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UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

GENETIC AND ENVIRONMENTAL INFLUENCES ON THE DEVELOPMENT OF REPRODUCTIVE STRATEGIES DURING ADOLESCENCE

A Dissertation

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

Doctor of Philosophy

By

Debby Doughty

Norman, Oklahoma

2000

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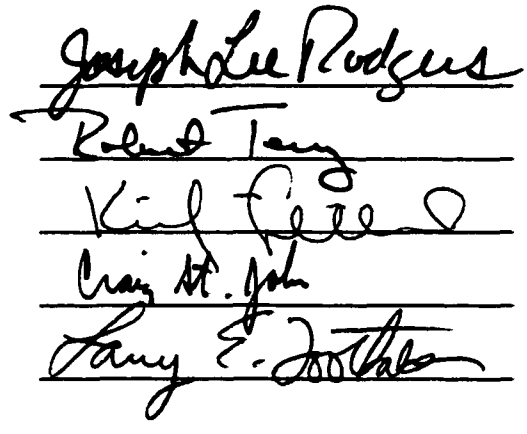
GENETIC AND ENVIRONMENTAL INFLUENCES ON THE DEVELOPMENT OF REPRODUCTIVE STRATEGIES DURING ADOLESCENCE

A Dissertation APPROVED FOR THE DEPARTMENT OF PSYCHOLOGY

BY



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Finally, I would like to dedicate this project to Matt and Brigitte Doughty with love and affection. Their contributions to my life during this journey are my most cherished gift.

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Abstract

This study examined the relative importance of the conditional model and the alternative model. These models have been used to explain the development of reproductive strategies in humans. The conditional model assumes a common genotype among individuals. Within this model, the choice of a long-term or short-term orientation to reproductive strategy is thought to be contingent on environmental cues. The alternative model suggests that genetic differences between individuals determine whether they adopt a short-term mating strategy without paternal investment in the rearing of children, or a long-term mating strategy that includes high parental investment in children. DeFries and Fulker regression analysis was used to examine the relative importance of the shared environment, nonshared environment, and genes on family attachment or bonding, attitudes relevant to mating relationships, sexual behavior, and childbearing in adolescence, and behavioral outcomes such as commitment to a partner before having sexual intercourse, age at first intercourse, and the number of sexual partners. The results supported the alternative model of reproductive strategy with moderate heritabilities found across all measures. Small to moderate shared environmental influences were found for attachment related to fathers, attitudes regarding the consequences of a pregnancy in adolescence, and the number of sex partners. No genetic influence was found for the attitude that getting pregnant or getting someone pregnant at this time would be so bad, providing some support for the conditional model. The results demonstrate that both nature and nurture make important contributions to adolescents' relationships with family members, attitudes, and sexual behaviors. The relationship of the findings to evolutionary theory is discussed.

Genetic and Environmental Influences on the Development of Reproductive Strategies During Adolescence

Are desires to form an enduring romantic attachment to a mate and desires to parent offspring universal human traits? This study focuses on two major questions that are of interest to scientists seeking to explain variation in human reproductive behavior. Are individual differences in pair-bonding patterns due to genetic differences? What is the role of the environment in maintaining phenotypic variance in mating patterns?

There are two major competing models (see Rowe, 2000) of reproductive strategy, each one rooted in evolutionary theory, to explain preferences in mating and parental investment in child rearing. The *conditional strategy model* predicts that environmental cues trigger either an orientation toward short-term pair-bonds, plentiful reproduction, and little expectation of paternal investment in offspring; or an orientation toward restricting sexual behavior to form long-term pair-bonds, limited reproduction, and paternal provisioning of offspring. This strategy assumes a common genotype across individuals, with reproductive strategy depending on environmental contingencies. The *alternative strategy model* predicts that individuals are genetically predisposed toward either multiple short-term mating relationships or toward long-term relationships (along with their concomitant reproductive behaviors). This model assumes different genotypes across individuals. Theories have been presented starting from either conditional or alternative strategy models. Whether the choice of reproductive strategy is a result of social/psychological mechanisms or biological mechanisms remains unclear.

Another possibility is that both conditional and alternative strategies coexist in the population (although not within individuals), and individuals therefore differ along a

continuum of plasticity of phenotypes (Belsky, 2000). For example, some individuals may be more capable of fitting into a variety of niches, depending on the environmental context in which they develop (the conditional model), while other individuals may demonstrate traits and developmental courses that are more or less genetically fixed (the alternative model). Rowe (2000) found partial support for both environmental and genetic bases of pubertal development, which may be related to subsequent strategies of mating. His paper will be described in detail in a later section.

One within-individual developmental model has even been proposed. Trumbetta and Gottesman (2000) suggested that genetic influences on pair-bonding strategies may be greater at younger ages when the likelihood of childbearing is greater, and then weaker when functions associated with marriage, childbearing, and raising children lose their centrality as individuals age. This model has not been tested with behavior genetic designs on an adolescent sample.

The present study will use behavior genetic methods to test evolutionary theories of reproduction related behavior, focusing on conditional and alternative strategy models. Behavioral genetic analyses provide an appropriate and powerful method for examining the relative contributions of each model, even including the possibility that individual differences in reproductive behaviors are simultaneously environmentally contingent and genetically influenced. This paper will review theories of the evolution of reproductive strategies that seek to explain empirical patterns in the formation and characteristics of pair-bonds, and initiation of sexual behaviors. An empirical study that integrates behavior genetic and evolutionary paradigms will be presented using longitudinal data representing the U.S. adolescent population. The study examines genetic, personality,

and family environmental influences on parent-child attachment, the subsequent development of attitudes and behaviors related to pair-bonding and childbearing, and initiation of sexual behaviors during adolescence. Finally, the relationship of the findings to evolutionary theory is discussed.

Theories of the Evolution of Reproductive Strategies

Conditional Strategy Models

Conditional strategy models explain the emergence of individual differences in personality and behavior as an outcome of environmental cues. If this class of models is correct, we would expect to find no genetic influence on patterns of pair-bonding, commitment to a relationship before initiating sexual behavior, age at first intercourse, or personality characteristics related to these behaviors. Instead, these models say that differences in mating and reproduction-related behaviors are context dependent, and may originate from experiences that occur during critical periods of development that calibrate species-typical mechanisms (Buss, 1991). Examples are presented in the following description of theories of the importance of family environment.

Conditional models assume that specific familial environmental cues that the child detects are incorporated into his or her concept of the appropriate mating strategy. Two examples of family environmental cues that may be relevant to the development of mating patterns and attitudes toward parental investment are father absence and attachment. Draper & Harpending (1982) reviewed the literature on father absence and suggested that a sensitive period of learning between ages 1 to 5 for receptivity to fathering has evolved in children. As a result of the child's perception of family structure and parental investment, gender differences that have evolved in brain organization and

function are modified and give rise to different reproductive strategies. These evolved cognitive differences predict that girls initially show greater interest in verbal communication, people, relationships, and competition, while males show greater spatial/quantitative ability and interest in objects and technology (see Draper & Harpending, 1982). Males who have not had parenting by fathers available, or have not perceived parenting by fathers to be important during this sensitive learning period, have been noted to possess more developed verbal than spatial / quantitative abilities. These males may have a greater interest in verbal manipulation, competitiveness, and aggression in relationships, which may in turn be expressed as exploitation of females and exaggerated masculine behavior (Biller, 1970; Biller & Bahm, 1971). Females growing up with a father perceive that paternal involvement is important for reproduction and parenting, resulting in delayed sexual activity and formation of more stable pair-bonds. Alternatively, females who do not perceive paternal investment as necessary are more likely to develop early sexual interest, a negative view of males, and show poor ability to form a stable bond with one male (Heatherington, 1972).

Draper & Harpending (1982) pointed out that father absence or presence may not serve as a motivating environmental cue, because the effects of father absence are opposite for widowed and divorced families (Hetherington, 1972). An alternative explanation is that the cue comes from the mother's orientation toward pair-bonding and resultant patterns of investment in child rearing. If the child develops in a home where parental conflict is present as a result of opportunistic mating and poor ability to bond with others, or the single mother has insecure attachment bonds, the interpersonal world the parent(s) provide in their rearing patterns reflects the world the child is expected to

encounter. These parents are more likely to rear their children to function in an environment of short-term, opportunistic relationships (Draper & Belsky, 1990).

Belsky, Steinberg, & Draper (1991) extended the Draper & Harpending theory by proposing that the evolutionary function of early childhood experience is to provide cues to the child pertaining to the availability of resources, the trustworthiness of others, and the enduringness of relationships that influence the development of mating strategies later expressed in adolescence. They suggested the ability to express the phenotype most suited to the encountered environment is selected because it allows individuals to cope with environmental variability. They use the evolutionary framework of r and K selection, originally developed to explain variability between species in the partitioning of effort between mating and reproduction, but they apply it to explain variability within humans.

R-selected species and/or individuals are threatened by rapid change or disasters that could destroy populations. These individuals evolve in unstable environments. They adopt the strategy of early maturation, a high rate of reproduction, and reduced parental care. Draper & Belsky (1990) hypothesized that insecurely attached females develop in a stressful environment, perceive others as untrustworthy and self serving, and adopt a short-term r-selected strategy of unrestricted sexual behavior due to the belief that others can't be counted on in the long run. In partial tests of this model, father absence (Doughty & Rodgers, 2000) and parental conflict (Moffit, Caspi, Belsky, & Silva, 1992) have predicted an earlier age at menarche, giving support to the earlier maturation component of Draper & Belsky's theory. Using this interpretation of r-K theory, an r-selected strategy also corresponds to Geronimus' (1991) weathering hypothesis, which

explains early nonmarital childbearing as an adaptive response of impoverished women to an environment where needed resources to support offspring are limited to the teen and early adult years.

On the other hand, K-selected individuals evolve in stable, densely populated environments and efficiently use resources by adopting a strategy of lower fertility, delayed maturation and greater parental care. Securely attached females adopt a K-selected strategy, anticipating enduring, close relationships. Again, both the motivational cues and the relationship strategies emerge from childhood experiences.

Draper and Belsky's r-K theory suggests that humans have been selected to desire (or not) enduring pair-bonds depending on the environment. In contrast, Attachment Fertility Theory (Zeifman & Hazan, 1997) posits that humans have been adapted to desire pair-bonds regardless of the context in which they develop. Throughout most of history, high paternal investment in small, closely attached hunter-gatherer groups was critical to survival, mating, and care of offspring (Miller & Fishkin, 1997). Only with the advent of agricultural societies (accounting for less than 1% of human evolutionary history), which supported larger human groups, could caregiving be assumed by non-parents. Thus, it is doubtful that short-term patterns of bonding could have been selected. To test this model, Miller & Fishkin (1997) predicted that securely attached men and women prefer only one or two romantic partners over a period of 20-30 years from age 18. Previous work by Buss & Schmitt (1993) found men desired an average of sixty-four partners over this period and women desired approximately three. Miller & Fishkin replicated their study, getting the same results, but they offered revised interpretations based on inspection of skewness. When medians were examined, men and women

desired one partner over that period of time. Only poor paternal caregiving and poor attachment predicted seeking short-term relationships. Miller & Fishkin suggested that the increased variability in paternal caregiving in agricultural society created the differences in childrens' social environments, resulting in the potential for insecure relationships with less responsive caregivers. This, in turn, influenced later sexual strategies. They explained the tendency to seek out short-term relationships as a result of failure to interface with the social environment for which humans have been adapted. Zeifman and Hazen (1997) hypothesized that if attachments are biologically-based, irrepressible needs, children will repeatedly attempt to satisfy them elsewhere if unmet by parents. They found that full attachments to peers were rare for adolescents securely attached to parents but common for adolescents insecurely attached to parents.

Alternative Strategy Models

Alternative strategy models explain differences in patterns of reproductive behavior as either due to genetically-based frequency-dependent selection or due to heritable variation in the calibration or threshold of a species-typical psychological mechanism (Buss, 1991). To demonstrate a genetic basis of reproductive behavior, behavior genetic methods would show the following characteristics described by Buss (1991): 1) Individual differences are heritable. 2) If the strategies are heritable, we would expect to find for each strategy a range of personality variables (such as those associated with restricted sexual behavior and those associated with unrestricted sexual behavior) that covary in an organized manner and in a way that fills some criteria for adaptation. 3) If a bimodal distribution of personality characteristics related to restricted

and unrestricted strategies exists, the alternatives would suggest evidence of frequency-dependent selection.

Gangestad and Simpson (1990) explained that frequency-dependent selection operates to maintain genetic variation in a population when the fitnesses of different genotypes, such as those for different reproductive strategies, vary as a function of their frequencies. If the two genotypes each have fitnesses that are frequency dependent, such that the fitness of each when rare exceeds that of the other, a stable polymorphism can result for frequencies that give equal fitnesses for the two genotypes. Because individuals adopting the same mating strategy compete the most for resources (mates), diversity in mating strategies can be maintained through frequency dependent selection to allow effective competition for resources. 4) If the personality distribution is continuous, this predicts moderate heritability and suggests that the adaptive significance for some strategies has fluctuated over time or place. The differences in threshold setting for a reproductive strategy may signify that past environments or niches had different adaptational requirements. A review of research supporting alternative strategies in reproductive behavior follows.

Snyder, Simpson, & Gangestad (1986) suggested that a specific genetic component underlies differences in mating strategies and proposed two mating strategies that parallel the restricted and unrestricted sexual orientations proposed by Draper and Belsky (1990): high self monitoring and low self monitoring. The high self monitoring style corresponds to an unrestricted sexual orientation favoring liberal sexual attitudes and behaviors while the low self monitoring style corresponds to a restricted sexual orientation, expressing more conservative sexual attitudes and behaviors. Individuals

with high self monitoring have been compared to actors. They are able to control their expressive behavior in a way that conceals their true motives and use their ability to draw attention and status to themselves. These individuals are noted to show weaker emotional attachments and have more sexual partners. Individuals with low self monitoring are less likely to control their behavior to gain social attention and status, and find it difficult to engage in casual sex. Evidence for a genetic predisposition toward these strategies came from twin correlations that found DZ twins 74% concordant and MZ twins nearly 100% concordant on an indicator of self monitoring (Gangestad & Simpson, 1993).

Gangestad & Simpson (1990) found that sociosexuality, a measure of differences in individuals' prerequisites to entering a sexual relationship such as time, psychological closeness, attachment, and commitment, was related to the personality dimensions of extraversion and lack of constraint through genetic variance that measures of these traits share. Further, they suggested that genetic variance for different mating strategies for *females* could have been maintained in the population through frequency dependent selection. They also presented evidence of the existance of two strategies in the population by demonstrating that a bimodal distribution of sociosexuality exists.

Rowe, Vzsonyi, & Figueredo (1997) examined whether mating effort in adolescent males, the acquisition of mates and guarding of mates from other males, is a conditional as opposed to an alternative strategy. A conditional strategy predicts that social failure, which was measured as school and interpersonal problems, is the environmental cue that determines high mating effort, and that mating effort will not be a familial trait. Social failure was not supported as an environmental cue for high mating effort and mating effort was correlated with siblings' measures of mating effort and of

delinquency. This study did not establish whether shared environmental influences, shared genes, or both explain the similarity in siblings' mating effort, although given previous findings in the behavior genetic literature of limited shared environmental influences, it gives greater support for an alternative strategy explanation of adolescent's mating effort. Other research has demonstrated a heritable predisposition for delinquent behavior (Rodgers, Buster, & Rowe, 2000). Correlations of mating effort and delinquency may reflect shared genetic variance for mating effort and delinquency, and should be further examined.

One study used behavior genetic methods to concurrently test a conditional and alternative strategy theory of pubertal development (Rowe, 2000). Heritable influences on age at menarche and on pubertal timing were found, with no significant shared family environment effect, giving support to an alternative model of pubertal development. However, measures suggestive of family stability and attachment, living with two parents, and perceived parental warmth were shown to be associated with delayed pubertal maturation, consistent with the conditional strategy view. No shared genetic variance for warmth and pubertal timing was found. This study suggests the potential for the coexistance of both genetic and environmental influences on reproduction related behaviors, which may be linked to later mating and fertility patterns.

Limitations of current theory and suggestions for future research

The conditional and alternative models suggested that attachment and paternal caregiving play a role in the adoption of different reproductive strategies. A problem with purely environmental interpretations of the results, however, is that these theories do not take into account the fact that genetic variability is already known to exist in

reproduction related behaviors such as timing of puberty (Rowe, 2000), menarche (Doughty & Rodgers, 2000), age at first intercourse (Dunne, et al, 1998; Rodgers, Rowe, & Buster, 1999), childbearing desires, expectations, and intentions (Miller, Pasta, MacMurray, Muhleman, & Comings, 2000; Rodgers & Doughty, 2000), age at first attempt to become pregnant (Rodgers, Kohler, Kyvik, & Christensen, 2000), family size (Rodgers & Doughty, 2000), and possibly constellations of problem behaviors in adolescents that include risky and early sexual behavior (Rowe, Vzsonyi, & Figueredo, 1997). Other research on the neurobiology of bonding behavior in animals (Insel, 1997), and affiliation and nurturance in humans (Miller, Pasta, MacMurray, Muhleman, & Comings, 2000) have also suggested the existance of possible heritable influences on sexual bonding in humans.

Further research into the mechanisms underlying reproductive strategies will need to consider the contribution of both environmentally contingent and genetically driven influences. Neither an alternative strategy nor a conditional strategy model alone appears sufficient to explain variability in reproductive behavior. A behavior genetic design provides a natural methodological setting in which to continue this type of research.

The present study has several goals. 1) It will attempt to replicate previous findings suggesting that attachment plays an important role in the development of attitudes toward sexual relationships and childbearing, and that these attitudes are related to behavioral outcomes. 2) It will extend previous research by attempting to demonstrate that there are genetic differences between individuals that also influence their attachments, attitudes, and behaviors, and that may better account for the differences in observed strategies of mating than a conditional model alone. 3) It is predicted that

behavioral genetic methods will show that both genetic (alternative model) and environmental (conditional model) influences are important in the development of mating preferences. Further, behavioral genetic modeling can quantify the degree to which each process (genetic, shared environment, and nonshared environment) contributes to individual differences to be directly measured. 4) It is hypothesized that more selection for long-term attachments has occurred, those individuals with phenotypes associated with an unrestricted short-term reproductive strategy will show a relatively greater contribution of shared environmental influences than those with phenotypes associated with a restricted long-term reproductive strategy, as demonstrated by separate analyses of extreme high and low scorers on measures of sexual and reproductive attitudes and behaviors. 5) Finally, this study will also determine if there is common shared genetic influence on attachments, attitudes, and behavioral outcomes in mating.

METHOD

Data

The data came from the National Longitudinal Study of Adolescent Health (AddHealth), which has three components: 1) The *school sample* is a stratified, random sample of all high schools in the U.S. A school was eligible for the sample if it included an 11th grade and had a minimum enrollment of 30 students. A feeder school (that which sent graduates to the high school and included a 7th grade) was also recruited from the community. More than 90,000 in-school questionnaires from 80 pairs of schools were completed by 7th-12th grade adolescents between September 1994 and April 1995. 2) All students listed on a school roster were eligible for selection into the *in-home sample*. Students at each school were stratified by grade and sex and randomly chosen from each

strata. A total of 12,105 adolescents were interviewed between April and December 1995. The interviews were repeated in a second round by 15,000 adolescents from April through August 1996. A parent in each residence, preferably the mother, also completed an interview. 3) A *genetic sample* consisting of pairs of siblings residing in the same household allowed construction of kinship links for behavior genetic analyses, making possible the distinction between parental social and genetic influences as well as the extent that important environmental influences are shared or not shared among siblings. The genetic sample included 289 identical and 452 fraternal twin pairs, 43 twin pairs of uncertain zygosity, 1251 full sibling pairs, 442 half sibling pairs, 201 cousin pairs, and 408 step sibling and unrelated pairs. This genetic sample will provide the basis for the current research.

Design

Studying the complexity of adolescent mating behaviors requires that the effects of many genes as well as environmental factors be taken into account. Phenotypic differences or similarities between individuals can be due to either or both genetic and environmental differences or similarities. Behavior genetic methods (which will be described later) have the ability to quantify the proportion of phenotypic variance accounted for by genetic and environmental factors.

When genetic influences on a trait are important, more highly related individuals residing in the same family show more phenotypic similarity on the trait than less related individuals. This similarity has been studied in the context of twin designs. When genetic influences are important, identical (MZ) twins will be more similar (correlate more highly) on a trait than fraternal (DZ) twins. When genetic influences are not

important, MZ twins are no more similar than DZ twins on the trait. Identical twins are 100% genetically related, while fraternal twins have an average degree of genetic relatedness of 50%. The proportion of phenotypic variance explained by genetic factors on a trait (the heritability) is estimated by doubling the difference between MZ and DZ twin correlations on that trait (Plomin, 1991). The remaining variance is accounted for by environmental factors and the error component. Three assumptions of behavior genetic designs need to be met to provide legitimate estimates of heritability: equal shared environments, little assortative mating, and additive genetic effects (although non-additivity caused by dominance effects can also be estimated). In attempting to model mating patterns in the population of U.S. adolescents, the resemblance of twin pairs may not be representative of that in the population. Twins may differ from less genetically related siblings in the general population by differential treatment from parents and non-family members. Twins also may encounter substantially less non-shared environmental influences than non-twins. Inclusion of the large number of other kin pair types available in the AddHealth survey increased ecological validity by allowing simultaneous analyses of the many different family structures present in the U.S. population, which also may play an important role in the adoption of different mating strategies. A mixed family design would include the following R coefficients of genetic relatedness (where R measures the average proportion of shared genes): R=1.0 for identical twins, R=0.5 for fraternal twins and full siblings, R=0.25 for half siblings, R=0.125 for cousins, and R=0 for step-siblings and unrelated pairs.

One problem with the inclusion of sibling pairs other than twins is the difference in ages among pairs. For example, an older member of the pair may report a recent onset

of sexual risk taking behaviors while the younger sibling who may also be predisposed to engage in similar behavior has not reached the age of potential onset. The method used to deal with the problem of censored data in the AddHealth data set was to age adjust by including the difference in ages of the kin pairs as an independent variable in the regression equation (Rodgers, Rowe, & Li, 1994). That is, the effect of the age space between kin pairs (which would indicate whether pairs more close in age were more similar and whether older members of the pairs were different from younger members) was evaluated as an independent variable in the regression equations for all analyses. No effect of age differences was found for any of the analyses, so the models in this study are reported without this parameter (to increase power to detect genetic and shared environmental effects). Other options such as restricting the range of analyses to certain age intervals such as 13-15 and 16-18, or age matching of siblings who are only one year apart between wave I and wave II were not performed due to inadequate sample sizes for behavior genetic analyses.

Measures

For this study, multiple measures were selected to evaluate the tendency toward pair-bonding and attachment, family household stability, attitudes toward sexual risk taking, and sexual and romantic behaviors. Gender differences were assessed in each analysis. Three types of gender analyses were performed: 1) a test of whether opposite sex kin pairs differed from same sex kin pairs (this was not significant in any of the analyses), 2) a test of differential genetic and environmental etiology as a function of gender for the full genetic sample, and 3) separate analyses on male-male and female-female pairs. As prepubertal intercourse is rare, an attempt was made to exclude

prepubertal adolescents from the analyses by using age at menarche as an indicator of puberty. The modal age for onset of menarche in the genetic sample was 12 (N = 873 , 31%), with 30% of the genetic sample reporting menarcheal onset before age 12. Therefore, a criterion for inclusion in the analyses was set at present age of 12 or older for females. Males from age 12 were included to make comparisons between males and females in the same age range. This criterion excluded less than 1% of the sample. Additionally, adolescents who reported an age of first intercourse younger than age 12 were not included in the analyses. In the analyses concerning number of sex partners, those adolescents who reported more than 20 partners had their number of partners scored as 20.

Variables used in the analyses.

All variables used in the analyses are shown in Table 1 with response frequencies for the full genetic sample and the distribution of responses for males and for females in the genetic sample. The pattern of responses did not differ substantially from those of the full AddHealth sample, which are not included in the table.

Bonding/Attachment Measures.

The selected attachment measures are for the person the adolescent identified as a mother or father to him/her at the time of the interview and includes both biological and non-biological parents. The attachment measures included the adolescents' perceptions of parents' feelings about them, adolescents' feelings of closeness toward parents, and combined measures of adolescent perceptions of the parents' feelings about them with their feelings towards parents (see Table 1).

Sexual Behavior Attitudes.

The attitude measures (see Table 1) focus on self control and responsibility in regards to birth control, how having sexual intercourse as an adolescent will affect the relationship with the partner, consequences of adolescent pregnancy, the role of commitment to the relationship on timing of intercourse, and willingness to choose non-marital childbearing as an option. Attitude toward non-marital childbearing was measured as a binary variable. Probit analyses would be more suitable for analyzing binary outcome variables than the least-squares regression analyses that were used in the present study (see Kohler & Rodgers, 1999). Therefore, for this variable, only kin pair correlations by level of genetic relatedness were analyzed.

Sexual Behavior Outcomes.

Behavioral outcome variables (see Table 1) included level of commitment to the relationship at the time of first intercourse, age at first intercourse, and the number of sex partners.

Analyses

Distributional Analysis.

Frequency distributions of scores (see Table 1) on the attachment, attitude, and behavior measures were constructed. These were assessed visually for bimodality.

Kinship Correlations

Correlations by level of sibling relationship were computed for each individual item in the scales and for each total scale score. If genetic influences are important, correlations would increase with increased genetic relatedness. If environmental

influences are important, a significant correlation between kinship pairs would be observed beyond that related to genetic similarity.

DF Analysis

The regression model developed by DeFries and Fulker (1985) allows simultaneous testing of both genetic and environmental influences by using scores from multiple levels of kinship pairs to provide parameter estimates of heritability (h^2), shared environmental variation (c^2), and a combination of nonshared environmental variation and measurement error.

Scores for each kinship pair were entered into the following regression model:

$$SV_1=b_0 + b_1SV_2 + b_2R + b_3(SV_2*R) + e \quad (1)$$

where SV_1 and SV_2 are the measures of the sexual attitude or behavior variables, attachment measures represented by the individual items of the scales, or the total score on the scale for the two members of the kinship pair. R is the coefficient of genetic relatedness, the b's are least squares regression coefficients, and e is the error or residual. Within the assumptions of the model, an unbiased estimate of additive genetic influence, or narrow-sense heritability (h^2) was provided by b_3, an unbiased estimate of shared environmental influences (c^2) was provided by b_1, and e was the residual containing variance due to the nonshared environment and measurement error (e.g., Rodgers & McGue, 1994). This model is referred to as the ACE model, with A referring to the additive genetic variance, C referring to the common (shared) environmental variance, and E referring to the nonshared environmental variance and error. If the h^2 or c^2 estimates were not significantly different from zero, that part of the model was dropped, increasing power to estimate the other parameter. For example, if behavior genetic

analyses find no influence of shared environment (a nonsignificant b_1), the c^2 term (b_1SV_2) is dropped and the model re-estimated, improving the power of the test of the estimate of h^2. Likewise, when genetic influence is not significant, the h^2 term ($b_3(SV_2*R)$) is dropped and the model re-estimated, improving the power of the test of the estimate of c^2. When the c^2 term is dropped, this model is referred to as the AE model. When the h^2 term is dropped, the model is referred to as the CE model.

If there were no significant shared environmental influences, an estimate of non-additive genetic influence associated with dominance (d^2) was tested (Waller, 1994). Dominance refers to the interaction of alleles at the same loci. Dominance effects were measured using the following model:

$$SV_1=b_0 + b_4R + b_5(SV_2*R) + b_6 (SV_2*D)+ e \qquad (2)$$

where b_5 estimates h^2, b_6 estimates d^2, and $b_5 + b_6$ estimates broad-sense heritability. The coefficient of dominance-relatedness, D, was 1.0 for MZ twins, 0.25 for DZ twins and full siblings, and zero for all other levels of kin relatedness. This model is referred to as the ADE model.

As neither member of the kinship pair was selected on the measure of the sexual attitude, behavior, or attachment variable, the data were double entered so that each member of the kin pair was entered in the equation twice, (in other words, the first member of the pair's sexual attitude, behavior, or attachment variable was entered as SV_1 and the second member's sexual attitude, behavior, or attachment variable as SV_2. Then, the second member's sexual attitude, behavior, or attachment variable was entered as SV_1 and the first member's sexual attitude, behavior, or attachment variable as SV_2). Standard

errors and conservative tests of significance were computed by adjusting the sample size back to the number of pairs.

The following extension presented by Rodgers, Rowe, and Li (1994) was used to test for nonshared environmental influences with a signed difference score between members of the kinship pairs for the environmental measure indicated by ENDIF:

$$SV_1 = b_0 + b_7SV_2 + b_8R + b_9(SV_2*R) + b_{10}ENDIF + e. \quad (3)$$

The specific environmental variables tested were the individual attachment items for obtaining the parameter estimates for the attitude and behavioral outcomes, and attachment and attitude items for predicting the parameter estimates for behavioral outcomes. The difference in the kin pairs' scores on these variables were entered as ENDIF in equation 3. The difference in kin pairs' age and gender (1 or 0) was also tested as an environmental difference variable. To test for differential genetic influence as a function of gender, the following extention was fit (DeFries & Gillis, 1993):

$$SV_1 = b_0 + b_{11}SV_2 + b_{12}R + b_{13}S_2 + b_{14}(SV_2*S_2) + b_{15}(R*S_2) \quad (4)$$

S referred to the second member of the kin pair's gender (coded 1 for males and 2 for females), b_{14} tested for differential shared environmental resemblance and b_{15} for differential genetic influence as a function of gender.

The conditional and alternative strategies models propose that phenotypic variance in the adolescent's behavioral outcomes such as number of sexual partners is shared with prior outcomes such as developing the perception that parents don't care about them. The heritabilities across these domains are not directly comparable because heritability is defined as the proportion of phenotypic variance associated with genetic influence, and the same amount of genetic influence appears greater in relation to large

phenotypic variance than small phenotypic variance. Houle (1992) proposed a more interpretable measure for comparing additive genetic variance across traits using the coefficient of variation (CV_a):

$$CV_a = (100\sqrt{V_a}) / M = (100\sqrt{V_p}\sqrt{h^2}) /M = (100\ S\ h) / M, \quad (5)$$

where CV_a is the coefficient of genetic variation, V_a is additive genetic variance, V_p is phenotypic variance, M is the trait mean and S is the trait standard deviation. CV_a values were computed for each of the variables for comparison across variables (e.g. Rodgers, Kohler, Kyvik, & Christensen, 2000).

Linking Analyses Between Genetically Mediated Behaviors, Attitudes, and Attachments

Cross trait correlations by level of sibling relationship were computed to determine common genetic effects between attachment, attitudes, and behaviors. If the genes affecting a measure of attachment/bonding are the same as those affecting a measure of restricted/unrestricted sexual attitudes or behaviors, the correlations should increase as genetic relatedness increases. Cross-trait DF analyses can then be run using the following models derived from equation 1:

$$\text{Sexual attitude}_1 = b_0 + b_1\text{Attachment}_2 + b_2R + b_3(\text{Attachment}_2{*}R) + e$$

$$\text{Sexual behavior}_1 = b_0 + b_1\text{Sexual attitude}_2 + b_2R + b_3(\text{Sexual attitude}_2{*}R) + e$$

$$\text{Sexual behavior}_1 = b_0 + b_1\text{Attachment}_2 + b_2R + b_3(\text{Attachment}_2{*}R) + e$$

Rodgers, Kohler, Kyvik, & Christensen (2000) demonstrated that cross-trait DF analysis provided similar parameter estimates to those obtained using maximum liklihood model fitting.

The assumptions of the DF model are additivity of genetic influences, minimal assortative mating, and equal shared environments across levels of genetic relatedness.

If the additivity assumption has been violated, the c^2 estimates may be slightly negative. Small negative c^2 estimates would suggest that the c^2 term should be dropped from the model because there are no significant shared environmental influences. Alternatively, a dominance model needs to be fit. If nonadditive effects are important, the correlation between DZ twins will be less than one-half the MZ twin correlation. If dominance effects are present and not specified in the model, the narrow sense heritability will be overestimated.

If assortative mating exists, the children receive genes from both parents related to the trait and on average will be more extreme on the trait than would be expected if random mating occurred. The similarity of MZ twins is not affected by assortative mating. Assortative mating increases the DZ twin correlation and will thus decrease the difference in correlations between MZ and DZ twins, decreasing the estimate of h^2. Assortative mating would increase estimates of the shared environment by increasing the similarity between less genetically related kin pairs and decreasing the difference between MZ twin and DZ twin correlations. When assortative mating is suspected, the correlations between parents' scores on the measure should be examined. If the model estimates significant shared environmental influences due to nonassortative mating, the similarity between values for the parents' measures could be controlled for in the regression model by including a difference score between their measures as an independent variable. Inclusion of the parents' difference score on the measure would have the result of decreasing the c^2 estimate.

The equal environments assumption that more related kin do not experience more similar environments than less related kin is questionable. It is possible that more

genetically related pairs resemble each other to a greater extent due to the amount of time they have lived together or due to more similar treatment by parents. It is much less likely that half siblings and unrelated pairs would resemble each other on environmental measures. In twin studies, more similar treatment of MZ twins than DZ twins would artificially increase estimates of heritability and underestimate the influence of shared environment. Violations of the equal environments assumption could be tested by comparing the DZ twin correlations and full sibling correlations. If DZ twins are more similar, due to spending more of their life together than full siblings, the DZ twin correlations would be greater. If the equal environments assumption has not been violated, DZ twin correlations and full sibling correlations should be similar due to the same genetic similarity on average. If c^2 is not the same for every level of genetic relatedness, c^2 is the estimate of average environmental influences over the different levels of genetic relatedness. How kin levels contribute differentially in the estimate of c^2 could be evaluated by dropping each level from the model one at a time, and refitting the equation (see Rodgers & McGue, 1994).

Some researchers have raised concern that dropping the c^2 term from the ADE model and re-estimating an AE model could result in a misspecification bias (see Pasta & Miller, 2000). They point out that if shared environmental influences are importat in the true model but do not reach significance in the tested sample, the ommission of the c^2 term would lead to artificially lower standard errors and overestimation of h^2. When the c^2 term has been dropped an ADE model should be evaluated first to rule out the presence of dominance genetic variance. For the present sample, once dominance effects have been ruled out, the number of twin pairs and the multiple levels of kin relatedness should

provide sufficient power to detect small c^2 effects of practical significance if these exist for the uncensored variables. As prior behavior genetic research has provided little evidence of significant shared environmental influences (see Rowe, 1994), dropping the c^2 term when it is not significant is more likely to provide greater precision in the estimate of h^2.

RESULTS

Distributional analyses for the full sample and by gender

Table 1 shows the distribution of responses for each variable tested in the analyses. The distributions for all the variables are highly skewed. The distributions for the attachment measures are all skewed in the direction of feeling loved and wanted and reporting the presence of parental warmth and closeness. Only 1 – 7% reported poor parental warmth and closeness, depending on the measure. The attitude measures regarding birth control were obtained only for participants that were at least 15 years old. The distributions for the attitude measures pertaining to birth control were similar for males and females and indicated that approximately 34% of the sample did not feel sure about their ability to use birth control once aroused and 30% did not feel it was easy enough to use it. About 16% of the males thought they would be more attractive to women if they had sexual intercourse, compared to about 5% of the females who thought having intercourse would make them more attractive to males. Slightly more females than males reported that getting pregnant / getting someone pregnant at this time in their life would not be all that bad (10% of females, 7% of males) and that getting pregnant / getting someone pregnant would not be one of the worst things that could happen to them (9% of females, 6% of males). Non-marital childbearing was an option that 21% of

males and 27% of females reported they would consider. Approximately 36% of the sample reported they would have sexual intercourse in their ideal romantic relationship and 24% reported having intercourse in a romantic or nonromantic relationship on the commitment to partner before having sexual intercourse scale (37% of males and 34% of females reported having had sexual intercourse to a yes/no inquiry). The majority of sexually active adolescents reported that they had spent some time with and were emotionally committed to their partners before having had sexual intercourse. The distribution of when intercourse occurred relative to other events in the relationship is shown in figure 1. Males and females did not differ on mean commitment scores (ES = .15). The distribution of age at first intercourse is shown in figure 2. The average age at first intercourse was 15.3 $\pm$ 2.2. On average, females were 6 months older than males on mean age of first intercourse (ES = .23). The distribution of number of sex partners is shown in figure 3. Although males reported more partners (M = 1.25 $\pm$ 3.18) than females (M = 0.76 $\pm$ 2.20), the mean number of partners was not significantly different (ES = .18). The distributions were similar for males and females (73% of males and 80% of females had no sex partners reported).

Kinship correlations and DF analysis

Full sample

Attachment. Descriptive statistics are shown in Table 2 for the full genetic sample and by gender for the attachment measures, which included adolescents' perceptions of parents feelings about them, adolescents' feelings of closeness toward parents, and combined measures of adolescent perceptions of the parents' feelings about them with their feelings towards parents. Table 3 shows the kinship correlations for the attachment

measures by level of genetic relatedness and Table 4 shows the parameter estimates for h^2 and c^2. No significant dominance (d^2) effects were found for any models tested in the study. Adolescents' perceptions about how the parent feels about them showed low to moderate heritabilities (feel loved and wanted, $h^2 = .30$). H^2 was slightly higher for fathers (dad warm and loving, $h^2 = .34$, how much he cares, $h^2 = .32$) than for mothers (mom warm and loving, $h^2 = .29$, how much she cares, $h^2 = .28$). These perceptions showed small influences of the shared environment in relation to fathers (dad warm and loving, $c^2 = .10$, how much he cares, $c^2 = .09$) but none for mothers. Of the variance in perceptions of how much parents care about them 59% was attributed to influences in the nonshared environment and measurement error for fathers and over 70% for mothers. These nonshared environmental influences can also include differential parental treatment within the family.

Half the variance (50%) in feeling close to fathers was attributed to genetic variance and 43% of the variance in feeling close to mothers was attributed to genetic variance, with the remaining variance explained by nonshared environmental influences and measurement error. For the combined measures, the father attachment scale (fscale) had an h^2 of .46 and c^2 of .10, while the mother attachment scale (mscale) had an h^2 of .71 with no significant shared environmental influence. The CV_a values were low for measures of how much parents cared (5.81 – 7.89), moderate for how close the adolescent felt toward them (11.78 – 15.97), and even higher for adolescents' perception of how warm and loving the parents were and how much they felt loved and wanted (23.03 – 28.07), indicating increasing sources of genetic influences respectively.

Attitudes. The attitude measures (see Tables 5 and 6) measured self control and responsibility in regards to birth control, how the participant believed having sexual intercourse would affect the relationship with the partner, consequences of adolescent pregnancy and level of commitment desired before having sexual intercourse with a partner. Moderate heritabilities (range of h^2 = .17 - .54) with no influence of the shared environment were found for all of these measures with the exception of the attitudes that getting pregnant / getting someone pregnant at this time in their life is one of the worst things that could happen to them (h^2 = .17, c^2 = .11), and that it would not be all that bad if you got pregnant/got someone pregnant at this time in your life, which showed no significant genetic influence and moderate shared environmental influence (c^2 = .18). Kinship correlations for this variable across increasing levels of genetic relatedness did not show a pattern consistent with genetic influence. The heritability of the binary attitude toward nonmarital childbearing variable was estimated by doubling the MZ – DZ difference in correlations. The heritablility for this measure was estimated as .36.

The ability to exercise enough self control to use birth control once highly aroused, the degree to which getting pregnant / getting someone pregnant would be one of the worst things that could happen at this time in your life, and the desired level of commitment before having sexual intercourse in a relationship had higher genetic variances (range of CV_a's 24.50 – 47.31) relative to other attitude measures, suggesting more sources of genetic influence on these measures. The extreme skewness of the desired commitment before having sexual intercourse variable contributes to the high CV_a value.

Behavioral Outcomes. Tables 7 and 8 show the kinship correlations and parameter estimates for the behavioral outcome measures. Both age at first intercourse and time/commitment to the relationship when intercourse occurred showed moderate heritabilities (h^2 = .36 and .31 respectively) with no shared environmental influence. There was greater genetic variance for when intercourse occurred in the relationship (CV_a = 40.68) than for age at first intercourse (CV_a = 8.51). The large coefficient of variation for commitment to the relationship when intercourse occurred is most likely due to the highly skewed distribution of scores relative to the mean. The total number of sexual partners had a small heritability, small shared environmental influence (h^2 = .15, c^2 = .07), and a high value for genetic variance (CV_a = 96.25) due to the extreme skewness of the distribution.

Analysis of gender differences

Attachment. Separate models for males and females gave similar estimates of genetic variance for all attachment measures (see Tables 10 and 12) except for the perception of how warm and loving their mother was. This variable did not show significant genetic variance for males, while 21% of phenotypic variance was attributable to the shared environment. Both males and females showed moderate shared environmental influences on how warm and loving their father was perceived to be and for females, the shared environment also accounted for a moderate amount of variability in how close they felt toward their fathers (c^2 = .15). The small sample size for each gender decreased power to detect the magnitude of genetic and shared environmental differences. There were no significant gender differences on attachment scores when controlling for gender differences in the df model for the full sample (equations 3 and 4).

Attitudes. Males and females evidenced different patterns of influence on attitudes (see Tables 14 and 16). Males showed significant genetic influence ($h^2 = .18$) on the attitude they could stop and use birth control once they were highly aroused and no shared environmental influence, while females showed no significant genetic influence and did show small shared environmental influence ($c^2 = .10$). Males showed significant genetic influence on desired level of commitment to a relationship before having sexual intercourse ($h^2 = .51$) and no shared environmental influence, while females showed the opposite pattern ($c^2 = .54$). Females showed moderate genetic influence on variation in believing if they had sexual intercourse they would be more attractive to men ($h^2 = .18$) and that it is too much hassel to use birth control ($h^2 = .36$). The remaining attitudes for females showed no genetic influence but moderate shared environmental influences ($c^2 = .22 - .28$). Males showed significant shared environmental influence in the CE model also on most measures. Note that unequal n's and smaller n's for levels of kin relatedness may be responsible for correlations between h^2 and c^2 values and differences between males and females. When the DF model controlling for gender differences (equation 5) was tested for the full sample, the c^2 estimate as a function of gender was significant for desired commitment to a relationship before sexual intercourse (c^2 x gender = .17, se = .09, $t(584) = 1.92$, $p = .0274$). Only the analysis for females gave a significant c^2 value. The h^2 value as a function of gender was significant for the attitude that having sexual intercourse would make one more attractive (h^2 x gender = .31, se = .18, $t(1624) = 1.73$, $p = .0418$). The analysis for females suggested a stronger role of genetic influence on this variable, while the analysis for males was less clear.

Behavioral outcomes. Both males and females evidenced moderate heritabilities for level of commitment desired before having sexual intercourse in a relationship, age at first intercourse, and the number of sexual partners. Although there was no influence of shared environment on number of sex partners for females in the ACE model, shared environmental influences were suggested for males (although correlated with genetic influence) as found in estimates for the full model. The smaller sample sizes, censored nature of the data, and skewness of the distribution of scores for commitment before having sexual intercourse and for number of sexual partners decrease confidence in the estimates (note for example, very large CV_a estimates for number of sexual partners).

Linking Analyses

An attempt was made to test for common genetic variance and common shared environmental variance between behavioral outcomes and attitudes, behavioral outcomes and attachments, and between attitudes and attachments, by examining kinship correlations and deriving parameter estimates with DF analysis after each variable had been standardized. These analyses did not lead to any interpretable results. Examination of the intercorrelations between the measures of interest in the linking analyses for the genetic sample and for the full AddHealth sample did not reveal any significant relationships. That is, the correlations between attachments and attitudes, attachments and behaviors, and attitudes and behaviors were not significant.

Between group analyses

Many participants were not included in the correlational analyses due to censoring on the behavioral outcome variables, ie the analyses were disproportionately restricted to those who engaged in the behaviors at younger ages. In an attempt to overcome the

censoring problem and determine whether differences existed on the attachment and attitude measures between participants who had had sexual intercourse (suggesting a short-term strategy) and those who had not had intercourse by their senior year (more likely to be pursuing a long-term strategy), two groups were formed for comparison. All adolescents who had reported an age of first intercourse were included in one group (N = 2747) and all adolescents who had not had intercourse and were 17 or older (N = 3103) were included in the other group. Effect sizes (ES) for differences in group means were computed on each attachment and attitude variable. Adolescents who had not had intercourse had significantly higher mean scores on their perception of how warm and loving their mother (ES = .26) and father (ES = .29) was. They scored lower on the belief that having sexual intercourse would make them more attractive (ES = .20) and higher on the belief that their partner would lose respect for them (ES = .49) if they had sexual intercourse. This group also scored higher than the adolescents having intercourse on the belief that getting pregnant / getting someone pregnant at this time in their life is one of the worst things that could happen to them (ES = .22), lower on the belief that getting pregnant / getting someone pregnant would not be all that bad (ES = .32), and lower on considering nonmarital childbearing as an option for themselves (ES = .45). Although the differences in means were statistically significant between the two groups for the remaining measures, the effect sizes were less than .2 for how much they believed each parent cared, how close they were to each parent, if they could use birth control once aroused, whether birth control was too much hassel, and the ideal time in a relationship to have sexual intercourse. For the full genetic sample, significantly more sex partners were reported by adolescents who did not perceive their father as warm and loving (ES = .21)

or caring (ES = .24), were not close to their mothers (ES = .31), felt having sexual intercourse made them more attractive to their partner (ES = .31), and would consider having a child as an unmarried person (ES = .33). Adolescents of never married mothers were more likely than adolescents with mothers who had been married once to believe getting pregnant / getting someone pregnant at this time would not be so bad (ES = .32). Adolescents were less likely to believe that getting pregnant / getting someone pregnant at this time in their life is one of the worst things that could happen to them if they were not close to their mother (ES = .63) or father (ES = .66) and were more likely to believe getting pregnant / getting someone pregnant at this time in their life would not be so bad if they were not close to their mother (ES = .28) or father (ES = .49).

Testing the equal environments assumption of the DF model

To examine the extent that the kin pairs at different levels of genetic relatedness shared the same environment, one attachment, one attitude, and one behavioral variable was re-analyzed by dropping out one kin category sequentially and re-estimating the ACE model (see Table 21). When DZ twin pairs were dropped from the model, the correlation between full sibling pairs was obtained. When full siblings were dropped from the model the correlation for DZ twins was obtained. The DZ and full sibling correlations were compared to determine whether they showed similar or different environments.

For the attachment variable "close to dad," the c^2 estimates were similar for each level of relatedness, except when unrelated pairs were dropped (range of c^2 was .03 to .06 with unrelated pairs, and c^2 was .11 without unrelated pairs). Unrelated pairs would be the least expected to share similar environments. Dropping the unrelated pairs that were

not correlated with each other left only kin pairs correlated at similar levels from cousins to full siblings and fraternal twins, allowing the c^2 estimate to become significant. The full sibling and fraternal twin correlations were similar, suggestive of similar environments. The pattern of correlations across the levels of genetic relatedness with the exception of unrelated pairs is consistent with that expected for shared environmental influences as well as genetic influence. This pattern of results suggests that the true model may include shared environmental influences on this measure. Alternatively, the same pattern could be found for assortative mating, although that assumption cannot be tested due to the lack of parental measures.

For the attitude variable "getting pregnant / getting someone pregnant at this time in my life would not be so bad," the c^2 estimates were similar across all levels of genetic relatedness except when cousins were dropped (range of c^2 was .17 to .21 with cousins and .07 without cousins). The correlations between cousin pairs were higher than for any other kin pairs. The cousin pairs could have contributed to finding higher estimates of c^2 on this variable than truly exist. The differences in correlations between MZ twins and DZ twin / full sibling pairs suggest genetic influence exists. When cousin pairs were dropped, the h^2 estimate increased substantially, although it did not reach significance. The fraternal twin correlations and full sibling correlations were similar and consistant with equal shared environments. The reason for the zero correlation between half siblings and not for other less related kin pairs is not clear. The results also suggest assortative mating influences on this variable may be present. The true model may include both genetic and shared environmental influence or genetic influence with assortative mating.

The behavior variable "age at first intercourse" was censored, and the number of kin pairs at each level of genetic relatedness was substantially lower than for the analysis of the attachment and attitude variables. The c^2 estimates were the least similar for half siblings and unrelated pairs. These are the two levels that would be expected to have the least environmental similarity. The half sibling correlation was negative. Dropping the half sibling and unrelated pairs had the greatest influence on estimates of h^2. The full sibling correlation and the fraternal twin correlation were different and suggest the equal environments assumption was violated for this variable. For all three measures examined, it appears that there were some violations of the equal environments assumption, particularly for half siblings and unrelated kin pairs.

DISCUSSION

The results of this study supported the prediction that genetic differences between individuals help to explain variation in reproduction related behaviors, attitudes, and even feelings of closeness to parents and of warmth in families. Moderate sized heritabilities were found across nearly all these measures, consistent with the alternative model of reproductive strategy. Small significant effects of the shared environment were found for attachment related to fathers, attitudes regarding the consequences of a pregnancy relative to other possibilities at this time in their life, and the number of sex partners reported. A moderate effect of the shared environment was found for the attitude that getting pregnant at this time would not be all that bad. These findings of environmental influence are consistent with the conditional model of reproductive strategy. However, violations of the equal environments assumption may have resulted in the shared environmental influence being overestimated and genetic influence underestimated. The

difference in MZ twin and DZ/full sibling correlations suggested that genetic influence may exist for this outcome as well. Thus, the results of the behavior genetic analyses supported a second prediction of finding both genetic and environmental influences on these measures to be important and that the degree to which each process was important could be quantified. Other predictions that common shared environmental and genetic influences would be detected to explain the interrelationships between family warmth or bonding, attitudes related to reproductive behavior, and adolescent pair-bonding or sexual behavior were not supported. The inability to detect these relationships with the DF analyses may be more related to weaknesses of the measures and the censored nature of the data than to weaknesses of the theory that links family warmth, attitudes toward reproduction-related behavior, and behavioral outcomes.

The remaining prediction of the study, that differential environmental and genetic contributions exist for a restricted verses unrestricted reproductive strategy could not be fully tested due to sample size limitations and censoring. Other analyses that were attempted to overcome the limitations of the censored data gave additional information to distinguish adolescents pursuing short-term relationships versus delayed sexual behavior. In a comparison of adolescents who had reported having sexual intercourse compared to those who had not at age 17 or older, there were significant differences in perceived parental warmth and expression of love, perceived consequences to the relationship of having sexual intercourse, and attitudes toward adolescent pregnancy and nonmarital childbearing. For the full sample, living with a never married mother versus a mother married once, closeness to the mother or father, and perception of the father being loving and caring, revealed significant differences in the number of sex partners and / or

attitudes toward adolescent pregnancy. The relative influences of environmental and genetic contributions to these outcomes remain to be determined. More detailed discussion of the implications of the findings for the attachment, attitude, and behavior measures is given after the following discussion regarding limitations of the sample, methodology, and measures.

Weaknesses of the study

Due to the censored nature of the data, the results are biased by disproportionately representing adolescents who have made the transition to intercourse at a young age. Adolescents who will transition to first intercourse or additional sex partners at older ages, yet will still be in high school, are not represented in the analyses. This explains the low mean age of 15.3 at first intercourse. Dunn et al, (1997) reported a mean age of first intercourse in an Australian twin sample of 27 – 40 year olds of 18.9. Rodgers, Rowe, & Buster (1999) reported a mean age at first intercourse of 16.7 for U.S. adolescents. Although the mean age at first intercourse in this sample is probably somewhat lower than what the mean of the completed sample will be, it is considerably above that reported for the bottom 15% of the NLSY distribution (M = 13.2) reported by Rodgers et al (1999).

The decreased variability in age at first intercourse and inadequate number of responses on the level of commitment to the relationship when sexual intercourse occurred may account for the absence of significant correlations between the behavior measures and the attachment and attitude measures. For example, the correlations are based disproportionately on those with the attitudes, parental bonding, desired sexual bonding, and sexual behaviors consistent with a short-term strategy. Those without

behavior scores because they had not reached the transition date at the time of the interview, or those with an orientation to long-term relationships and delayed transition after high school are not included in the analyses, resulting in a restricted sample for correlational analyses. It is not known if the parameter estimates obtained for the uncensored kin pairs apply to the kin pairs with censored information. Since similar pairs are more likely to be included than nonsimilar pairs in censored data, the heritability estimates may be biased (see Kohler & Rodgers, 1999).

Some limitations of the DF analysis methodology should be noted. In several of the models tested, small negative c^2 values were obtained, suggesting minor violations of the additive genetic model. Either dominance effects needed to be fit or the model with the c^2 term did not adequately fit the data. When dominance effects were tested, these were nonsignificant. Following, the AE model was tested. The AE models resulted in better fits evidenced by lower standard errors. As Pasta & Miller (2000) caution, dropping the c^2 term because it does not reach significance when the true model includes common environmental effects is a misspecification error and may lead to a biased estimation of the h^2 parameter. However, as significant shared environmental effects are not often found in behavior genetic analyses, dropping the term from the model probably more often resulted in more precise estimates.

Due to the nonorthogonal design (unequal n's at each level of genetic relatedness) correlations between the proband's score and the interaction of genetic relatedness with the proband's score occurred in the tests of the ACE model for each gender. Although parameter estimates for the CE and AE model were compared (see Pasta & Miller, 2000), these results should also be cautiously interpreted. For the DF analysis by gender, the

results obtained in this study were uninterpretable, as in some cases both reduced models were significant, and which model was correct could not be determined. Correlations between terms in the models for the full sample were not as problematic and led to better estimates of genetic and shared environmental influence. Although equal n's at each level of R would have corrected the problem of dependencies between the terms in the model, the present approach, using the n's at each level of R is approximately representative of the school population and gives greater ecological validity to the estimates. Finally, the small number of respondents with current measures on the variable of interest in the genetic sample decreased power for some of the models and made it difficult, if not impossible to conduct analyses by subgroups, or to interpret the findings.

Because the sample is drawn from the school population, high school drop-outs are not represented. This group of adolescents may include those with problem behaviors associated with short-term pair-bonding, unrestricted sexual behaviors, and adolescent pregnancy. As a result, the true incidence of short-term strategies of mating in adolescence is naturally underrepresented in any school based sample.

There are also some limitations of the measures. The desired level of commitment before having sexual intercourse scale was not worded to give adolescents a time range for when the desired relationship would occur. The ideal and actual relationship scales had different items, with more sexual behaviors on the actual than ideal scale. As a result, these scores are not directly comparable. Only those who indicated that sexual intercourse would occur in the ideal relationship (whether as adolescents or adults) were included in the analyses. Those who took that event out of

the description of their ideal relationship could have been included with a score of zero, increasing the sample size for that analysis, but the result would have been even less comparable to the behavioral outcome measure on commitment to the partner before having sexual intercourse. Additionally, the scale may not have accurately measured commitment or emotional bonding to a partner. Some adolescents may act out the role of commitment to obtain short-term sex, while other adolescents may consider practice in sexual relations to be part of the role of dating, to prepare for a future committed relationship, to demonstrate commitment or increase commitment of the partner, or to assess the partner as a potential long-term mate. The measure for the adolescent's attitude toward non-marital childbearing would have been more useful for these analyses if it had been measured on a 5-point scale like the other variables, and not scaled as a binary variable.

There was some discrepancy between self reports of age at first intercourse between waves 1 and 2. The correlation between the two measures was .51 ($p = .0001$). The average of the two reports correlated .89 with the reported age at wave 1 and .92 with the age reported at wave 2. Approximately 66% of the respondents' reports at wave 2 were within 1 year of their reported age at first intercourse at wave 1.

Finally, there were some violations of the equal environments assumption, and possibly violations of the nonassortative mating assumption. Behavior genetic research should test for violations of the assumptions of the models tested and adjust the models as appropriate, as these violations can substantially influence the parameter estimates that are obtained.

Implications of the findings and relationship of the findings to evolutionary theory

The present study provided important information about processes involved in parent – child bonding or warmth. In previous studies, father presence or absence in the home was suggested as a factor distinguishing between males and females who adopt an unrestricted strategy of sexual behavior oriented toward short-term relationships due to an inability to form enduring emotional bonds with others, and those who adopt a restricted strategy oriented toward establishing long-term relationships. These studies can be criticized on several points: the relationship between father absence and subsequent pair-bonding behavior with sexual partners is correlational only (other factors may better explain both father absence and unrestricted sexual behavior); the process by which adolescents adopt one pair-bonding strategy or another was not tested by these theories and may include genetic factors; the studies don't distinguish between children with absent fathers who have warm relationships with them and children who have poor relationships with their fathers whether they reside with them or not. The present study examined multiple measures of family warmth including relationships with absent fathers and non-biological fathers, rather than only presence or absence of a father to estimate the relative importance of genetic, family environmental, and non-shared environmental influences on parent – child attachment.

The results of the analyses on the family attachment measures showed that there are heritable differences in expressed and perceived warmth in families. There were also shared environmental influences on perceptions of expressed warmth of fathers that may be related to whether the father is physically or emotionally present or absent from the adolescent's life, or to personality characteristics of the father such as agreeableness,

which in past research has also shown significant heritability. The perception of how much the parents cared showed the least amount of genetic variance and was explained largely by environmental factors. What constitutes *differences* in parental care or parental investment appears to be defined to a much greater extent by the culture than by genetically influenced traits, suggesting selection pressure for parental care including paternal care resulted in decreased genetic variance in this trait. Genetic variance remaining in the trait could be related to frequency dependent selection or mutation. Psychosocial variables that could predict decreased care could include the parents' relationship with their spouse, financial or job factors, or that the child was the result of an unwanted pregnancy and remains unwanted. If the parent is raising the child alone, most likely the mother, she may have had less time to develop a close relationship with the child.

On the other hand, father absence may not be a psychosocial precursor of the development of a short-term orientation to pair-bonding and parental investment in the child, but a result of shared genes between parents and the child. If the mother has a genetic predisposition to form weaker emotional commitments and mate with more partners, she is more likely to mate with a male with a short-term orientation who will not stay and invest in the rearing of his children. Both parents contribute behaviors and genes encouraging a short-term strategy in their children.

Although common variance between the attachment measures and attitudes and behaviors were not found in these data, other research is being conducted to define the developmental neural substrate underlying bonding. While attachments and sexual behavior occur at different stages of development, are directed to different people, and

can be considered distinct concepts, attachments and sexual behaviors also share certain components and causal mechanisms which overlap with each other as well as with parenting behavior. Miller et al (2000) proposed that adult traits important in parent-child and adult sexual bonding derive from infant and child traits, although the links between them and neurotransmitters involved have not been well defined. The between group analyses in this study suggested that there is a relationship between family closeness or warmth, family structure, and attitudes toward mating relationships, sexual behavior in adolescence, and nonmarital childbearing in adolescence.

How can genetic differences between individuals in forming or maintaining attachments be adaptive? The role of attachments and organized social groups would be to provide protection against predators and increase survival. Individuals who were alone would be more vulnerable. In reasonably stable environments, pair-bonding and increased parental investment helps to increase survival and reproductive success. If in the earlier hunter-gatherer environment, only those who formed long-term attachments with a mate survived and kept their offspring alive long enough to reproduce, then genes contributing to the inability to form bonds with others would have been wiped out of the population. Unattached individuals would have died, and those with the affiliative, protective traits necessary for survival would have reproduced. Survival and reproductive fitness, through the protection of a tightly knit group, would become genetically determined. Eventually variance in reproductive fitness would disappear as predicted by Fisher's theorem. This is the outcome assumed by attachment fertility theory. However, spatial differences in environments could also maintain genetic variation. In environments where climate, predators, disease, or poverty decrease the

likelihood of children and mates surviving (or relationships with mates and children surviving), selective pressure for reproductive success, independent of parental investment would occur. In harsh environments with limited resources and a higher probability of mate and offspring demise, it may be more adaptive to have weaker emotional bonds to parents, children, and successive mates and continue the work of survival by focusing on short-term payoffs, such as quickly resuming mating behavior with a new partner. This type of environment would also favor risk taking traits that have been found to covary with unrestricted sexual behaviors.

In ancestral environments, attitudes or motivations to bear children may have had little influence on mating patterns and sexual behaviors. For attachment behaviors and attitudes to be considered fitness traits, genetic variance in these measures would have to be linked to reproduction related behaviors such as age at first intercourse, timing of intercourse in a relationship, number of sexual partners, and number of children (although this last outcome was not measured in the present study). Although the linking analyses planned for this study did not reveal evidence of shared genetic variance between these measures, the between group analyses did suggest that subgroup mean differences exist. Further analyses of common and unique genetic variance between these traits with structural equations methodology will be possible with the wave 3 data being collected at this time. If the traits are not linked, the genetic variance in each would be due to genetic polymorphisms that have arisen from other evolutionary sources of genetic variation such as mutation, frequency dependent selection, and spatial or temporal variation in environments.

Spatial variation in environments may have required different adaptations during the same time, maintaining genetic variability. As a result, genetic differences in thresholds to engage in short or long-term relationships may exist in response to current environmental conditions. One such source of current environmental influences could be prevailing cultural or familial attitudes toward contraceptive use, consequences of adolescent childbearing and casual sexual behavior.

For this sample, familial influence was important for attitudes regarding childbearing desires or motivation to not have children during adolescence. For females especially, family environment was more important than for males for attitudes about desired commitment to a partner before having sexual intercourse. These attitudes could have been influenced by behavior modeled in the family, and by verbal teaching from parents that would serve to suppress genetic influence in more restrictive homes and release genetic influence in homes where the behavior had already occurred with the parents. These parental attitudes could also be genetically influenced. These influences could be further researched with the AddHealth data on parental attitudes.

Heritability was moderately high for desired commitment in a relationship before having sexual intercourse and low for the remaining attitudes. Nonshared environment and error accounted for 46 – 82% of the total variance in attitudes or expectations regarding measures related to reproductive strategy. The distributions for the attitude measures suggested that the current nonshared environment holds a restrictive view on adolescent pregnancy and consequences of sexual behaviors for most adolescents, somewhat suppressing individual differences related to genetic differences in perceived self restraint and desires. For example, no genetic influence was present for the attitude

that it would not be that bad if they got/got someone pregnant at this time in their life. Shared environmental influences may have come from perceptions of parental or sibling values and behavior, or perceived life options relative to parenting in their environment.

Females showed a significantly higher influence of genes on the attitude that having sexual intercourse would make them more attractive to a partner than males did. This may be a result of greater nonshared environmental messages to males that sexual experience makes them more attractive to females. The set of attitudes having to do with restraint in sexual behavior, responsible use of birth control, and perceived consequences of a pregnancy at this time in their life had larger genetic variances suggestive of multiple heritable traits influencing outcomes. These traits may include impulsivity, childbearing motivation, educational desires, and the influence of mood disorders such as depression. All these variables should be assessed in future research for covariation of genetic influences.

For adolescents of never-married mothers, or from households with less parental warmth, adolescent childbearing was not viewed as negatively by the adolescent, consistent with parental behavior indicating a short-term orientation to pair-bonding and reproduction, perhaps accounting for the significant shared environmental influence that was found.

Similar to the process involved in environmental mediation of phenotypes for attitudes, the influence of genetic variability among individuals on behavior can be suppressed or hidden in more restrictive environments. For example, Dunn et al found no heritability for age at first intercourse for males in a sample of twins who reported age at first intercourse was prior to 1970 and moderate heritability for females (h^2=.32) with

different types of within family and cultural influences for males and females. For a younger cohort that reported age at first intercourse after 1970, a larger decline in shared environmental influence was found for men but not women, indicating shared and nonshared environmental influences on early sexual behavior have changed more rapidly for men than for women. As cultural norms became more relaxed and accepting of a variety of lifestyles and medical innovations are developed that influence fertility outcomes, genetic and psychological characteristics such as childbearing motivation, mood disorders, etc. that previously had no influence on fertility outcomes may be expressed as reproductive fitness traits (see Rodgers et al, 2000 in press).

For the AddHealth sample, increasing choices in modern society allow heritable differences in affiliation, mood, attitudes, personality characteristics such as impulsiveness, conscientiousness, and motivation to bear or not bear children to be expressed. Individuals can exercise choice in reproduction related behaviors on the basis of these differences in bonding, motivation, and personality that are heritable. This could cause age of first intercourse, commitments to relationship partners, and number of partners to increase in heritability because individuals now have the choice to express genetic differences. In environments where choices are available, the choices that are made will express genetic behavioral predispositions (Udry, 2000, Kohler & Christensen 2000).

The release of genetic sources of variation in reproduction related behavioral outcomes was indicated by the findings for age at first intercourse in the AddHealth sample. The analyses for the full genetic sample provided strong evidence for genetic variability in desired level of commitment to a partner before having sexual intercourse,

as well as actual level of commitment to a partner when sexual intercourse occurred in the relationship. Age at first intercourse also demonstrated moderate genetic influence ($h^2 = .36$) in this sample of adolescents who had not all completed the transition to first intercourse that will in middle or high school. Rodgers, Rowe, & Buster (1999) reported an h^2 of .38 for age at first intercourse in the National Longitudinal Survey of Youth, where all respondents were past adolescence and transition information was more complete. Dunne et al (1997) found heritabilities of first intercourse of .72 for males and .49 for females in the Australian Twin Registry who were 27 to 40 years old in 1993.

In this study, age was not significantly correlated with any of the outcome measures. Due to the right censoring of the data, it may have been impossible to detect increasing numbers of adolescents transitioning to first intercourse with increasing age, or to detect a relationship between number of sex partners with age, as the sample is biased toward the data provided by young transitioners and does not have complete information on adolescents who will transition at older ages. On the other hand, age may account for very little variance in these measures relative to heritable influences on personality traits correlated with early sexual behaviors and environmental influences such as the behavior of peers and older siblings. Dunn et al (1997) found that age accounted for only 0.49% of the variance in age at first intercourse for both males and females aged 27 to 40 in 1993. Age effects on timing of first intercourse may be driven by compliance with restrictive environmental norms. Once puberty is reached, heritable differences between individuals may be more salient than age in influencing sexual behaviors where the culture is more permissive.

Few gender differences were found. Unlike earlier studies which find differences in males and females on fertility precursors, males and females in this current adolescent sample were more alike than different, and did not show a difference in age at first intercourse or the number of sexual partners. These findings suggest that cultural differences in prescribed norms for males and females may be decreasing.

For the attachment measures, those concerning perceived and felt warmth and love had the lowest h^2's and highest CV_a's. Houle found that direct fitness components had the highest CV_a's and lowest h^2's. Although the CV_a's for commitment to a relationship may be inflated due to skewness, they may also be consistent with values of h^2 and CV_a for fitness traits. The heritability estimate for age at first intercourse as a fitness component in humans was similar to those found in previous studies. Hughes and Burleson (2000) report average h^2 across 5 studies on age of first intercourse was .39 and the average CV_a was 10.5, consistent with the values in this paper. This is an example of concurrent validity, which increases confidence in other results obtained from this sample.

Conclusion

The results for the present sample indicated there are heritable differences in family warmth, attitudes, and behaviors that may translate to subsequent pair-bonding strategies of adolescents expressed in their attitudes toward contraceptive use, consequences of sexual behavior in a relationship, desired commitment from a relationship partner and sexual behaviors including age at first intercourse and level of commitment to a partner before having sexual intercourse. If no genetic variance had been found for these measures, then the genes controlling reproduction related behaviors

would be the same for everyone and environmental cues would determine what pattern of behavior was expressed. Relationships between parental warmth and pair-bonding patterns and adolescent attitudes and behaviors suggest that a heritable predisposition toward a short-term or long-term reproductive strategy in the parents is transmitted to their children. Not only genetic influences, but family environment also appears to play a role in learning attitudes and behaviors pertaining to the consequences of adolescent pregnancy and to the number of sex partners. Thus, the results of the study support the alternative model of reproductive strategy.

Family environmental influences could themselves be mediated by genetically based predispositions of the parents or response from the parents to genetically influenced behavior from their children. Children may also seek out environments that are in line with their genetic predispositons. Influences from the nonshared environment also play a substantial role in the adoption of a short-term or long-term strategy and may influence phenotypic plasticity independent of family influence. These findings give additional support to previous studies showing nonshared environmental influences on the sexual behavior of adolescents and suggest that family studies should control for genetic influences that may explain why parents and children are alike instead of, or in addition to social learning processes.

Unfortunately, whether some individuals are more susceptible to environmental influences than others can not be tested with current behavior genetic methodology. Heritable differences in susceptibility to the environment (gene-environment interactions) are another means by which variation in humans is maintained. If the culture continues to be more sexually permissive and as new medical innovations affecting contraception

choices and fertility become available, new sources of genetic variability in personality traits will be released to influence reproduction related behaviors, and ultimately fertility outcomes. These personality traits become reproductive fitness traits subject to selection.

For instance, conscientiousness related to birth control would become a fitness trait, and childbearing motivation would become a fitness trait as more couples are able to achieve pregnancies with infertility treatments. In less developed countries where contraceptive measures have not been allowed or have not been available, women have had little, or no choice regarding who their mate(s) would be, age of marriage, or number and spacing of children. In these environments, population growth is now or is expected to exceed available resources. When women are allowed to control their reproduction, choices related to genetically influenced predispositions to bear or not bear children, when, and how many, may help keep population growth at replacement level . As Rodgers et al (2000, in press) predict, the release of genetic influences due to human reproductive choice not relevant to other species implies evolutionary processes for human reproductive behavior may be accelerating, and we may likely see profound influences of genes on fertility differentials.

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Table 1. Variables used in the analyses with response frequencies for the full genetic sample and by gender.

	Full genetic sample (N,%) N = 6278		Male-Male pairs (N,%)		Female-Female pairs (N, %)	
Attachment						
1. How close do you feel to your (father/ adoptive father/ stepfather/ foster father/ etc.)?						
1 = Not at all	65	1.5	10	0.8	25	2.1
2 = very little	202	4.7	46	3.8	68	5.6
3 = somewhat	585	13.7	126	10.3	201	16.5
4 = quite a bit	1156	27.1	341	27.9	339	27.8
5 = very much	2254	52.9	701	57.3	585	48.0
missing	2016		456		622	
2. Most of the time your father is warm and loving toward you.						
1 = strongly disagree	78	1.8	15	1.2	24	2.0
2 = disagree	206	4.8	43	3.5	65	5.3
3 = neither agree nor disagree	477	11.2	130	10.6	126	10.3
4 = agree	1898	44.6	579	47.3	518	42.5
5 = strongly agree	1601	37.6	457	37.3	485	39.8
missing			456		622	
3. How much do you think he cares about you?						
1 = not at all	20	0.5	4	0.3	6	0.5
2 = very little	78	1.8	20	1.6	22	1.8
3 = somewhat	163	3.8	36	2.9	55	4.5
4 = quite a bit	530	12.4	153	12.5	140	11.5
5 = very much	3469	81.4	1011	82.6	995	81.7
missing	2018		456		622	

(Table 1 continued)

	Full genetic sample (N,%)		Male-Male pairs (N, %)		Female-Female pairs (N, %)	
4. Fscale (Father bond scale) sum of items 1, 2, 3; alpha = .80						
5. You feel loved and wanted						
1 = strongly disagree	28	0.5	4	0.2	6	0.3
2 = disagree	150	2.4	20	1.2	60	3.3
3 = neither agree nor disagree	526	8.5	112	6.7	176	9.6
4 = agree	3986	49.8	876	52.5	886	48.2
5 = strongly agree	2402	38.8	656	39.3	710	38.6
missing	86		12		2	
6. How close do you feel to your (mother/ adoptive mother/ stepmother/ foster mother/ etc.)?						
1 = Not at all	40	0.7	10	0.6	14	0.8
2 = very little	151	2.6	31	2.0	52	3.0
3 = somewhat	500	8.5	97	6.2	180	10.4
4 = quite a bit	1254	21.4	339	21.6	392	22.7
5 = very much	3917	66.8	1096	64.7	1088	63.0
missing	416		107		114	
7. Most of the time your mother is warm and loving toward you.						
1 = strongly disagree	68	1.2	19	1.2	22	1.3
2 = disagree	169	2.9	32	2.0	49	2.8
3 = neither agree nor disagree	399	6.1	85	5.4	110	6.4
4 = agree	2426	41.4	670	42.6	691	40.1
5 = strongly agree	2833	48.4	756	48.7	851	49.4
missing	423		109		117	

(Table 1 continued)

	Full genetic sample (N,%)		Male-Male pairs (N, %)		Female-Female pairs (N, %)	
8. How much do you think she cares about you?						
1 = not at all	18	0.3	4	0.3	5	0.3
2 = very little	59	1.0	9	0.6	25	1.5
3 = somewhat	125	2.1	25	1.6	37	2.1
4 = quite a bit	491	8.4	115	7.3	165	9.6
5 = very much	5164	88.2	1419	90.3	1491	86.5
missing	421					
9. Mscale (Mother bond scale) sum of item 5 and 6; alpha = .50						
Attitudes (Only respondents at least 15 years old were asked about ability to take health protective measures)						
1. If you wanted to use birth control, how sure are you that you could stop yourself and use birth control once you were highly aroused or turned on?						
1 = very sure	2034	46.4	495	40.4	618	48.5
2 = moderately sure	846	19.3	284	23.2	216	17.0
3 = neither sure nor unsure	865	19.7	259	21.1	250	19.6
4 = moderately unsure	251	5.7	91	7.4	67	5.3
5 = very unsure	230	5.2	60	4.9	75	5.9
6 = I never want to use bc	158	3.6	37	3.0	48	3.8
missing	1894		454		566	
2. In general, birth control is too much of a hassle to use						
1 = strongly agree	312	6.7	97	7.4	78	5.8
2 = agree	347	7.4	88	6.7	78	5.8
3 = neither agree nor disagree	720	15.4	204	15.6	182	13.5
4 = disagree	1344	28.7	421	32.3	350	25.9
5 = strongly disagree	1958	41.8	494	37.9	661	49.0
missing	1597		376		491	

(Table 1 continued)

	Full genetic sample (N,%)		Male-Male pairs (N, %)		Female-Female pairs (N, %)	
3. If you had sexual intercourse, it would make you more attractive to women/men.						
1 = strongly agree	145	3.3	62	5.0	16	1.3
2 = agree	329	7.5	138	11.2	42	3.3
3 = neither agree nor disagree	1586	36.1	552	44.9	352	27.7
4 = disagree	1422	32.4	332	27.0	470	36.9
5 = strongly disagree	907	20.7	146	11.9	392	30.8
missing	1889		450		568	
4. If you had sexual intercourse your partner would lose respect for you.						
1 = strongly agree	264	6.0	56	4.5	111	8.7
2 = agree	490	11.2	104	8.4	180	14.2
3 = neither agree nor disagree	1342	30.6	401	32.6	355	28.0
4 = disagree	1591	36.2	482	39.2	413	32.5
5 = strongly disagree	705	16.1	188	15.3	211	16.6
missing	1886		449		570	
5. It wouldn't be all that bad if you got (got someone) pregnant at this time in your life.						
1 = strongly agree	76	1.7	18	1.4	22	1.7
2 = agree	359	8.1	73	5.9	113	8.7
3 = neither agree nor disagree	454	10.2	115	9.2	135	10.4
4 = disagree	1440	32.3	419	33.7	406	31.3
5 = strongly disagree	2127	47.7	620	49.8	622	47.9
missing	1822		435		542	

(Table 1 continued)

	Full genetic sample (N,%)		Male-Male pairs (N, %)		Female-Female pairs (N, %)	
6. Getting pregnant (getting someone pregnant) at this time in your life is one of the worst things that could happen to you.						
1 = strongly agree	2553	57.3	723	58.0	754	58.1
2 = agree	1144	25.7	349	28.0	303	23.3
3 = neither agree nor disagree	383	8.6	101	8.1	119	9.2
4 = disagree	283	6.3	53	4.3	89	6.9
5 = strongly disagree	94	2.1	20	1.6	33	2.5
missing	1821		434		542	
7. Regardless of whether you have ever had a child, would you consider having a child in the future as an unmarried person?						
0 = no	4665	75.7	1317	79.1	1328	73.1
1 = yes	1497	24.3	347	20.9	488	26.9
missing	116		16		24	

8. Ideal time in romantic relationship to have sexual intercourse (includes only those participants who would have sexual intercourse in an ideal romantic relationship)

Put in order the following events (participant may leave out events he/she would not do):	(score for "we would have sex," N, %)								
*We would go out	1	46	2.0	1	8	0.1	1	17	3.1
together in a group	2	435	18.9	2	131	16.2	2	109	19.9
*I would meet my	3	684	29.7	3	230	28.4	3	203	37.0
partner's parents	4	370	16.1	4	146	18.0	4	78	14.2
*I would tell other people	5	222	9.6	5	89	11.0	5	35	6.4
that we were a couple	6	148	6.4	6	50	6.2	6	32	5.8
*I would see less of my	7	100	4.3	7	45	5.5	7	16	2.9
other friends so I could	8	65	2.8	8	28	3.5	8	10	1.8
spend more time with	9	45	2.0	9	15	1.8	9	10	1.8
my partner	10	44	1.9	10	18	2.2	10	8	1.5
*We would go out	11	43	1.9	11	15	1.8	11	11	2.0
together alone	12	19	0.8	12	2	0.2	12	6	1.1

(Table 1 continued)

	Full genetic sample (N,%)			Male-Male pairs (N, %)			Female-Female pairs (N, %)		
*We would hold hands	13	19	0.8	13	11	1.4	13	5	0.9
*I would give my	14	32	1.4	14	12	1.5	14	5	0.9
partner a present	15	24	1.0	15	10	1.2	15	---	
*My partner would give	16	8	0.3	16	1	0.1	16	4	0.7
me a present									

*I would tell my partner that I loved him or her
*My partner would tell me that he or she loved me
*We would think of ourselves as a couple
*We would talk about contraception or sexually transmitted diseases
*We would kiss
*We would touch each other under our clothing or with no clothes on
*We would have sex
*We would get married

If "we would have sex" is the first thing they would do, score = 16; the second thing they would do, score = 15 . . .

Behavioral Outcomes

1. Time in first actual romantic or nonromantic relationship participant had sexual intercourse

Put in order the following events (score for "we had sexual intercourse," N, %) (participant may leave out events he/she did not do):									
*We went out	1	233	15.6	1	43	11.2	1	82	19.5
together in a group	2	257	17.2	2	82	21.4	2	79	18.8
*I met my partner's	3	191	12.8	3	55	14.4	3	69	16.4
parents	4	159	10.6	4	39	10.2	4	40	9.5
*I told other people	5	108	7.2	5	20	5.2	5	34	8.1
that we were a couple	6	95	6.3	6	25	6.5	6	15	3.6
*I saw less of my other	7	69	4.6	7	22	5.7	7	16	3.8
friends so I could spend	8	86	5.7	8	17	4.4	8	21	5.0
more time with my	9	72	4.8	9	17	4.4	9	14	3.3
partner	10	67	4.5	10	19	5.0	10	22	5.2

(Table 1 continued)

	Full genetic sample (N,%)			Male-Male pairs (N, %)			Female-Female pairs (N, %)		
*We went out together	11	53	3.5	11	14	3.7	11	11	
alone	12	34	2.3	12	6	1.6	12	10	
*We held hands	13	38	2.5	13	13	3.4	13	13	
*I gave my partner a	14	18	1.2	14	6	1.6	14	---	
present	15	5	0.3	15	3	0.8	15	2	
*My partner gave me	16	12	0.8	16	2	0.5	16	3	
a present	missing				1297			1409	
*I told my partner									
that I loved him or her									
*My partner told me that he or she loved me									
*We thought of ourselves as a couple									
*We talked about contraception or sexually transmitted diseases									
*We kissed									
*We touched each other under our clothing or with no clothes on									
*We had sexual intercourse									
*We touched each others' genitals (private parts)									

If "we had sexual intercourse" is the first thing they did, score = 16; the second thing they did, score = 15 . . .

2. Age at first intercourse was the average of the responses for waves 1 and 2 to the question "in what month and year did you have sexual intercourse for the very first time" and was analyzed in months. Frequencies are shown for age in years:

12	171	6.2	12	89	6.9	12	27	3.3
13	302	11.0	13	161	12.5	13	74	9.1
14	546	19.9	14	228	17.8	14	183	22.5
15	608	22.1	15	266	20.7	15	183	22.5
16	547	19.9	16	262	20.4	16	170	20.9
17	382	13.9	17	183	14.3	17	113	13.9
18	133	4.8	18	65	5.1	18	47	5.8
19	53	1.9	19	28	2.2	19	14	1.7
20	5	0.2	20	2	0.2	20	3	0.4

(Table 1 continued)

	Full genetic sample (N,%)		Male-Male pairs (N, %)		Female-Female pairs (N, %)	

3. Total number of sex partners was the response to "with how many people in total including romantic relationship partners have you ever had a sexual relationship?" Although participants who had not reported sexual intercourse were not asked this question, those participants were assigned a score of zero for the analysis. (Number of sex partners, frequency, %)

0	4198	66.9	0	1159	72.9	0	1355	79.3
1	318	5.1	1	84	5.3	1	98	5.7
2	255	4.1	2	61	3.8	2	68	4.0
3	249	4.0	3	80	5.0	3	55	3.2
4	155	2.5	4	41	2.6	4	37	2.2
5	162	2.6	5	46	2.9	5	33	1.9
6	84	1.3	6	27	1.7	6	14	0.8
7	54	0.9	7	12	0.8	7	7	0.4
8	30	0.5	8	10	0.6	8	8	0.5
9	16	0.3	9	4	0.3	9	5	0.3
10	53	0.8	10	13	0.8	10	6	0.4
11	13	0.2	11	3	0.2	11	3	0.2
12	23	0.4	12	8	0.5	12	3	0.2
13	10	0.2	13	2	0.1	13	3	0.2
14	6	0.1	14	2	0.1	14	1	0.1
15	28	0.5	15	8	0.5	15	-------	----
16	3	0.1	16	------	-----	16	2	0.1
17	8	0.1	17	2	0.1	17	1	0.1
18	3	0.1	18	1	0.1	18	1	0.1
19	7	0.1	19	1	0.1	19	3	0.2
20+	78	1.2	20+	26	1.6	20+	5	0.3

Table 2. Descriptive statistics for attachment, attitudes, and behavioral outcome measures, full genetic sample and by gender

Variable	Full Sample N	Full Sample M	Full Sample SD	Male-Male pairs N	Male-Male pairs M	Male-Male pairs SD	Female-Female pairs N	Female-Female pairs M	Female-Female pairs SD
				Attachment					
Close to dad	4262	4.25	0.96	1224	4.37	0.87	1218	4.14	1.02
Dad warm and loving	4260	1.89	0.91	1224	1.84	0.84	1218	1.87	0.94
How much does he care	4260	4.73	0.66	1224	4.75	0.62	1218	4.72	0.68
Fscale	4264	13.08	2.19	1225	13.27	1.97	1219	12.98	2.29
Loved and Wanted	6192	1.76	0.74	1668	1.71	0.67	1838	1.78	0.77
Close to mom	5862	4.51	0.81	1573	4.58	0.75	1726	4.44	0.86
Mom warm and loving	5855	1.67	0.81	1571	1.64	0.78	1723	1.67	0.82
How much does she care	5857	4.83	0.53	1572	4.87	0.46	1723	4.81	0.57
Mscale	6222	8.49	1.66	1675	8.58	1.59	1836	8.39	1.71

(Table 2 continued)

Variable	Full Sample N	Full Sample M	Full Sample SD	Male-Male pairs N	Male-Male pairs M	Male-Male pairs SD	Female-Female pairs N	Female-Female pairs M	Female-Female pairs SD
Attitudes									
Stop and use BC if aroused	4384	2.15	1.38	1226	2.22	1.34	1274	2.14	1.42
BC too Bothersome	4681	3.92	1.21	1304	3.86	1.21	1349	4.07	1.17
If had sexual interc. would be more attractive	4389	3.60	1.00	1230	3.29	0.99	1272	3.93	0.91
If had sexual interc. would lose part.'s respect	4392	3.45	1.07	1231	3.52	1.00	1270	3.34	1.17
Getting pregnant not so bad	4456	4.16	1.01	1245	4.24	0.95	1298	4.15	1.03
Getting pregnant one of worst	4457	1.70	1.01	1246	1.63	0.92	1298	1.72	1.05
Consider having child as un-married person	6162	0.24	0.43	1664	0.21	0.41	1816	0.27	0.44
Ideal time in Relationship to have sex. interc.	2365	4.52	2.91	811	4.70	2.92	549	4.17	2.83

(Table 2 continued)

Variable	Full Sample N	Full Sample M	Full Sample SD	Male-Male pairs N	Male-Male pairs M	Male-Male pairs SD	Female-Female pairs N	Female-Female pairs M	Female-Female pairs SD
Behavioral Outcomes									
Actual time in relationship started sex. int.	1497	5.05	3.69	698	5.34	3.76	799	4.79	3.61
Age at first int. (wave1&2ave)	2850	183.18 (15.3 yrs)	25.98 (2.17 yrs)	780	180.56 (15.05 yrs)	31.59 (2.63 yrs)	832	186.84 (15.6 yrs)	21.29 (1.8 yrs)
Total number sex partners (coded zero for virgins)	5720	1.36	3.38	1510	1.25	3.18	1689	0.76	2.20

Table 3. Kinship correlations for the attachment measures on the full genetic sample.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Close to dad		.00 (514)	.25** (142)	.20*** (346)	.24*** (2456)	.46*** (388)
Dad warm and loving		.06 (514)	.30*** (142)	.24*** (344)	.25*** (2456)	.46*** (386)
How much does he care		.04 (514)	.07 (142)	.23*** (346)	.23*** (2452)	.34*** (388)
Fscale		.03 (514)	.32*** (142)	.31*** (346)	.31*** (2458)	.55*** (388)
Feel loved and wanted		.06 (804)	.09 (400)	.07* (840)	.13*** (3362)	.34*** (562)
Close to mom		-.06 (670)	.04 (346)	.10** (792)	.20*** (3178)	.44*** (506)
Mom warm and loving		.01 (670)	.05 (348)	.04 (790)	.16*** (3164)	.23*** (506)
How much does she care		-.00 (672)	.08 (346)	.13*** (792)	.14*** (3168)	.23*** (504)
Mscale		.01 (806)	-.04 (400)	.18*** (840)	.36*** (3370)	.67*** (562)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 4. DF analyses on the full sample for the attachment measures.

		ACE model							AE model				CE model	
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	CV_a	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Close to dad	3898	.41	.09	.05	.04	4.82	1.22		.50	.04	11.48	15.97			
Dad warm and loving	3894	.34	.09	.10	.05	3.80	2.26	28.07							
How much does he care	3894	.32	.09	.09	.04	3.63	2.22	7.89							
Fscale	3900	.46	.09	.10	.04	5.32	2.41	11.36							
Feel loved and Wanted	6054	.26	.07	.02	.03	3.85	0.64		.30	.04	8.17	23.03			
Close to mom	5570	.47	.07	-.03	.03	6.60	-0.74		.43	.04	11.00	11.78			
Mom warm and loving	5556	.27	.07	.01	.04	3.70	0.42		.29	.04	7.58	26.12			
How much does she care	5560	.20	.07	.04	.03	2.87	1.32		.28	.04	6.75	5.81			
Mscale	6064	.69	.06	.01	.03	11.66	0.33		.71	.03	20.91	16.48			

N = the number of double entered pairs (se's and t values based on the total number of pairs)

Table 5. Kinship correlations for the attitude measures on the full genetic sample.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Stop and use BC if aroused		-.06 (430)	.16* (190)	.12* (262)	.10*** (1894)	.16** (414)
BC too bothersome		.05 (490)	-.08 (244)	.07 (348)	.13*** (2052)	.24*** (434)
If had sexual interc. would be more attractive		-.02 (422)	-.00 (198)	.25*** (266)	.08*** (1900)	.20*** (416)
If had sexual interc. would lose part.'s respect		.02 (426)	.19** (198)	-.04 (266)	.17*** (1908)	.26*** (406)
Getting pregnant not so bad		.16*** (431)	.49*** (302)	-.00 (270)	.15*** (1948)	.26*** (422)
Getting pregnant one of worst		.16*** (438)	.09 (202)	.07 (270)	.18*** (1952)	.30*** (422)
Consider having child unmarried		.14*** (788)	.10 (398)	.04 (842)	.15*** (3300)	.33*** (554)
Ideal time in Relationship to have sex. interc.		.14 (126)	-.24 (56)	.03 (140)	.36*** (592)	.42*** (136)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 6. DF analyses on the full sample for the attitude measures.

		ACE model							AE model				CE model		
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	CV_a	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Stop and use BC if aroused	3240	.14	.08	.03	.05	1.57	0.58		.18	.05	3.91	27.23			
BC too Bothersome	3622	.23	.08	.01	.04	2.74	0.33		.26	.05	5.59	15.74			
If had sexual interc. would be more attractive	3252	.17	.09	.02	.05	1.87	0.49		.20	.05	4.30	12.42			
If had sexual interc. would lose part.'s respect	3256	.23	.09	.04	.05	2.67	.84		.29	.05	6.41	16.70			
Getting pregnant not so bad	3334	.02	.09	.17	.05	0.28	3.75						.18	.02	7.38
Getting pregnant one of worst	3338	.17	.09	.11	.05	1.90	2.38	24.50							
Ideal time in Relationship to have sex. interc.	1172	.40	.16	.09	.08	2.50	1.03		.54	.08	6.80	47.31			

N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 7. Kinship correlations for the behavior measures on the full genetic sample.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Actual time in Relationship started sex. int.		.06 (82)	.20 (40)	-.11 (40)	.03 (234)	.54*** (70)
Age at first int.		.11 (222)	.12 (128)	-.13 (228)	.21*** (770)	.37*** (176)
Total number sex partners		.14** (646)	-.04 (302)	.07* (684)	.13*** (2908)	.33*** (508)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 8. DF analyses on the full sample for the behavior measures.

		ACE model							AE model				CE model	
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	CV_a	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Actual time in relationship started sex. int.	476	.43	.22	-.07	.12	1.94	-.63		.31	.12	2.57	40.68			
Age at first int. (wave1&2ave)	1546	.34	.13	.01	.06	2.67	.23		.36	.08	4.79	8.51			
Total number sex partners (coded zero for virgins)	5128	.15	.08	.07	.03	1.90	2.26	96.25							

N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 9. Kinship correlations for the attachment measures on male-male pairs.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Close to dad		-.01 (122)	-.15 (24)	-.01 (102)	.23** (692)	.33*** (180)
Dad warm and loving		.10 (122)	.07 (24)	.16 (102)	.21** (692)	.33*** (180)
How much does he care		-.01 (122)	.28 (24)	.01 (102)	.25*** (692)	.21 (180)
Fscale		.01 (122)	-.02 (24)	.07 (102)	.31*** (692)	.40*** (180)
Feel loved and wanted		.10 (188)	.11 (72)	-.03 (194)	.10** (890)	.33*** (264)
Close to mom		-.10 (158)	-.06 (62)	.06 (176)	.26*** (862)	.26*** (250)
Mom warm and loving		.21** (156)	.13 (62)	.04 (174)	.23*** (902)	.19** (250)
How much does she care		-.08 (158)	.05 (62)	-.08 (176)	.27*** (860)	.28*** (234)
Mscale		.14 (?)	-.15 (72)	.14* (194)	.37*** (894)	.71*** (?)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 10. DF analyses for the attachment measures on the male-male pairs.

		ACE model						AE model						CE model
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	h^2	se- h^2	t- h^2	CV_a c^2	se- c^2	t- c^2	
Close to dad	1146	.39	.15	.01	.08	2.63	0.07	.40	.08	5.16	12.59			
Dad warm and loving	1146	.24	.16	.10	.09	1.51[a]	1.12[a]	.40	.07	5.34	28.87	.21	.04	5.23
How much does he care	1146	.33	.15	.05	.07	2.23	0.66	.41	.09	4.82	8.36			
Fscale	1208	.46	.15	.05	.08	2.98	0.65	.54	.08	6.87	10.91			
Feel loved and Wanted	1642	.29	.12	-.01	.07	2.40	-1.41	.27	.06	4.34	20.36			
Close to mom	1524	.43	.13	-.01	.06	3.33	-0.19	.41	.07	5.66	10.49			
Mom warm and loving	1518	.07	.12	.17	.07	0.57	2.50					.21	.04	5.88
How much does she care	1522	.45	.13	-.03	.06	3.42	-0.48	.39	.08	5.20	5.90			
Mscale	1648	.67	.10	.04	.06	6.96	0.69	.73	.05	13.30	15.83			

[a] The correlation between regression variables associated with h^2 and c^2 was .54, p = .0001
N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 11. Kinship correlations for the attachment measures on female-female pairs.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Close to dad		.20* (130)	.54*** (32)	.10 (78)	.30*** (666)	.53*** (196)
Dad warm and loving		.22* (130)	.22 (32)	.50*** (78)	.30*** (668)	.56*** (194)
How much does he care		.12 (130)	.29 (32)	.08 (78)	.26*** (666)	.49*** (196)
Fscale		.22* (130)	.41** (32)	.29** (78)	.34*** (668)	.66*** (196)
Feel loved and wanted		.10	.09	.15*	.12** (942)	.35***
Close to mom		.09 (176)	.23* (106)	.08 (198)	.24*** (882)	.50*** (254)
Mom warm and loving		-.11 (176)	-.07 (108)	.03 (198)	.19*** (874)	.26*** (254)
How much does she care		-.05 (176)	.13 (106)	.17* (198)	.12*** (878)	.21*** (252)
Mscale		.01 (?)	.03 (?)	.28*** (?)	.42*** (942)	.67*** (?)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 12. DF analyses for the attachment measures on the female-female pairs.

		ACE model							AE model				CE model	
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	CV_a	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Close to dad	1128	.35	.14	.15	.08	2.52	1.90	14.58							
Dad warm and loving	1128	.33	.15	.20	.08	2.21	2.33	28.88							
How much does he care	1128	.41	.15	.09	.08	2.78	1.17		.55	.08	7.18	10.68			
Fscale	1130	.45	.14	.17	.08	3.19	2.22	11.83							
Feel loved and Wanted	1810	.26	.12	.04	.07	2.21	0.59		.31	.06	5.40	24.09			
Close to mom	1662	.44	.12	.05	.07	3.67	0.71		.51	.06	8.55	9.88			
Mom warm and loving	1656	.41	.12	-.06	.06	3.40	-0.88		.32	.06	5.03	27.78			
How much does she care	1656	.19	.12	.03	.06	1.63	0.47		.24	.06	3.80	5.81			
Mscale	1810	.67	.10	.06	.06	6.63	1.03		.76	.05	14.35	15.49			

N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 13. Kinship correlations for the attitude measures on male-male pairs.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Stop and use BC if aroused		-.20 (116)	.21 (28)	-.27* (70)	.11* (526)	.17* (206)
BC too bothersome		-.00 (126)	.16 (42)	.02 (94)	.12** (574)	.06 (210)
If had sexual interc. would be more attractive		-.07 (108)	.17 (32)	.13 (70)	.14** (532)	.11 (208)
If had sexual interc. would lose part.'s respect		-.03 (112)	.42 (32)	-.08 (70)	.29*** (532)	.26*** (204)
Getting pregnant not so bad		.06 (116)	.50** (32)	-.15 (72)	.16*** (542)	.24*** (208)
Getting pregnant one of worst		-.01 (116)	.13 (32)	.33** (72)	.25*** (546)	.13 (208)
Consider having child unmarried		.07 (182)	.45*** (72)	-.08 (?)	.14*** (882)	.14* (258)
Ideal time in Relationship to have sex. interc.		-.01 (52)	-.33 (14)	.23 (64)	.32*** (260)	.45*** (82)

*p < .05, **p < .01, ***p < .001

N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 14. DF analyses for the attitude measures on the male-male pairs.

		ACE model						AE model						CE model
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	h^2	se- h^2	t- h^2	CV_a c^2	se- c^2	t- c^2	
Stop and use BC if aroused	966	.32	.15	-.10	.09	2.16	-1.10	.18	.07	2.40	25.61			
BC too Bothersome	1070	.07	.15	.06	.08	0.47[a]	0.72[a]	.16	.08	2.03	12.54	.09	.04	2.11
If had sexual interc. would be more attractive	970	.05	.15	.10	.09	0.30[b]	1.15[b]	.19	.08	2.54	13.12	.12	.05	2.77
If had sexual interc. would lose part.'s respect	972	.20	.14	.12	.09	1.39[c]	1.40[c]	.37	.07	5.07	17.28	.22	.04	5.07
Getting pregnant not so bad.	994	.14	.14	.10	.08	1.00[d]	1.21[d]	.28	.08	3.70	11.86	.17	.04	3.76
Getting pregnant one of worst	998	.04	.15	.18	.09	0.28	2.02					.20	.04	4.48
Ideal time in Relationship to have sex. interc.	488	.42	.23	.06	.13	1.86	0.44	.51	.11	4.59	44.37			

[a] The correlation between regression variables associated with h^2 and c^2 was .48, p = .0001; [b] The correlation between regression variables associated with h^2 and c^2 was .46, p = .0001; [c] The correlation between regression variables associated with h^2 and c^2 was .37, p = .0001; [d] The correlation between regression variables associated with h^2 and c^2 was .37, p = .0001

N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 15. Kinship correlations for the attitude measures on female-female pairs.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Stop and use BC if aroused		.03 (104)	.31* (54)	.05 (56)	.09* (528)	.13 (194)
BC too bothersome		.25* (128)	-.03 (60)	-.05 (70)	.20*** (562)	.34*** (210)
If had sexual interc. would be more attractive		.09 (104)	-.27 (54)	.13 (56)	.07 (528)	.22** (194)
If had sexual interc. would lose part.'s respect		.32** (102)	.26 (54)	.25 (56)	.28*** (532)	.26*** (188)
Getting pregnant not so bad		.28** (110)	.36** (56)	.09 (56)	.23*** (546)	.38*** (?)
Getting pregnant one of worst		.28** (110)	.15 (56)	.09 (56)	.18*** (546)	.43*** (?)
Consider having child unmarried		.42*** (202)	.03 (?)	.15* (?)	.21*** (920)	.44*** (277)
Ideal time in Relationship to have sex. interc.		-.04 (24)	.61 (10)	.02 (20)	.69*** (110)	.31* (54)

*p < .05, **p < .01, ***p < .001

N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 16. DF analyses on the attitude measures for the female-female pairs

		ACE model						AE model				CE model		
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Stop and use BC if aroused	966	-.01	.15	.10	.09	-0.06	1.15					.10	.05	2.16
BC too Bothersome	1060	.19	.14	.12	.08	1.41[a]	1.51[a]	.36	.07	5.10	17.25	.22	.04	5.13
If had sexual interc. would be more attractive	966	.20	.14	-.01	.08	1.37	-0.11	.18	.07	.2.44	9.82			
If had sexual interc. would lose part.'s respect	962	-.07	.15	.31	.09	-0.45	3.54					.28	.04	6.32
Getting pregnant not so bad	998	.07	.14	.23	.08	0.52	2.87					.26	.04	6.07
Getting pregnant one of worst	998	.21	.14	.15	.08	1.49	1.80					.25	.04	5.66
Ideal time in Relationship to have sex. interc.	224	-.08	.34	.58	.20	-0.24	2.89					.54	.08	6.69

[a] The correlation between regression variables associated with h^2 and c^2 was .42, p = .0001.
N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 17. Kinship correlations for the behavior measures on male-male pairs.

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Actual time in Relationship started sex. int.		-.01 (28)	.35 (8)	-.09 (8)	.04 (60)	.69** (22)
Age at first int.		.03 (62)	.20 (24)	-.28* (66)	.23*** (224)	.24* (84)
Total number sex partners		.11 (146)	.01 (64)	-.15 (152)	.10** (790)	.29*** (236)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 18. *DF analyses on the behavior measures for the male-male pairs*

		ACE model						AE model				CE model		
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Actual time in relationship started sex. int.	128	.45	.42	-.01	.22	1.06	-.06	.43	.24	1.82	30.28			
Age at first int.	466	.28	.22	-.01	.11	1.27	-0.08	.27	.14	1.98	9.09			
Total number sex partners	1420	.18	.13	.03	.06	1.41[a]	.48[a]	.23	.08	2.96	122.0			

N = number of double entered pairs (se's and t values based on the total number of pairs)

Table 19. Kinship correlations for the behavior measures on female-female pairs

Variable	r (N)	UR	CO	HS	FS/DZ	MZ
Actual time in Relationship started sex. int.		.15 (30)	.09 (16)	-.23 (16)	.10 (64)	.47** (48)
Age at first int.		.04 (64)	.28 (38)	-.14 (58)	.13 (226)	.54*** (92)
Total number sex partners		-.01 (166)	.24* (94)	-.01 (170)	.10** (818)	.53*** (258)

*p < .05, **p < .01, ***p < .001
N = the number of double entered pairs (Twins of unknown zygosity are not shown in the correlations but were included in the DF analysis)

Table 20. DF analyses on the behavior measures for the female-female pairs.

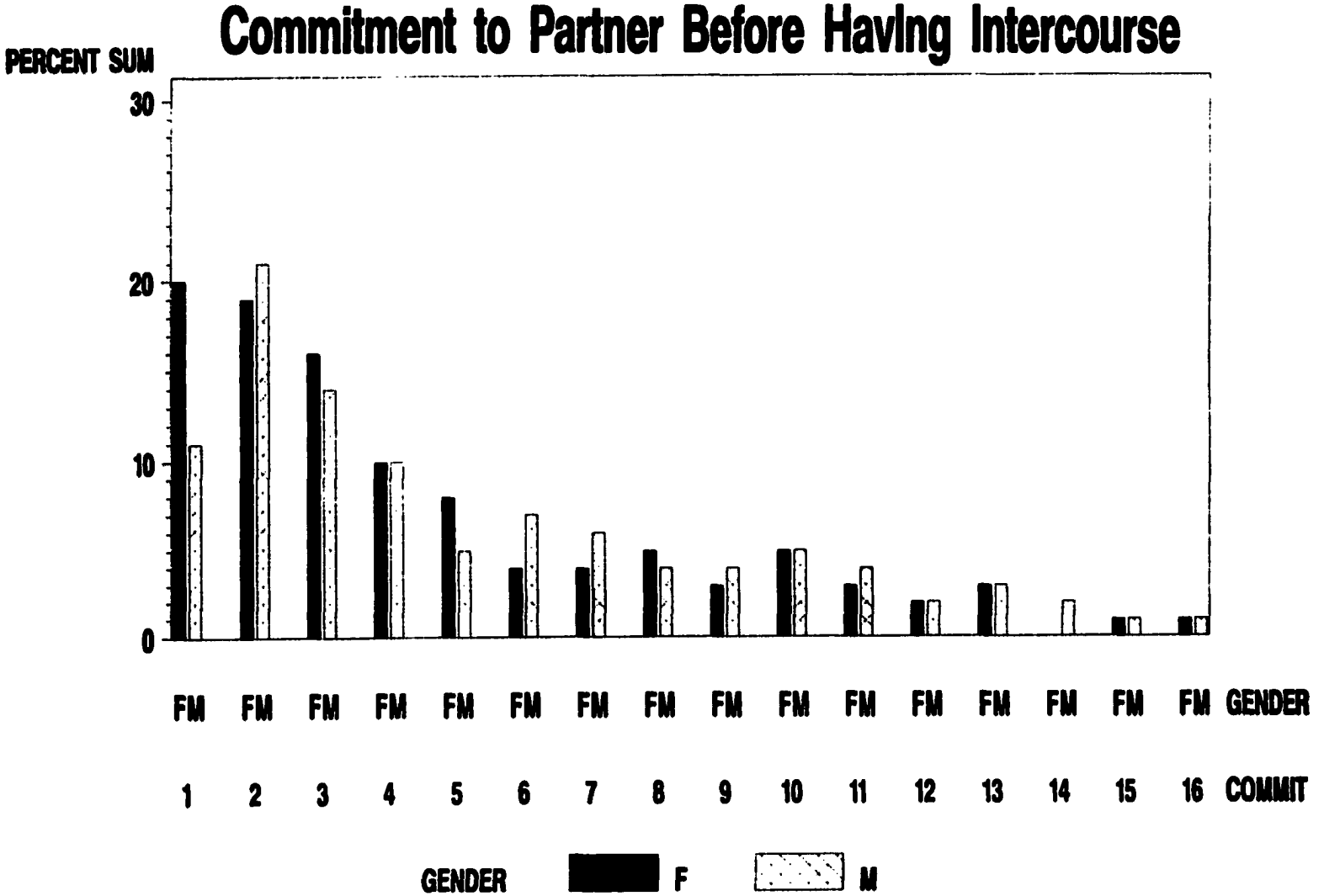
		ACE model						AE model					CE model	
Variable	N	h^2	se- h^2	c^2	se- c^2	t- h^2	t- c^2	h^2	se- h^2	t- h^2	CV_a	c^2	se- c^2	t- c^2
Actual time in relationship started sex. int.	182	.46	.32	-.04	.20	1.41[a]	-.21[a]	.40	.16	2.47	30.15	.21	.10	1.99
Age at first int. (wave1&2ave)	492	.47	.19	-.02	.10	2.55	-.19	.45	.11	3.97	7.64			
Total number sex partners (coded zero for virgins)	1554	.43	.12	-.04	.06	3.60	-.69	.36	.07	4.87	173.68			

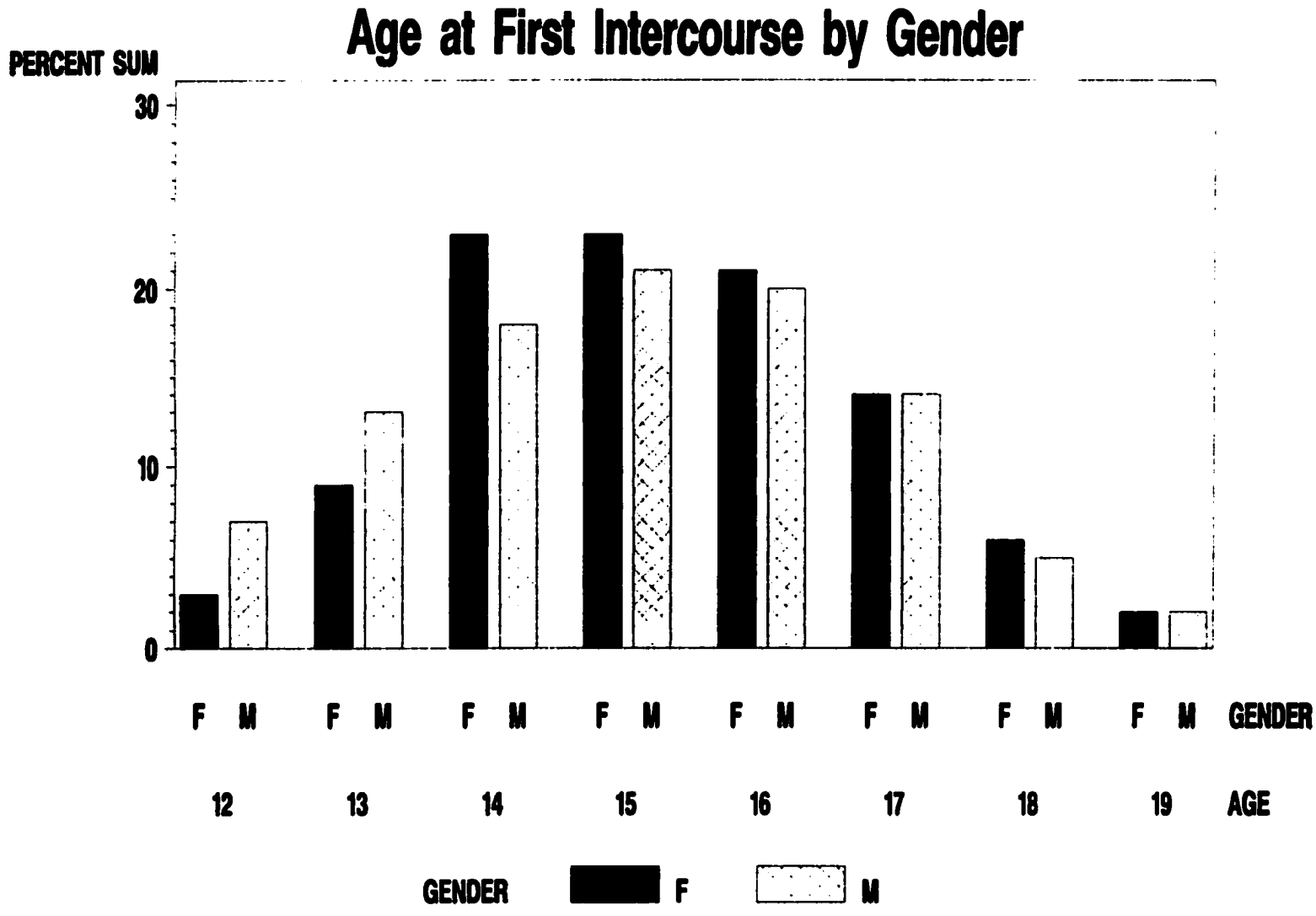
[a] The correlation between regression variables associated with h^2 and c^2 was .70, p = .0001
N = number of double entered pairs (se's and t values based on the total number of pairs)

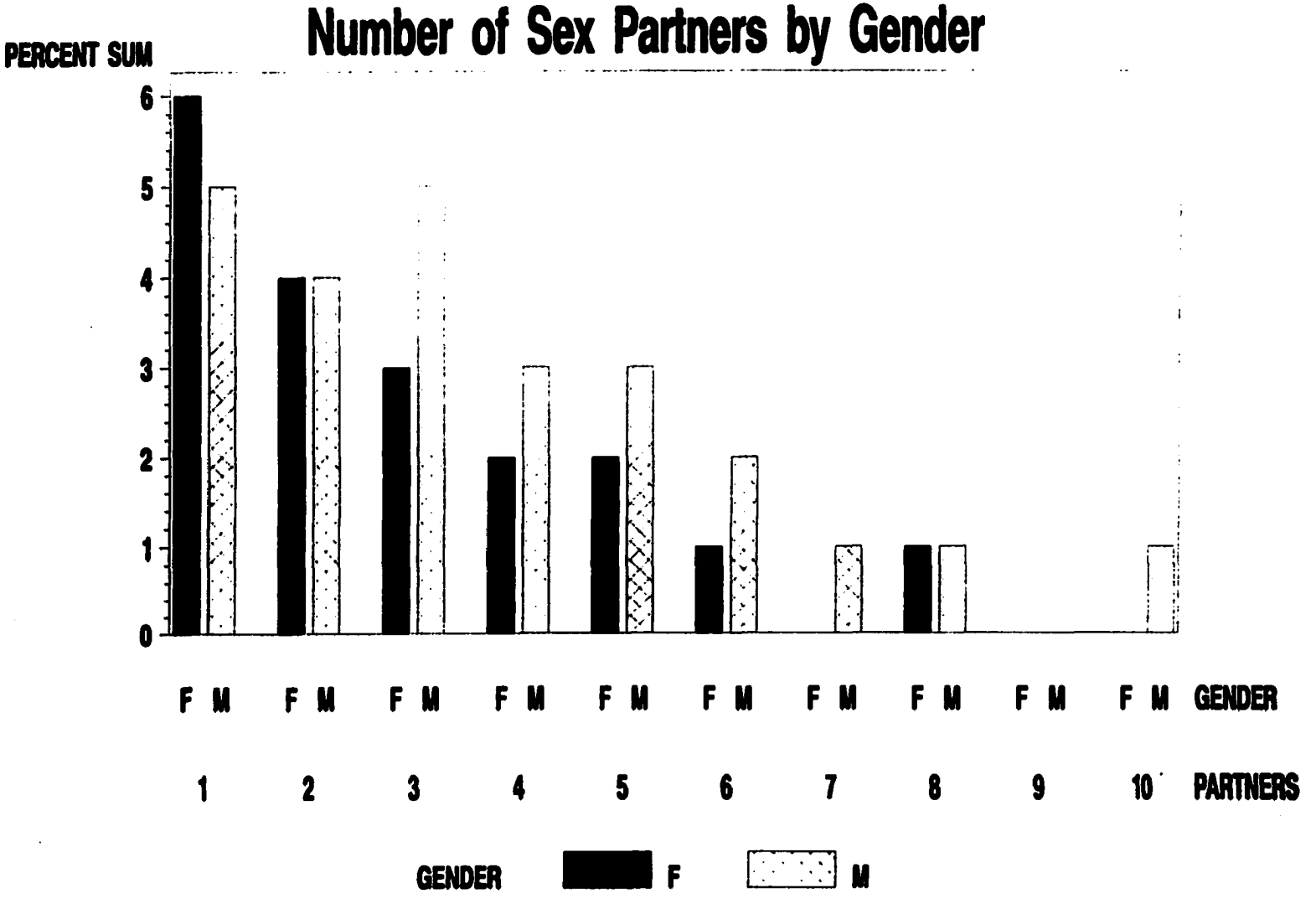
Table 21. Testing the equal environments assumption

Kin category dropped	N	h^2	h^2 - t	h^2 - se	c^2	c^2 - t	c^2 - se	r full sibs	r DZ twins
Attachment variable: Close to dad									
MZ TWINS	3510	.42	3.52	.11	.05	0.99	.05		
DZ TWINS	3308	.41	4.79	.08	.05	1.18	.04	.23*** n=1866	
FULL SIBLINGS	2032	.44	4.88	.08	.06	1.39	.04		.26*** n=590
HALF SIBLINGS	3552	.44	5.06	.08	.03	0.64	.04		
COUSINS	3756	.44	5.02	.08	.03	0.73	.04		
NONRELATED	3384	.30	2.60	.11	.11	1.80	.05		
UNDEFINED TWINS	3846	.39	4.57	.08	.06	1.29	.04		
Attitude variable: Getting pregnant / someone pregnant at this time would not be so bad									
MZ TWINS	2912	-.12	-.93	.13	.12	3.94	.06		
DZ TWINS	2694	.03	.38	.08	.17	3.80	.04	.16*** n=2352	
FULL SIBLINGS	2026	.04	.45	.08	.18	3.76	.04		.14*** n=640
HALF SIBLINGS	3064	-.02	-.18	.08	.20	4.28	.04		
COUSINS	3132	.13	1.45	.08	.09	1.95	.04		
NONRELATED	2896	.01	.08	.11	.18	2.78	.06		
UNDEFINED TWINS	3280	.02	.24	.08	.17	3.75	.04		
Behavior variable: Age at first intercourse									
MZ TWINS	1370	.33	1.75	.18	.01	0.18	.07		
DZ TWINS	1342	.31	2.40	.13	.00	0.01	.07	.16*** n=566	
FULL SIBLINGS	980	.36	2.60	.14	.01	0.23	.07		.33*** n=204
HALF SIBLINGS	1318	.24	1.94	.13	.11	1.66	.07		
COUSINS	1418	.38	2.86	.14	-.01	-.19	.07		
NONRELATED	1324	.47	3.01	.16	-.07	-.83	.08		
UNDEFINED TWINS	1524	.33	2.55	.13	.02	0.26	.07		

*** $p < .0001$


Commitment to Partner Before Having Intercourse
PERCENT SUM
30
20
10
0
FM FM FM FM FM FM FM FM FM FM FM FM FM FM FM FM GENDER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 COMMIT
GENDER
F
M


Age at First Intercourse by Gender
PERCENT SUM
30
20
10
0
F M F M F M F M F M F M F M F M GENDER
12 13 14 15 16 17 18 19 AGE
GENDER F M


Number of Sex Partners by Gender
PERCENT SUM
6
5
4
3
2
1
0
F M F M F M F M F M F M F M F M F M F M GENDER
1 2 3 4 5 6 7 8 9 10 PARTNERS
GENDER F M