*). Because of the substantial number of absent partners, these ratings tended to have bimodal distributions. To create normal distributions, the ratings were recoded into the following 3-point scales: (0 = 0; 1 = 0; 2 = 1; 3 = 1; 4 = 2). Consistent with the theory of Belsky et al. (1991), this recoding placed fathers who were physically and psychologically absent into the same category. The eight ratings (four from each era) were averaged to derive a total score for level of supportiveness in the parental dyad ($M = 1.41$, $SD = 0.53$; coefficient alpha across the eight ratings = .88; interrater $r = .86$). Twenty-three mothers (8%) had missing data on this variable. In general, these mothers were involved in ambiguous relationships with

romantic partners (e.g., divorced but involved, dating but not committed) and chose not to answer questions about these relationships.

Time spent by the father in childcare—Mothers were asked to recall each era and to answer this question: "Who were your child's main caregivers during this time?" Following this question, the interviewer completed one rating of the amount of time the father spent taking care of child, on a 4-point scale ranging from 1 (*brief care*) to 4 (*major care*). This variable showed a clear bimodal distribution, with most fathers at either the highest or lowest end of the scale. Thus, scores of 1 and 2 were recoded as 0 (low paternal care) and scores of 3 and 4 were recoded as 1 (high paternal care). The ratings from the two eras were averaged to yield a score for level of paternal caregiving (M = .66, SD = .36; alpha across the two ratings = .77; interrater r = .72).

Year 1 Home Observation Measures

Additional measures of quality of family relationships were obtained through home observation of a subset of 84 girls and their families. These observations focused on quality of maternal and paternal caregiving, Using a prekindergarten measure of aggression provided by the parents (Child Behavior Checklist; Achenbach & Edelbrock, 1983), we selected this subsample to have approximately equal numbers of high-, medium-, and low-aggression children. Data on mother–daughter interactions were obtained on all 84 families; data on father–daughter interactions were obtained on the 59 families in which the father resided in the home. Families were observed at home in the summer and early fall following the prekindergarten recruitment. Observers were doctoral students trained by a senior investigator by reading manuals, completing a 2-day workshop, conducting practice observations, and achieving acceptable levels of reliability. Using methods developed by Pettit and Bates (1989, 1990), two 2-hr observations were conducted for each family during the dinner hour or at other times when all family members were present. Family members were asked to go about their usual activities while a home visitor sat and wrote extensive notes about family behavior, Separate global ratings were completed for mother–daughter and father–daughter interactions at the end of the 4 hr of observation. To assess reliability, a second observer was present for one or both observations of 26 randomly selected families. From the global ratings, the following two parenting measures were derived.

Mother–daughter and father–daughter affectionate–positivity—This measure consisted of four 5-point Likert-type items: "Most interactions between this parent and child are characterized by (1 = *generally negative affect;* 3 = *neutral affect;* 5 = *generally positive affect*)." "When interactions between this parent and child are positive, the degree of positiveness is (1 = *mild;* 3 = *mid-range;* 5 = *highly warm and supportive*)." "How does this parent respond when the child gets excited about something (1 = *interferes;* 3 = *somewhat accepting;* 5 = *delighted with child*)?" "How does this parent respond when the child has learned a new skill or accomplished something new (1 = *appears indifferent;* 3 = *average levels of interest; 5 = responds with delight*)?" Affectionate–positivity scores were recorded as the sum of the four Likert-type ratings (Cronbach's α = .86 for mothers and .85 for fathers; primary and reliability observer r = .72 for mothers and .45 for fathers).

Mother–daughter and father–daughter coercive control—This measure consisted of three 5-point Likert-type items and two 5-point rankings: "When interactions between this parent and child are negative, the degree of negativity is (1 = *low-level, mild;* 3 = *midrange, variable;* 5 = *extreme, explosive*).)?" "How often does this parent have conflicts with the child (1 = *rarely or never;* 3 = *occasionally, average amount;* 5 = *frequently, repeatedly*)?" "When conflicts occur between this parent and child, how intense are they in terms of expressed negativity (1 = *low intensity;* 3 = *moderately severe;* 5 = *highly negative, serious,*

damaging)?" "Does this parent react with physical punishment when the child misbehaves (1 = *least typical response;* 5 = *most typical response*)?" "Does this parent react with power assertion (e.g., take something away, time out, etc.) when the child misbehaves (1 = *least typical response;* 5 = *most typical response*)?" Coercive control scores were recorded as the sum of the five items (Cronbach's α = .78 for mothers and .74 for fathers; primary and reliability observer r = .76 for mothers and .55 for fathers).

As shown above, the interrater correlations for the father–daughter measures were lower than for the mother–daughter measures. These lower correlations probably reflect the fact that father–daughter interactions occurred less frequently than mother–daughter interactions and were thus more difficult to code. Nonetheless, the interrater correlations for the father–daughter measures averaged .50 (both ps < .05); these levels of interrater reliability were judged to be adequate.

Year 8 Assessment of Pubertal Timing

Adolescent daughters were interviewed (either at home or at school) in Year 8 of the study and answered questions concerning pubertal development at that time. Level of pubertal development was assessed by a questionnaire version (Carskadon & Acebo, 1993) of the Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988). The questionnaire version was used so participants could complete the PDS in private (given the sensitive nature of the questions). In the instruction packet for scoring the PDS, Petersen et al. recommended using only menarcheal status, breast development, and body hair growth for the composite measure of pubertal development. Girls thus completed self-ratings on whether they had begun to menstruate (1 = *no;* 4 = *yes*) and on their levels of body hair growth and breast development (1 = *not yet started;* 2 = *barely started;* 3 = *definitely started;* 4 = *seems complete*). Each item included an "1 don't know" response (which girls were instructed to mark if they did not understand a question or did not know the answer). Adolescent girls have been found to be accurate reporters of their menarcheal status (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Rierdan &. Koff, 1985), and girls' self-ratings on the body hair growth and breast development questions have been found to correlate strongly with physician ratings (Brooks-Gunn et at., 1987). Overall pubertal development scores were based on the average of the three items (M = 2.53, SD = 0.86; Cronbach's α = .51). Pubertal development scores were then converted into pubertal timing scores by partialing out girls' age. The pubertal timing scores were used in all data analyses. Higher scores indicated earlier pubertal timing (i.e., greater pubertal development in seventh grade, controlling for age).

Of the 217 girls who participated in the Year 8 follow-up, 198 filled out the PDS. (Some girls declined to complete the scale because of the invasiveness of the questions.) Of these 198 girls, 25 either failed to respond or marked "I don't know" to at least one of the three puberty items. These 25 girls were coded as missing, leaving a total of 173 girls with pubertal timing scores. The 173 girls with usable puberty scores did not differ from the 44 girls without usable puberty scores on age, race, or any of the measures of contextual family stressors or quality of family relationships.

Results

Interrelations Among Contextual Family Stressors and Quality of Family Relationships

Contextual family stressors—Belsky et al. (1991) conceptualized families as inhabiting ecological contexts that vary along a continuum of stress. The theory specifies having low SES, being raised in a single-parent household, and experiencing stressful life events as major contextual stressors on the family. As one would expect, these forms of contextual stress correlated significantly (ps < .001). Single-parent families tended to experience more family

life stress, $r(262) = .30$, and to have lower SES, $r(258) = -.44$. Likewise, lower SES was associated with higher family life stress, $r(273) = -.26$.

Quality of family relationships—Quality of family relationships is central to the theorizing of Belsky et al. (1991), as it is conceptualized as the most adaptively significant feature of the individual's early childhood environment. According to the theory, the child perceives and experiences family relationships along a continuum varying from harsh, rejecting, and opportunistic to sensitive, supportive, and reciprocally rewarding. Consistent with this viewpoint, there were significant correlations among various measures of quality of family relationships (see Table 1). For example, families that were characterized by greater use of harsh discipline by parents tended to also be characterized by greater severity of conflict in the parental dyad, less supportiveness in the parental dyad, less time spent by the father in child care, and more frequent use of coercive control by parents. Importantly, the measures of parenting correlated across independent data sources. Thus, for example, the interview-based measure of harsh discipline was significantly correlated with the behavioral observation measures of mother–daughter and father–daughter coercive control. Likewise, the interview-based measure of supportiveness in the parental dyad was significantly correlated with the behavioral observation measures of mother–daughter and father–daughter affectionate–positivity.

Relations Between Contextual Family Stressors and Quality of Family Relationships

The first proposition of Belsky el al.' s (1991) model of individual differences in pubertal timing is that contextual family stressors foster more harsh and rejecting (or less warm and supportive) family relationships. This proposition was clearly supported by the data (see Table 2). Having lower SES,. being raised in a single-parent household, and experiencing greater family life stress were each associated with harsher discipline, greater severity of conflict in the parental dyad, less supportiveness in the parental dyad, less time spent by the father in child care, and more mother–daughter coercive control.

Relations Between Quality of Family Relationships and Daughters' Pubertal Timing

Validity of the puberty measure—Two external criteria for validating a measure of pubertal development are age and race. In the 11–13 age range, girls who are older tend to be more pubertally developed than girls who are younger (Brooks-Gunn et al., 1987). In addition, African American girls tend to experience earlier pubertal timing than do Caucasian girls (National Heart, Lung, and Blood Institute Growth and Health Study Research Group, 1992). The age range at Year 8 for the girls in the present study was small (minimum age = 11.89 years, maximum age = 12.90 years; $M = 12.39$, $SD = .30$). Despite this small range, there was a trend for older girls to report more pubertal development, $r(171) = .14$, $p = .07$.[3] When girls who were at least one standard deviation below the mean in age ($n = 25$; mean level of pubertal development = 2.08) were compared with girls who were at least one standard deviation above the mean in age ($n = 42$; mean level of pubertal development = 2.67), the difference in pubertal development was highly significant, $t(65) = -3.08$, $p = .003$. In terms of race, the difference between Caucasians ($n = 143$; mean level of pubertal development = 2.50, $SD = 0.86$) and African Americans ($n = 28$; mean level of pubertal development = 2.63, $SD = 0.92$) was in the expected direction but was not statistically significant, $t(169) = -0.68$, $p = .50$. Given the small number of African Americans in the present study, it was not surprising that the two groups were not significantly different. In total, the relations with age and race were largely consistent with expectations.

[3]The original pubertal development measure, rather than the converted pubertal timing measure, was used in these validation analyses.

Relations with pubertal timing—The second proposition of Belsky et al.'s (1991) model is that quality of early family relationships influences the development of reproductive strategies. The specific prediction tested in this study is that girls whose early family relationships are more harsh, rejecting, and opportunistic (or less sensitive, supportive, and reciprocally rewarding) will experience earlier pubertal timing. This prediction received mixed, though reasonable, support (see Table 3). There were four interview-based measures of the quality of family relationships in the first 5 years of life. Of these, supportiveness in the parental dyad and time spent by the father in child care were statistically significant predictors of daughters' pubertal timing, whereas harshness of discipline and severity of conflict in the parental dyad were not. Consistent with the theory, greater supportiveness in the parental dyad and more time spent by the father in child care were each associated with later pubertal timing in daughters (see Table 3). There were also four behavioral observation measures of quality of early family relationships. Of these, mother–daughter affectionate–positivity and father–daughter affectionate–positivity were statistically significant predictors of pubertal timing, whereas mother–daughter coercive control and father–daughter coercive control were not. Again, consistent with the theory, more affectionate–positivity was associated with later pubertal timing (see Table 3).

All correlations between quality of family relationships and pubertal timing were recalculated after controlling for race. (Race was coded as a dummy variable and partialed out of the pubertal timing measure.) All four of the statistically significant correlations remained significant (and virtually unchanged) after controlling for race.

Positive versus negative dimensions of the quality of family relationships—Do positive and negative dimensions of family relationships, as assessed in early childhood, differ in their relation to daughters' pubertal timing in adolescence? To address this question, we first examined the structure of the family relationships data. Two principal-components analyses were performed on the measures of quality of family relationships and were followed by oblique rotation. Oblique rotation was used to allow the factors to covary (if warranted by the data). The first analysis involved the four interviewer-based measures of family relationships: harshness of discipline, conflict in the parental dyad, supportiveness in the parental dyad, and time spent by the father in child care. The second analysis involved the four behavioral observation measures of family relationships: mother–daughter coercive control, father–daughter coercive control, mother–daughter affectionate–positivity, and father–daughter affectionate–positivity.[4] On the basis of eigenvalue scree, two factors were extracted in each analysis. In both analyses, the first factor clearly tapped the positive dimension of family relationships (i.e., there were high loadings on positively valenced items, and low loadings on negatively valenced items), and the second factor clearly tapped the negative dimension of family relationships (i.e., there were high loadings on negatively valenced items, and low loadings on positively valenced items). These factors were moderately correlated in both data sources, $r(250) = -.33$ between the interview-based factors, and $r(58) = -.28$ between the behavioral observation factors. These data indicate that positive and negative family relationships were distinct but negatively correlated dimensions of family environment. We estimated these dimensions by weighting variables by their factor score regression coefficients in linear composites. This produced two overall scores for both Positive Family Relationships and Negative Family Relationships (one based on interview data, the other on behavioral observation data). Correlations were then calculated between both the Positive and Negative Family Relationships factors and daughters' pubertal timing (see Table 4).

[4]These two groups of measures were factor analyzed separately because combining the interviewer and observer measures would have reduced the sample through listwise deletion to 51 families. This reduced group would have included only father-present families (because the observer measures of father–daughter interactions were only collected in father-present homes), resulting in a factor analytic subsample that was qualitatively distinct from the full sample.

As shown in Table 4, higher levels of Positive Family Relationships during the first 5 years of life predicted significantly later pubertal timing in daughters. These relations held whether the assessment of Positive Family Relationships was based on interview or behavioral observation data. In contrast, variations in levels of Negative Family Relationships were not associated with pubertal timing. Further, as one can see in Table 3, the positively valenced measures of family relationships (supportiveness in the parental dyad, time spent by the father in child care, mother–daughter affectionate–positivity, and father–daughter affectionate–positivity) were all significantly related to pubertal timing, whereas the negatively valenced measures of family relationships (harshness of discipline, conflict in the parental dyad, mother–daughter coercive control, and father–daughter coercive control) were not. In total, these results indicated that the relation between quality of early family relationships and daughters' pubertal timing was driven by variation in the positive–harmonious dimension of family relationships rather than by variation in the negative–coercive dimension.

Quality of Paternal Investment and Daughters' Pubertal Timing

Father absence—Do girls raised in single-mother homes tend to experience earlier pubertal timing than girls raised in homes with both a mother and a father present? Whether single-mother families were compared with biologically intact families or with the larger set of all two-parent families, there was a small, significant relation between single-mother family and pubertal timing ($r = .17$, $p < .05$; see Table 3). As predicted by the theory, girls who were in single-mother homes at age 5 tended to experience earlier puberty. These correlations dropped slightly (though to nonsignificant levels) when controlling for race. Given this change, correlations were recalculated using the Caucasian subsample only. As in the full sample, Caucasian girls raised in single-mother homes tended to experience earlier pubertal timing than Caucasian girls raised in either intact biological families, $r(123) = .23$, $p < .05$, or in the larger set of all two-parent families, $r(134) = .23$, $p < .01$. There were not enough African Americans in the study to run the analyses on that subsample also.

The dimensional quality of paternal investment within father-present homes—An implication of Belsky et al.'s (1991) model is that father-effects on daughters' pubertal timing should involve more than just father-absent effects; that is, quality of paternal investment should predict daughters' pubertal timing even within father-present homes. We have already reported one set of results that are consistent with this hypothesis: Greater father–daughter affectionate–positivity during the prekindergarten observations was associated with later pubertal timing by daughters in seventh grade (see Table 3). All of the behavioral-observation data on father–daughter interactions were collected in father-present homes.

As an additional test of the effects of quality of paternal investment on daughters' pubertal timing (separate from the effects of father absence on pubertal timing), we selected cases in which girls were living in father-present homes during the first 5 years of life and then recomputed the correlations between daughters' pubertal timing and (a) time spent by the father in child care during those first 5 years and (b) supportiveness in the parental dyad during those first 5 years. These two predictor variables were used because they each indexed fathers' investment in the family (the former assessed father–daughter investment, and the latter assessed father–mother investment). Analyses were conducted using both the subsample of biologically intact families and the subsample of all two-parent families. Within the biologically intact families, more time spent by the father in child care, $r(107) = -.24$, $p < .05$, continued to predict later pubertal timing by daughters in seventh grade, but greater supportiveness in the parental dyad did not, $r(107) = -.05$, $p = ns$, despite the substantial correlation between the two predictors (as can be seen in Table 1). Likewise, within the larger set of all two-parent families, more time spent by the father in child care, $r(121) = -.18$, $p < .05$, significantly predicted later pubertal timing, but greater supportiveness in the parental dyad

did not, $r(121) = -.11$, $p = ns$. These data indicated that even when the range of paternal investment was restricted to the subset of families in which the father was present in the home, variations in the amount of time spent by the father in child care still significantly predicted variations in daughters' pubertal timing.

One possible interpretation of these data is that fathers who spend relatively little time in child care are more likely to become divorced. By this reasoning, the association between time spent by the father in child care and daughters' pubertal timing could be a latent father-absent effect deriving from the tendency of uninvolved fathers to subsequently become absent fathers. To examine this possibility, we selected cases in which girls had lived in father-present homes throughout their lives. Analyses were conducted using the subsample of girls who had lived in biologically intact families or in the same two-parent families (mother and either father or stepfather) throughout the duration of the study. Within the long-term biologically intact families, $r(78) = -.30$, $p < .01$, as well as within the larger set of all long-term two-parent families, $r(87) = -.29$, $p < .01$, more time spent by fathers in child care during the first 5 years of daughters' lives continued to predict later pubertal timing. Thus, even when the range of time spent by fathers in child care was restricted to the subset of families in which the fathers were permanently present in the home, variations in levels of caretaking by fathers during the early years of their daughters' lives still significantly predicted variations in daughters' pubertal timing in early adolescence.

Comparison of Father-Effects and Mother-Effects on Daughters' Pubertal Timing

Belsky et al. (1991) did not specifically distinguish between the influence of fathers and mothers on daughters' pubertal timing. However, a father-based model of pubertal timing, which is consistent with the theorizing of Draper and Harpending (1982, 1988), suggests that fathers' investment in the family will influence daughters' pubertal timing more than will mothers' investment in the family (and that if mother-effects emerge at all, they will be redundant with father-effects). We investigated this issue using the behavioral observation data because we did not have specific, distinct measures of both mothering and fathering in the interview data. We used the behavioral observation data to compare the effects of father–daughter interactions and mother–daughter interactions on daughters' pubertal timing in intact families only. Analysis of intact families was necessary because it was not possible to conduct observations on the quality of paternal care-giving in father-absent homes.

Did the quality of paternal caregiving, more than the quality of maternal caregiving, predict daughters' pubertal timing? As reported earlier, more father–daughter affectionate–positivity and more mother–daughter affectionate–positivity each predicted later pubertal timing in daughters, To compare the predictive utility of the mother-based and father-based caregiving variables, we conducted two hierarchical regressions. In the first regression, daughter's pubertal timing was the dependent variable, the mother variables (mother–daughter affectionate–positivity and mother–daughter coercive control) were entered on the first step, and father–daughter affectionate–positivity was entered on the second step. As shown in Table 5, even after controlling for the mother variables, father–daughter affectionate–positivity remained a statistically significant predictor of daughter's pubertal timing. In the second regression, daughters' pubertal timing was the dependent variable, the father variables (father–daughter affectionate–positivity and father–daughter coercive control) were entered on the first step, and mother–daughter affectionate–positivity was entered on the second step. As shown in Table 5, after controlling for the effects of the father variables, the addition of mother–daughter affectionate–positivity did not increment the prediction of daughters' pubertal timing.

In total, these data indicated that the effects of maternal care-giving on daughters' pubertal timing were redundant with the effects of paternal caregiving, whereas the effects of paternal caregiving contributed uniquely to the prediction of daughters' pubertal timing. In addition, as

shown in the second hierarchical regression (see Table 5), more father–daughter affectionate–positivity and more father–daughter coercive control each significantly predicted later pubertal timing in daughters when entered simultaneously into the regression equation (Step 1; $R^2 = .30$). These data suggested that more father–daughter interaction per se (whether positive or negative) may be associated with later pubertal maturation in daughters.

Discussion

In their now classic article on father absence and reproductive strategy, Draper and Harpending (1982) proposed that individuals have evolved to be sensitive to specific features of their early childhood environments, and that girls whose early family experiences are characterized by father absence and discordant male–female relationships will tend to perceive that male parental investment is not crucial to reproduction and will develop in a manner that accelerates onset of sexual activity and reproduction without careful choice of mates. Belsky et al. (1991) proposed several extensions to Draper and Harpending's original theory, including the addition of early pubertal timing as a component of the accelerated reproductive strategy, a shift in emphasis from the social address of father absence to more dynamic family processes, and the expansion from a more delimited father-based model to a more general family ecology model.

The central and most intriguing hypothesis proposed by Belsky et al. (1991)—that quality of early family relationships influences timing of pubertal development in adolescence—received reasonable support from this study. As predicted only by the theory and no other formulation of socialization processes, more time spent by the father in child care, greater supportiveness in the parental dyad, more father–daughter affectionate–positivity, and more mother–daughter affectionate–positivity each predicted later pubertal timing by daughters in seventh grade. These relations emerged (a) even though there was an 8-year time period between measurements (prekindergarten assessment of quality of family relationships vs. seventh-grade assessment of daughters' puberty), (b) even though the correlations were across independent data sources (interview reports and behavioral observations of family relationships vs. daughters' self-reported pubertal timing), and (c) whether quality of family relationships was assessed indirectly through mother-based interviewer reports or directly through home observations. The results of the present study generally support and extend past longitudinal research linking quality of family relationships to timing of pubertal maturation in girls (Ellis & Garber, in press; Graber et al., 1995; Moffitt et al., 1992; Steinberg, 1988; Wierson et al., 1993).

An important limitation of the present study was that it was not genetically informative. The evolutionary models of pubertal timing presented in this article rest on the concept of *conditional* reproductive strategies; that is, they emphasize environmentally triggered processes that shunt individuals toward given reproductive strategies. An alternative explanation, however, is that individual differences in pubertal timing and associated characteristics represent *alternative* reproductive strategies, which result from genetic differences. Consider this possibility: Girls who mature earlier tend to exhibit earlier onset of sexual activity (e.g., Bingham, Miller, & Adams, 1990; Helm & Lidegaard, 1990; Phinney, Jensen, Olsen, & Cundick, 1990) and earlier age of first marriage and first birth (Manlove, 1997; Udry, 1979; Udry & Cliquet, 1982), which in turn are associated with increased probability of divorce and lower quality paternal investment. This covariation may occur because early pubertal timing results in precocious sexual and, reproductive behavior (cf. Caspi & Moffitt, 1991) or because pubertal, sexual, and reproductive timing are genetically correlated traits. Because mothers who are early maturers tend to have daughters who are early maturers (Brooks-Gunn & Warren, 1988; Garn, 1980), the correlation between quality of paternal investment and timing of pubertal maturation in girls may be spurious; that is, it may simply

be due to genetic transmission of pubertal timing and associated characteristics (Kim & Smith, 1998; Surbey, 1990).

On the basis of the present study, we cannot rule out this alternative explanation. It is worth noting, however, that previous studies that have controlled for either mothers' timing of pubertal maturation (Graber et al., 1995) or mothers' age at first childbirth (Ellis & Garber, in press) have still found significant associations between quality of family relationships and timing of daughters' puberty. Nevertheless, our study would have provided a better test of Belsky et al.'s (1991) conditional adaptation model if it had controlled for parents' pubertal timing. Unfortunately, relevant data on parental puberty were not collected.

Experimental research designs are needed to test for the causal influence of family relationships on pubertal timing. Forgatch (1991) and Kellam and Rebok (1992) have suggested that randomized, longitudinally designed prevention trials can be used to test the causal status of parenting practices. In the case of pubertal timing, the prevention trials should begin prior to the onset of puberty (no later than the 2nd grade), should target dysfunctional families, and should focus on improving the positive quality of family relationships and paternal investment. Given a successful preventive intervention, the conditional adaptation model predicts that girls in the experimental condition will experience later pubertal timing than girls in the control condition. Such a preventive intervention study is currently underway (Ellis, Dodge, McFadyen-Ketchum, & The Conduct Problems Prevention Research Group, 1999). Without such experimental data, however, one must be cautious about attributing causal status to the observed relations between family environment and pubertal timing. With this limitation in mind, we now turn to implications of the present findings.

The Social Address of Father Absence Versus the Dimensional Quality of Father–Daughter Relationships

Whereas Draper and Harpending (1982, 1988) focused largely on the social address of father absence, Belsky et al. (1991) emphasized the role of more dynamic family processes, especially parent–child processes, in the development of female reproductive strategies. An implication of Belsky et al.'s model is that not only in father-absent homes, but also in dysfunctional father-present homes, girls should experience relatively early pubertal timing. The present study provides support for this approach. Consistent with past research (e.g., Ellis & Garber, in press; Moffitt et al., 1992; Surbey, 1990), girls who were raised in single-mother homes tended to experience earlier pubertal timing than girls who were raised in two-parent homes. Extending past research, among girls who were raised in two-parent homes, variations in the dimensional quality of father–daughter relationships were associated with individual differences in pubertal timing. Two sets of results converged on this conclusion. First, greater father–daughter affectionate–positivity during the prekindergarten observations was associated with later pubertal timing in daughters. All of the father–daughter behavioral observations were made in father-present homes. Second, within father–present homes, more time spent by fathers in child care during the first 5 years of their daughters' lives was associated with later pubertal timing. This relation held even in the subset of families in which the fathers had been present in the home throughout their daughters' entire childhood. In sum, father-effects on daughters' pubertal timing clearly involved more than just father-absent effects. These data highlight the dimensional quality of father–daughter relationships as a possible influence on the timing of daughters' pubertal development.

Positive Versus Negative Dimensions of Early Family Relationships

Belsky et al. (1991) conceptualized negative–coercive family relationships and positive–harmonious family relationships as opposite sides of the same coin. Whereas negative–coercive relationships were hypothesized to provoke earlier pubertal timing, positive–harmonious

family relationships were hypothesized to promote later pubertal timing. The present data suggest that this theorizing was partially correct and partially incorrect. Factor analyses of both the interview and behavioral-observation data indicated that positive and negative family relationships were distinct but correlated dimensions of family environment. These dimensions differed in their relation to daughters' pubertal timing. As predicted by Belsky et al., higher levels of positive family relationships predicted significantly later pubertal timing by daughters. This finding replicated across both the interviewer ratings and behavioral observation ratings of positive family relationships. In contrast, variations in levels of negative family relationships were not associated with pubertal timing. This null finding was contrary to Belsky et al.'s theory. Taken together, *these data indicate that it was levels of positive investment and support in family relationships, rather than levels of conflict and coercion in these relationships, that accounted for the relations with daughters' pubertal timing*.

A possible interpretation of the null relations found in our study between negative family relationships and daughters' pubertal timing is that the measures of negative family relationships were poorly indexed. This interpretation is unlikely, however, because the measures of negative family relationships generally showed good internal consistency, reliability across raters, and reliability across independent data sources (i.e., behavioral observation vs. interviewer reports). Further, other analyses have shown that the present measures of negative family relationships are good long-term predictors of child adjustment (Dodge, Pettit, & Bates, 1994; McFadyen-Ketchum, Bates, Dodge, & Pettit, 1996; Pettit, Bates, & Dodge, 1997).

Why did the predicted relation between negative–coercive family relationships in early childhood and subsequent pubertal timing fail to emerge? There are theoretical grounds for calling the prediction into question, Drawing on life history theory, MacDonald (1997) and Miller (1994) argued that in K-selected species (those characterized by high-investment, low-fertility reproductive strategies, such as those of humans) there should be a negative correlation between stress levels and speed of sexual maturation, rather than a positive correlation. Both of these theorists suggested that from an evolutionary perspective, it makes more sense in the face of physical or psychological stress for individuals to delay maturation and reproductive viability until predictably better times.[5] Consistent with this perspective, Susman and colleagues (Susman, Dorn, & Chrousos, 1991; Susman et al., 1985) have hypothesized that stressful environments tend to delay pubertal onset by increasing levels of stress-related hormones from the adrenal axis. Increases in adrenal hormones have an inhibitor effect on sex steroid levels, resulting in delay of pubertal development.

Belsky's Family Ecology Model Versus a More Specific Father-Effects Model

Draper and Harpending's (1982, 1988) original theory of the development of reproductive strategies focused on fathers' role in the family. Belsky et al.'s (1991) theory of the development of reproductive strategies expanded this father-based model into a more general family ecology model. This family ecology model subsumed all of the predictions of a more limited father-effects model of pubertal timing (i.e., that father–daughter and father–mother relationships will influence puberty) and added to it new predictions (i.e., that mother–daughter relationships will influence pubertal timing and that proximal family relationships will mediate the link between contextual family stressors and puberty).

Although our study supports Belsky et al.'s (1991) focus on dynamic family processes and novel conceptualization of pubertal timing as an outcome of these processes, we found

[5]There is one form of stress—temporarily increased adult mortality rates—that has been shown to lead to earlier ages of sexual maturation in a variety of animal species, including mammals (Roff, 1992; Stearns, 1992). Under such risky circumstances, accelerated reproduction is strongly favored over delayed reproduction.

relatively little support for Belsky et al.'s shift to a general family ecology framework. A more limited father-effects model appears to provide a better fit to the data. As predicted by both the family ecology and father-effects models, the quality of fathers' early investment in the family emerged as a consistent predictor of daughters' pubertal timing, Beyond these father effects, however, the additional predictions of the family ecology model were not consistently supported. There are two sets of results that are relevant to this issue. First, of the contextual family stressors used in the present study (low SES, family life stressors, and single-parent status), only single-parent status (i.e., father absence) was associated with earlier pubertal timing in daughters. This association, of course, is consistent with a father-effects model. Second, father-effects emerged more strongly than mother effects. The direct comparison of mother- and father-effects on daughters' pubertal timing was conducted on the behavioral observation subsample. Consistent with the family ecology model, both mother–daughter affectionate–positivity and father–daughter affectionate–positivity were associated with later pubertal timing in daughters. However, only father–daughter affectionate–positivity made a unique contribution to the prediction of daughters' puberty (after controlling for the quality of mother–daughter relationships). Further, beyond mother–daughter affectionate–positivity, all of the other predictor variables in the study that were significantly correlated with pubertal timing were markers of fathers' investment in the family (i.e., father absence, time spent by the father in child care, supportiveness in the parental dyad, and father–daughter affectionate–positivity).

In total, *the present data suggest that the quality of fathers' investment in the family is the most important feature of the proximal family environment relative to daughters' pubertal timing*. This conclusion is consistent with Surbey's (1990) finding that girls who grew up in father-absent homes, but not in mother-absent homes, experienced earlier menarche than girls who grew up with both parents present. The primacy of father effects is notable, given that quality of mothering is generally more closely associated with child outcomes than is quality of fathering (Rothbaum & Weisz, 1994).

Although the zero-order correlations presented in Table 3 highlight the relation between positive paternal investment and daughters' pubertal timing, the second multiple regression presented in Table 5 suggests that paternal investment per se (whether positive or negative) may account for the relations with daughters' pubertal timing. When father–daughter affectionate–positivity and father–daughter coercive control were entered simultaneously on Step 1 of the regression, each accounted for unique variance in daughters' pubertal timing. Most striking, not only did more father–daughter affectionate–positivity predict later pubertal timing in daughters (after controlling for father–daughter coercive control), but also more father–daughter coercive control predicted later pubertal timing in daughters (after controlling for father–daughter affectionate–positivity). Because the measures of both affectionate–positivity and coercive control were sensitive to frequency of father–daughter interactions, it may be that more father–daughter interaction or involvement per se delays pubertal maturation in daughters.

Why Fathers?

In all regions of the world and across all social and economic systems, mothers invest more time and energy in the direct care of children than do fathers (reviewed in Geary, 1998). Although mothers (and sometimes their female kin) form the primary foundation of parental care in all societies, the contribution of fathers to the family is—and presumably always has been—widely variable (see Draper & Harpending, 1982, 1988; Geary, 1998). Within and across cultures, some men tend to form transient relationships with female partners and contribute relatively little to the care and provisioning of children, whereas other men tend to form long-term relationships with female partners and make considerable investment in

children. Over the course of human evolution, this variability in male reproductive strategies must have afforded young girls with important cues to the reproductive opportunities and constraints they were likely to encounter later in life. Drawing on this logic, Draper and Harpending (1982, 1988) posited that girls have evolved to experience early socialization with their "antennae" tuned to the father's role in the family (both in terms of father–mother and father–daughter relationships) and that different paternal roles bias girls toward the acquisition of different reproductive strategies. The present data showing an association between early paternal investment and subsequent timing of puberty in daughters is consistent with this theorizing.

Possible Mechanisms

Although the present data highlight the role of positive family relationships and paternal investment in the regulation of daughters' reproductive development, they do not directly shed light on the psychological mechanisms and processes that mediate the relation between early family relationships and adolescent pubertal timing. As discussed earlier, one possibility is that the relation is spurious—the result of genetic transmission of pubertal timing and associated reproductive behaviors. Another possibility, consistent with Belsky et al. (1991), is that stress is the causal mechanism but that it is the particular kind of stress associated with either low levels of positive family relationships, a lack of paternal investment, or both that provokes earlier puberty. Future research could address this issue by collecting both behavioral data on family relationships and physiological data on daughters' stress responses (see Flinn & England, 1995, for the use of this methodology).

A third possibility is that exposure to unrelated adult males is the causal mechanism (Ellis & Garber, in press; Surbey, 1990), Research on a variety of mammalian species (e.g., mice, cows, pigs, tamarins) indicates that exposure to pheromones produced by unrelated adult male conspecifics accelerates female pubertal development (Izard, 1990; Sanders & Reinisch, 1990; Ziegler, Snowdon, & Uno, 1990). Consistent with findings from this animal research, Ellis and Garber's (in press) findings indicated that years of exposure to unrelated father figures (stepfathers and mothers' boyfriends), rather than years of biological father absence, best accounted for earlier pubertal timing in girls. It may be that girls from paternally deprived homes are more likely to become exposed to the pheromones of stepfathers and other unrelated adult males, which in turn accelerates pubertal development. Unfortunately, the present study did not include enough information on daughters' exposure to unrelated males to test for its effects.

Another possible mechanism is inhibition of pubertal development through pheromonal exposure to the biological father (Hoogland, 1982; Surbey, 1990). There is some evidence in the animal research literature that the presence of closely related adult males inhibits reproductive maturation in females (and may function as an incest avoidance mechanism). In prairie dogs, for example, first ovulation is delayed in females who remain in contact with their biological fathers (Hoogland, 1982). In the present study, among the subset of girls who had lived with their biological fathers throughout their lives (and thus were not exposed to stepfathers), more time spent by the father in child care during the girls' first 5 years of life was associated with later pubertal timing in seventh grade. Further, as discussed above, more father–daughter interaction or involvement per se was associated with later pubertal maturation. These data are consistent with the hypothesis that increased pheromonal exposure to biological fathers inhibits sexual maturation. However, it is also likely that girls who have high-investing fathers in the home tend to begin sex and dating at a later age (e.g., Flinn, 1988; Hetherington, 1972) and thus have less pheromonal exposure to male dating partners in early adolescence.

In closing, we would like to comment on the possible clinical implications of this work, As noted earlier, both father absence and early pubertal timing have been implicated as risk factors

for female sexual promiscuity and teenage pregnancy, A father-based model of female reproductive development suggests that early pubertal maturation, risky sexual behavior, and early age of first birth are all components of an integrated reproductive strategy that derives, in part, from low paternal investment. The present data highlight the importance of early paternal involvement in the development of "healthy" reproductive functioning in daughters. At the same time, one should not interpret these data as suggesting that any adult male involvement is beneficial, as other research suggests that the presence of unrelated father figures may actually accelerate pubertal maturation in girls (Ellis & Garber, in press).

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Table 1

Intercorrelations Between Family Relationships Measures

Measure	1	2	3	4	5	6	7	8
1. Harshness of discipline	—							
2. Severity of conflict in parental dyad	.37*** (258)	—						
3. Supportiveness in parental dyad	−.36*** (258)	−.38*** (250)	—					
4. Time spent by father in child care	−.26*** (280)	−.23*** (258)	.60*** (258)	—				
5. Mother–daughter affectionate–positivity	−.22* (84)	−.11 (78)	.41*** (84)	.23* (84)	—			
6. Father–daughter affectionate–positivity	−.20 (59)	−.05 (58)	.36** (59)	.07 (59)	.60*** (59)	—		
7. Mother–daughter coercive control	.33** (84)	.15 (78)	−.33** (84)	−.24* (84)	−.51*** (84)	−.46*** (59)	—	
8. Father–daughter coercive control	.30* (58)	.02 (57)	.00 (58)	.09 (58)	−.11 (58)	−.25 (58)	.41*** (58)	—

Note. Number of participants for each analysis is shown in parentheses. All significance tests are two-tailed.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 2
Correlations Between Contextual Family Stressors and Quality of Family Relationships

Quality of family relationships	Contextual family stressor		
	SES	Single-parent status	Family life stress
1. Harshness of discipline	−.46*** (273)	.25*** (262)	.30*** (280)
2. Severity of conflict in parental dyad	−.25*** (251)	.35*** (242)	.35*** (258)
3. Supportiveness in parental dyad	.38*** (251)	−.62*** (242)	−.29*** (258)
4. Time spent by father in child care	.40*** (273)	−.66*** (262)	−.21*** (280)
5. Mother–daughter affectionate–positivity	49** (84)	−.27* (81)	−.13 (84)
6. Father–daughter affectionate–positivity	.04 (59)	—	−.16 (59)
7. Mother–daughter coercive control	−.22* (84)	.33** (81)	.24* (84)
8. Father–daughter coercive control	−.25 (58)	—	.24 (58)

Note. Number of participants for each analysis is shown in parentheses. All significance tests are two-tailed. Dashes indicate that data were not obtained (because all father–daughter interactions occurred within two-parent homes). SES = socioeconomic status.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Prekindergarten Measures of Contextual Family Stressors and Quality of Family Relationships Correlated With Seventh-Grade Pubertal Timing

Prekindergarten measure	*n* (pairwise)	Pubertal timing
Contextual family stressors		
Socioeconomic status	170	.01
Father absence[a]	149	.17*
Single-parent status[b]	163	.17*
Family life stressors	173	.02
Quality of family relationships		
Harshness of discipline	173	.04
Severity of conflict in parental dyad	161	−.11
Supportiveness in parental dyad	162	−.25***
Time spent by father in child care	173	−.23**
Mother–daughter affectionate-positivity	59	−.29*
Father–daughter affectionate-positivity	41	−.43**
Mother–daughter coercive control	59	.23
Father–daughter coercive control	40	−.22

Note. All significance tests are two-tailed.

[a] Intact biological families versus single mothers.

[b] Two-parent families versus single mothers.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4

Correlations Between Positive and Negative Family Relationships Factors and Daughters' Pubertal Timing

Family relationships factors	*n*	Pubertal timing
Factors derived from interview data		
Positive Family Relationships	157	−.31***
Negative Family Relationships	157	−.03
Factors derived from observational data		
Positive Family Relationships	40	−.45**
Negative Family Relationships	40	−.16

Note. All significance tests are two-tailed.

** $p < .01$.

*** $p < .001$.

Table 5

Hierarchical Multiple Regressions: Comparison of Father-Effects and Mother-Effects on Daughters' Pubertal Timing (n = 40)

Variable	R^2 change	F change	β	t
Father-effects model[a]				
Step 1	.12	2.63		
Mother–daughter affectionate–positivity			−.36	−2.21*
Mother–daughter coercive control			−.02	−0.13
Step 2	.09	3.98*		
Father–daughter affectionate–positivity			−.36	−2.00*
Mother-effects model[b]				
Step 1	.30	8.17***		
Father–daughter affectionate–positivity			−.53	−3.70***
Father–daughter coercive control			−.36	−2.56*
Step 2	.01	0.49		
Mother–daughter affectionate–positivity			−.12	−0.70

Note. All significance tests are two-tailed.

[a] Effects of father–daughter affectionate–positivity, controlling for mother–daughter affectionate–positivity and mother–daughter coercive control.

[b] Effects of mother–daughter affectionate–positivity, controlling for father–daughter affectionate–positivity and father–daughter coercive control.

* $p \leq .05$.

*** $p < .001$.