# Sociobiology, Status, and Parental Investment in Sons and Daughters: Testing the Trivers-Willard Hypothesis[1]

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While some dismiss sociobiological theories as untestable, post hoc explanations, this article argues that sociologists should instead increase their efforts to identify and engage those theories that have novel empirical implications. Regarding parental investment, Trivers and Willard use Darwinian reasoning to hypothesize that high-status parents favor sons over daughters and that low-status parents favor daughters over sons. The application of this hypothesis to contemporary societies has been widely accepted by sociobiologists, although it has received little actual empirical scrutiny. The Trivers-Willard hypothesis is tested in this study using two nationally representative surveys of American adolescents and their parents. Across several different measures of investment, little evidence of the predicted parental investment behaviors is found. This article seeks not only to contribute to settling the empirical point at issue but also to encourage a renewed and empirically focused dialogue between sociologists and sociobiologists.

## INTRODUCTION

Sociological research has long suggested that parental investment strongly influences educational and life outcomes and that investment is a function of both available parental resources and parental choices (Coleman 1966; Blau and Duncan 1967). To understand why some parents choose to invest more than others in the future of their offspring, sociologists typically have emphasized the interplay of a variety of *proximate* factors, including

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parents' incomes and education, family configuration and racial/ethnic background, and children's sex and age (e.g., Steelman and Powell 1991; Schneider and Coleman 1993; Downey 1995). Meanwhile, others contend that parental investment in general, and how it is influenced by proximate variables, can be adequately understood only by attending to *ultimate* causes. In this regard, many have urged sociologists to look to some of the evolutionary theories that have been proposed by sociobiologists (Rossi 1984; Nielsen 1994). These theories posit that parents' behavior toward their children is structured by innate cognitive mechanisms, which developed originally as evolutionary adaptations, and that contemporary patterns of parental investment reflect those behaviors that led to the greatest reproductive success in our evolutionary past. The idea that parental behavior is strongly shaped by past Darwinian pressures has been used to provide evolutionary explanations of phenomena such as why mothers tend to invest more in their children than do fathers (Blum 1997) and why parents tend to invest more in biological children than in stepchildren (Daly and Wilson 1988).

The real promise of sociobiological theories is not that they can help us make sense of known patterns but that they may enable us to deduce new facts about the social world that have not yet been found. Yet, a recurrent criticism of current sociobiological theories is that they too often provide nothing more than a post hoc explanation of how existing phenomena could have arisen as a direct result of Darwinian selection. Because the theories have no empirical implications beyond what they were originally devised to explain, they cannot be put to any genuine test. While it is true that much of sociobiology's work on parental investment is not deductively based and cannot be readily tested, one prominent and longstanding exception is the Trivers-Willard hypothesis. Using elegant evolutionary reasoning, Trivers and Willard (1973) conjecture that parents should exhibit a sensitivity to their position in the social hierarchy when deciding to invest in sons versus daughters. For reasons described below, Trivers and Willard argue that throughout most of evolutionary history, low-ranking parents have produced the greatest number of grandchildren and great-grandchildren by investing more in their daughters than their sons, while high-ranking parents achieved the most progeny by investing in sons over daughters. For nonhuman animals, Trivers and Willard argue that rank is primarily a matter of "physiological condition," while for humans, rank is to be conceived in terms of position "on a socioeconomic scale." Trivers and Willard predict that, even in the most developed societies, less advantaged parents will favor their daughters and more advantaged parents will favor their sons.

Sociobiologists have widely accepted the applicability of the Trivers-

Willard hypothesis to humans, so much so that Hrdy (1987, p. 101) states that many consider it a "proved theory." Some have argued that the Darwinian impetus for the rich to favor their sons is so strong that it explains why the wealthy of some societies practice female infanticide (Dickemann 1979). Others claim that the impetus for the poor to favor their daughters explains why, in some impoverished societies, infant mortality rates are much higher for boys than girls (Cronk 1989). It also has been suggested that the biases in parental investment predicted by Trivers and Willard exert lifelong effects on personality: Sulloway (1996, p. 431), for example, speculates that upper-class women may tend toward radicalism as the result of being systematically "discriminated against" by their parents.

Evidence for the Trivers-Willard hypothesis among humans is mixed, despite its confident use by many sociobiologists. Some seem to take for granted its applicability to parental behavior toward older children and adolescents in advanced Western societies, but to our knowledge the hypothesis has never formally been tested within this population. This article seeks to determine whether such confidence in the Trivers-Willard hypothesis is warranted by testing whether its predictions hold true among parents of adolescents in the United States. We use primarily a large, nationally representative sample of American eighth graders and their parents, but we also supplement the analysis with comparable data on high school sophomores. By testing the Trivers-Willard hypothesis, we seek both to contribute toward settling the empirical point in question and to encourage a renewed dialogue between those who embrace sociobiology and those who remain skeptical. At the same time, however, we hope to underscore the importance of using *empirical criteria* to evaluate the role that Darwinian theories should play in sociologists' thinking about social issues.

## BACKGROUND

### Sociology, Sociobiology, and Science

Both within and outside sociology, the reputation of sociobiology has suffered from its association with a troubled history of efforts to reduce social phenomena to alleged Darwinian roots (see Gould 1981; Degler 1991). From Herbert Spencer (1891) to *The Bell Curve* (Herrnstein and Murray 1994), contested biological reasoning has been used to support political agendas and to justify imperialism, stratification, racial and sexual discrimination, and even genocide. Yet the line of research that emerged from Edward O. Wilson's (1975) *Sociobiology* has been careful, especially in recent years, to distance itself from those who emphasize supposedly innate differences among races and classes (see Nielsen [1994] for a

thoughtful review).[2] Contemporary sociobiology emphasizes putatively universal aspects of human behavior and argues that these universalities derive from a shared and highly specialized set of cognitive mechanisms ("modules") that developed over millions of years of Darwinian selection. Examples of such modular explanations that have been applied to contemporary developed societies include those offered for language (Jackendoff 1993; Pinker 1994), sexuality (Buss 1994), social contracts (Cosmides and Tooby 1992), and, as is important here, parental investment.

Sociobiology has enjoyed growing visibility in a variety of fields, including psychology (Simpson and Kenrick 1997), anthropology (Barkow, Cosmides, and Tooby 1992), and economics (Rothschild 1990; Krugman 1996). Among sociologists, Cohen and Machalek (1988; see also Vila and Cohen 1993) have offered a theory of criminal behavior very much in the spirit of recent sociobiology: they conjecture that expropriative crime is rooted in an evolved strategic sensitivity to specific conditions and opportunities, but they deny that there are any essential genetic differences between criminals and noncriminals. Concerning parental investment, Biblarz, Raftery, and Bucur (1997) find that men raised in stepfamilies or by single fathers have lower socioeconomic attainment than men raised by both biological parents or by single mothers—a pattern, they argue, that is consistent with Hamilton's (1964) evolutionary model of kin selection.

At present, many sociologists are still skeptical of sociobiology, and few have tried to incorporate sociobiological propositions into their work. Some sociobiologists have taken the resistance of sociologists as evidence of biological ignorance, ideological bias, or intellectual irrelevance. In this vein, van den Berghe (1990, p. 173) expresses sentiments not uncommon in the sociobiological literature: "The general failure of sociologists to understand, much less accept, an evolutionary perspective on human behavior transcends mere ignorance and ideological bias, although it incorporates a good deal of both. It also includes a general anthropocentric discomfort with evolutionary thinking, a self-interested resistance to self-understanding, and a trained sociological incapacity to accept the fundamental canons of scientific theory construction." Two decades ago, Ellis (1977) compared the relationship between sociology and sociobiology to that of astrology and astronomy, predicting that the decline of sociology was imminent if the discipline did not incorporate more sociobiological

[2] Of particular interest to this article, Nielsen (1994) provides a nice overview and discussion of efforts to apply sociobiological theories to modern societies. In addition, it is following his usage that we apply "sociobiology" to work now known by many other names, most prominently "evolutionary psychology" but also "Darwinian anthropology" and "biosociology."

thinking. More recently, Ellis (1996) has claimed that the shrinking numbers of sociology majors bear out his prediction, maintaining that sociology is doomed if it cannot cure its irrational, unscientific "biophobia."

Criticisms of sociology's resistance to evolutionary explanation typically assume that this resistance has little to do with the merits of the explanations themselves. Yet there are several reasons why a cautious stance toward sociobiological theory may be well justified. As noted, sociobiology has been dismissed by some for offering little more than post hoc explanations (Gould 1997). Many of the theories that do appear to have testable implications are indistinguishable in their predictions from a more parsimonious rational actor (or other) model (Kitcher 1985; Cronk 1991). In addition, sociobiological theories are often so complicated and intertwined that one proposition can be invoked to rescue the empirical failure of another. For example, Simon (1990) has proposed that apparent Darwinian imperatives may sometimes be subverted by strong adaptive pressures toward docility and conformity; the consequence of this for empirical testing, as Horgan (1995, p. 179) points out, is that "if a given behavior accords with Darwinian tenets, fine; if it does not, it merely demonstrates our docility."[3] For these reasons, one may doubt whether the bulk of sociobiological claims can be empirically falsified, and, consequently, one may question whether the enterprise deserves the scientific status it claims. If ultimate explanations do not imply new and testable knowledge about the social world, one might ask, then how do they move beyond being just speculations? Because so little is known about our evolutionary past, and because the possibilities of adaptive explanation are so little constrained, the acceptance or rejection of particular sociobiological propositions too often seems to depend less on scientific criteria than on how much one accepts the untestable assumptions underlying the claims.[4]

Nonetheless, it should be remembered that the testability of a claim stands in no necessary relationship to its truth. Many sociologists of scientific knowledge maintain that successful scientific programs are *invariably* built upon at least some assumptions that cannot be empirically falsified (Barnes, Bloor, and Henry 1996). In sociobiology, the ratio of untestable to testable assertions may seem high, but an alternative to dismissing the entire program on these grounds is to make a greater effort to find and

[3] Certainly, sociology has not been immune to theoretical frameworks capable of accommodating contradictory empirical possibilities, as pointed out in some of the more prominent criticisms of Parsonian structural-functionalism (e.g., Wrong 1976).

[4] In this regard, Gould (1997) points out that sociobiological claims that a particular disposition or behavior had adaptive value in our evolutionary past are rarely accompanied by paleontological or other corroborating evidence.

engage those hypotheses that have novel empirical implications. New sociobiological theories are often explicitly presented as challenges to prevailing sociological ideas, and, in recent years, some of these theories have received a popular attention that other social scientists can only envy. By pursuing those claims that can be clearly and straightforwardly tested, such as the Trivers-Willard hypothesis, sociologists not only contribute to resolving the empirical point at issue but also may contribute to the dialogue over where the "burden of proof" should reside for other sociobiological theories that turn on similar assumptions but are not readily testable.

## The Trivers-Willard Hypothesis

Trivers and Willard (1973) start with the premise that the reproductive success of males tends to be closely and positively related to their social rank, in part because high-ranking males are more likely to procreate with more than one female. In polygynous human societies, for example, high-status males are more likely than low-status males to have more than one wife (and many offspring), while low-status males are more likely to have no wives (and no offspring). The reproductive success of females is less variable than that of males, for their reproductive potential is less strongly affected by the possibility of multiple mates. As a result, in the vast majority of evolutionary environments, high-status males may be expected to have a higher average number of offspring than their sisters, while low-status females have more offspring on average than their brothers.

According to Trivers and Willard, if we assume that the rank of parents is correlated with that of their children, then it follows that high-status parents who have sons will have more grandchildren than high-status parents who have daughters. On the other hand, low-status parents with daughters will have more grandchildren than low-status parents with sons. This is illustrated in figure 1. Because differences in rates of reproduction are what drive natural selection, Trivers and Willard argue that species should have developed a mechanism by which members vary the sex ratio of their offspring in response to their rank, with low-ranking parents producing more daughters and high-ranking parents producing more sons. Evidence for Trivers and Willard's conjecture about varying sex ratios has been supported in studies of several nonhuman species (e.g., Rivers and Crawford [1974] for mice; McFarland Symington [1987] for spider monkeys; and Clutton-Brock, Albon, and Guinness [1986] for red deer), while the evidence for humans has been more mixed (see Hrdy 1987).

Of more interest to sociologists, however, Trivers and Willard claim

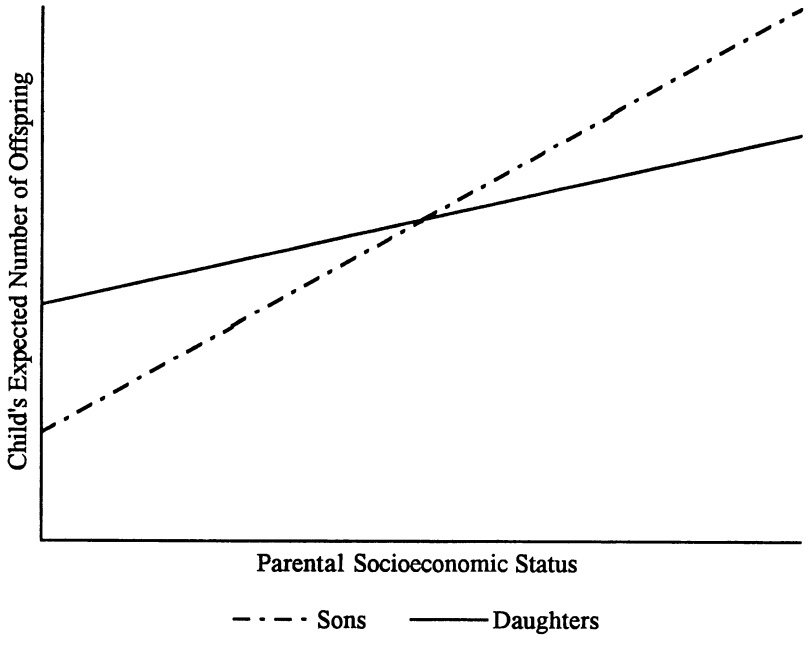


FIG. 1.—The relationship among sex, parents' status, and expected number of offspring (theoretical).

that their hypothesis applies to *parents' behavior toward children after birth just as it applies to the sex ratio.* They write: "If the model is correct, natural selection favors deviations away from 50/50 investment in the sexes, rather than deviations in sex ratios per se. In species with a long period of [parental investment] after birth of young [such as humans], one might expect biases in parental behavior toward offspring of different sex, according to parental condition; parents in better condition would be expected to show a bias toward male offspring" (Trivers and Willard 1973, p. 91).

We are thus to expect low-status parents to invest more in female children than male children, while high-status parents should invest more in males than females. Moreover, as we discuss shortly, once such a tendency has evolved, its influence on parental investment should persist even in evolutionary environments in which a Trivers-Willard effect does not contribute to greater fertility (e.g., in contemporary American society and others in which social status and number of offspring are not positively related). The effect is also expected when it runs counter to apparent cultural

prescriptions (Cronk 1991); along these lines, Wright (1994, p. 173) contends that the Trivers-Willard hypothesis works "by shaping human feelings, not by making humans conscious of its logic."[5]

For children with opposite-sex siblings, the Trivers-Willard hypothesis presents a scenario of direct competition: we would expect sons in high-status families to receive greater investment on average than daughters, while daughters in low-status families should receive more investment on average than sons. At the same time, however, we would also expect to observe concurrent sex differences in the investment received by children with no siblings and children with only same-sex siblings. This is because sociobiological theories of kin selection—the logical base of the Trivers-Willard hypothesis—do not concern only the allocation of resources from parents to offspring (Buss 1995; Pinker 1997; Crawford 1998). Instead, the question of how much to invest in each child is considered part of a much broader problem in which parents must also consider how much to invest in their other blood relatives (e.g., siblings, nieces, nephews, and cousins) and how much to invest in other activities that may help maximize their own fitness (e.g., saving for future offspring, pursuing additional mating opportunities, or attempting to advance one's own position in the status hierarchy). Against these different sources of competition, the greater evolutionary value of sons in advantaged families and daughters in disadvantaged families should influence parental decisions. As a result, the evolutionary logic outlined above leads us to expect similar sex differences in parental investment for children in all types of sibling relationships: comparing across families, boys with high-status parents should receive more parental investment on average than girls, while girls with low-status parents should receive more investment than boys. (At the same time, because one could argue that Trivers-Willard effects should reveal themselves most plainly in families with both sons and daughters, our study examines *both* a general sample of child respondents and a sample restricted to only those children with opposite-sex siblings).

[5] This said, the prevailing wisdom among those theorists of the "coevolution" of biology and culture would seem to expect cultural prescriptions about child rearing to reflect biological imperatives, rather than be opposed to them (see, e.g., Lumsden and Wilson 1981; Cavelli-Sforza and Feldman 1981; Boyd and Richerson 1985; Barkow 1989). No theory of the actual physiological or cognitive mechanism affecting parental investment in the predicted manner is offered by Trivers and Willard. Our study examines only the question of whether the predicted patterns obtain within a sample of contemporary adolescents. Should these patterns exist and exist for the reasons outlined by Trivers and Willard, we would still not know what are the proximate mechanisms influencing parental behavior.

## Research on the Trivers-Willard Hypothesis

Previous studies examining the Trivers-Willard hypothesis have used widely divergent methods and conceptualizations of investment. We noted above that some scholars have claimed to find support for the Trivers-Willard hypothesis in the observation that some less developed societies have higher rates of infant mortality for boys than girls. This work assumes, without corroborating evidence, that sex differences in infant mortality are determined largely by parents' investing more in children of the healthier sex, rather than by other factors, such as sex differences in an infants' vulnerability to a region's diseases. Parental infanticide has also been used as an indicator of an unwillingness to invest in children of the murdered sex; as mentioned above, Dickemann (1979) invokes the Trivers-Willard hypothesis to explain why female infanticide is practiced among the wealthy of some societies. Kitcher (1985), however, argues cogently that female infanticide is unlikely to serve the Darwinian ends that Dickemann suggests. Other studies that claim support for the Trivers-Willard hypothesis measure parental investment in terms of frequency of parent-child interaction (Betzig and Turke's [1986] study of the Ifaluk) and bridewealth payments (Borgerhoff Mulder's [1987] study of the Kipsigis); meanwhile, patterns of parental investment contradicting the Trivers-Willard hypothesis have been observed in cross-cultural comparisons by Hartung (1982; see Betzig 1990) and in ethnographic accounts of the Mundugumor of New Guinea (McDowell 1991).

Testing the Trivers-Willard hypothesis in contemporary Western societies may appear to be complicated by the diminishing relationship between status and fertility: indeed, at present the two may be inversely related (U.S. Bureau of the Census 1991). As a result, although the Trivers-Willard strategy likely would maximize the number of grandchildren in our evolutionary past, it would not necessarily do so today. At the same time, however, a core principle of the leading program in sociobiology (evolutionary psychology) is that modern, developed societies have not existed long enough to reverse or substantively alter the cognitive mechanisms that have evolved over the last thousands or millions of years (Nielsen 1994; Crawford 1998). For sociobiologists, the tendency for humans to seek and value status is rooted in its connection to reproductive success; the idea that humans in contemporary societies value status *as if* it were still connected to fertility provides the linchpin of contemporary applications of many sociobiological theories (e.g., Buss [1994] on sexual attraction; Wright [1994, pp. 242–50] on gender stratification; Thornhill [1998] on aesthetics; and Fisher [1992] on marriage and divorce). As a consequence, to expect the Trivers-Willard hypoth-

esis to hold under contemporary conditions is consistent with the prevailing theoretical logic of sociobiology. Moreover, Gaulin and Robbins (1991) provide evidence that the assumptions necessary for the Trivers-Willard mechanism to evolve still hold in present-day North America.

Indeed, Trivers and Willard *specifically* cite the contemporary United States as an example of the applicability of their hypothesis to human societies. For the contemporary United States and Canada, Gaulin and Robbins (1991) also report a series of findings that they claim are consistent with the hypothesis, but their measures of parental investment (primarily nursing behavior and interbirth interval) are questionable.[6] A study of contemporary inheritance practices in the Vancouver area found that parents with large estates tended to favor sons in their bequests, while parents with small estates favored their daughters (Smith, Kish, and Crawford 1987). While this would seem to support the Trivers-Willard hypothesis, a similar study of inheritance in Sacramento County failed to replicate these results (Judge and Hrdy 1992). At the same time, we know of no study of a developed society that tests whether the Trivers-Willard hypothesis holds for parents of pre- or early adolescents. This is somewhat surprising, for some sociobiologists have argued that parents should be most strongly attached to children of this age (Crawford, Salter, and Jang 1989).

## Sociological Research on Parental Investment

Although sociologists have heretofore not addressed the Trivers-Willard hypothesis, sociological work in the status attainment, rational choice, and human capital traditions has afforded a number of important insights into the proximate variables that affect parental investment. Muller and Kerbow (1993) report a strong positive correlation between parents' education and parents' involvement with their children; Muller (1993) and Muller and Kerbow (1993) find a similarly high correlation between involvement and parents' income. Family structure also influences investment: children in step- and single-parent households (Downey 1994), children in large families (Blake 1989; Steelman and Powell 1991; Downey 1995), and children spaced closely together (Powell and Steelman 1993, 1995) all

[6] Sieff (1990) notes problems with using nursing behavior as a measure of parental investment for humans. In using birth spacing as a measure of investment, Gaulin and Robbins (1991) use not only the interval following a child's birth but also the interval *prior,* although this would imply the unlikely scenario of parents systematically waiting longer to conceive because they know what the sex of their next child will be.

tend to receive fewer resources from their parents than other children. None of these main effects on investment presage or preclude the interaction between child's sex and parents' status predicted by Trivers and Willard.

Concerning the effect of child's sex on investment, recent research has challenged the conventional wisdom (e.g., Rosen and Aneshensel 1978) that parents in the United States are generally biased in favor of boys. Carter and Wojokietwicz (1997), for example, find that parents are more closely involved in the education of their daughters than their sons. In a study more tightly focused on pecuniary investments in children, economists Behrman, Pollak, and Taubman ([1986] 1995, p. 85) suggest that "parental preferences either exhibit equal concern or slightly favor girls." Parents, however, do report preferring that their next child be male; contradicting the Trivers-Willard hypothesis, Coombs (1978) reports the preference for sons is strongest among those of low status. Parents with male children also are more likely to remain married than parents with no children or only female children (Morgan, Lye, and Condran 1988). As divorce has been suggested to have a number of negative effects on children, including reduced investment (Seltzer 1994), boys may be said to profit relative to girls from a lower likelihood of their parents divorcing.

These last differences aside, at present, the United States is unusual among world societies for its relatively high levels of investment in daughters. Research on other developed and (especially) developing societies has documented a clear bias pervading all social classes in favor of boys (Fawcett 1983; King and Hill 1993; see also, e.g., Parish and Whyte [1978] on China; Brinton [1988] on Japan; Rosenzweig and Schultz [1982] on India; Tallman, Marotz-Baden, and Pindas [1983] on Mexico; Kagitcibasi and Sunar [1992] on Turkey; and Buchmann [1996] on Kenya). It may seem inconsistent with the Trivers-Willard hypothesis that the United States, as one of the world's wealthiest societies, would feature relatively high levels of average investment in daughters versus sons when compared to other, less developed societies. At the same time, this observation is counterbalanced by Greenhalgh's (1985) finding that as East Asian societies have become more wealthy, the bias in parental investment toward sons has become stronger (as Trivers and Willard might predict). However, the Trivers-Willard hypothesis ultimately concerns differences in parental investment that occur *within* societies, not between them, and testing the hypothesis requires data comparing children in the same society.[7] Our test using such data is described in the next section.

[7] Intrafamilial comparisons are not possible using NELS or other data of similar size, scope, and quality concerning adolescents. We have no reason to expect our use of interfamilal instead of intrafamilial data to bias systematically the relevant interaction

## DATA AND METHODS

### Data

To test the Trivers-Willard hypothesis, we rely primarily on the National Educational Longitudinal Study of 1988 (NELS), a general-purpose survey of 24,599 eighth graders sponsored by the National Center for Educational Statistics. NELS was designed to provide information on a wide variety of factors thought to affect children's development, educational performance, and life outcomes. Most of our measures are constructed from the 1988 survey, but two are taken from a 1990 follow-up of the original respondents. NELS participants were chosen using a stratified, two-stage probability sample in which first schools were randomly selected and then students were randomly selected within these schools.[8]

The NELS data are particularly appropriate to testing sociobiological hypotheses of parental investment for several reasons. First, the data set includes many different measures of investment, drawing upon information gathered from the students and their parents.[9] Using different measures drawn from different sources increases the assurance that our findings are less vulnerable to biases in student or parent responses or problems with any single measure of investment. Second, as a study of eighth graders, the NELS data capture students at a relatively advanced stage of the period of intensive parental investment and just at the onset of their own potential reproductive careers. As noted above, this is also the age in which sociobiologists expect the highest level of attachment of parents to children. Third, the large sample size not only permits the use of multivariate analyses and the testing of interaction effects but also increases the likelihood that even very modest influences on parental investment will be statistically significant; the data consequently allow a relatively liberal test of the hypothesis.

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effects in one direction or the other. Moreover, comparisons of results of interfamilial and intrafamilial studies indicate that they largely tend to reveal the same patterns but that results from intrafamilial studies tend to be less significant than those from interfamilial studies. As a result, using interfamilial data here may be seen as providing a *generous* test of the hypothesis.

[8] Winship and Radbill (1994) discourage using sampling weights in certain circumstances, but weights are necessary here because the weights are a function of at least one of the dependent variables (enrollment in private school). Analyses using unweighted data yield similar results.

[9] Most research indicates that, under conditions similar to those here, adolescents' and parents' reports of behavior are reasonably consistent with behavioral data gathered through other means (see, e.g., Davies and Kandel 1981; Swearingen and Cohen 1985). Some work has suggested that parents overestimate their investment in their children relative to children's own reports; in this circumstance, we would expect the intercepts of our models to be affected but not the interaction effects at issue here.

## Measures of Parental Investment

The Trivers-Willard hypothesis predicts that parents of low socioeconomic status will invest more heavily in daughters than sons, while high-status parents will invest more heavily in sons than daughters. Sociobiology tends to treat parental investment as a unidimensional concept, encompassing everything from the production of children per se to all behaviors toward children throughout their development. Sociologists, on the other hand, have considered there to be several, qualitatively different, means of investment through which parents may expend resources to positively affect the futures of their children. Parents may be willing to expend enormous resources for their children's benefit in some ways while being much less generous in others. In a similar way, some forms of investment may be marked by a systematic favoring of one gender over another, while others are not. Focusing on one type of resource may obscure evidence supporting the Trivers-Willard hypothesis. As a consequence, to provide as broad a test as possible, we analyzed how child's sex and parents' status influence five general categories of investment: *economic, interactional, supervisory, social,* and *cultural.*[10] These categories should not be taken as mutually exclusive, for there undoubtedly is some overlap among them. Table 1 provides summary statistics and descriptions of all the measures of parental investment used in our study, as well as of the measures of socioeconomic status discussed in the next section.

*Economic investments.*—Economic investments may be the most salient way in which parents differ in their level of investment: parents differ in the amount of money they have to invest, but they also choose to spend more or less of this money on their children. We concentrate here on measures of parents' spending on their children's education.[11] In the NELS questionnaire, parents were asked whether they had saved any money for their children's future education; those who reported saving money were asked how much they had saved. We use both as measures of economic investment. We also use whether or not parents send their children to a private school. While parents may send their children to a private school for a variety of reasons, the utilization of private schools very often implies

[10] Indeed, a recurrent criticism of sociological, and economic, scholarship on parental investments is that it has not looked at a wide enough range of resources (Coleman 1988). At the same time, as the results will show, our overall conclusions about the Trivers-Willard hypothesis do not stand or fall on the inclusion or exclusion of any one measure of parental investment or even of any one *type* of investment.

[11] Investments in education benefit children not only in terms of their occupational future. Access to more privileged educational institutions (e.g., private schools, elite colleges) also increases the likelihood that the child's peers will be from high-status families and, more important from a sociobiological perspective, increases the likelihood that the child will marry and reproduce with a high-status mate.

salient financial considerations. Another measure of economic investment we use is the number of educational items families have in their homes, such as reference books and periodicals.[12] The presence of these objects in the home is associated with both superior achievement within school and higher incomes as adults, even for children of similar socioeconomic backgrounds (Teachman 1987; Downey 1995; Fejgin 1995). As with private schooling, the acquisition of educational objects implicates considerations beyond the economic, yet the objects also entail expenses that parents could have foregone.

*Interactional investments.*—Financial expenditures may greatly enhance children's futures, but several studies also show that children benefit from greater personal involvement by parents in their education (Muller 1993; Sui-Chu and Willms 1996; Carter and Wojtkiewicz 1997). Parents may provide instruction and guidance to their children by regularly talking with them about their educational experiences. We measure the amount of parent-child interaction about education by how often children talk to their parents about course selection, school activities, and class material. Parents may be more or less actively involved in their child's school, which we measure in terms of whether parents have gone to a school event, attended a school meeting, or visited the child's classes in the current school year. Parents may also participate more or less actively in the school's parent-teacher organization, which allows them to receive information about curricula and perhaps also to influence school policies or teacher expectations in their child's favor. We measure affiliation with a parent-teacher organization in terms of membership, meeting attendance, and involvement in the organization's activities.

*Supervisory investments.*—Just as parents are more or less closely involved in their child's schooling, they also more or less closely supervise their child's activities outside of school. In rational choice theory, effort spent monitoring and supervising the activities of other persons is a cost no different than spending money (Becker 1981; Hechter 1987). Parental supervision is associated positively with improvements in children's self-reliance, happiness, sense of social responsibility, and educational success (Baumrind 1989). Here, we use a scale of parental supervision that measures how much effort parents spend trying to find out what their child does outside of school, who the child's friends are, and how the child spends her or his money.

*Social investments.*—In developing the concept of "social capital," Coleman (1988, 1990, pp. 300–21) has argued that overlap between the interactional networks of parents and children may provide important

[12] When a personal computer is included among educational objects in the home, the relevant results do not change.

TABLE 1

DESCRIPTIVE STATISTICS FOR PARENTAL INVESTMENT AND SOCIOECONOMIC STATUS, NATIONAL EDUCATIONAL LONGITUDINAL SURVEY, 1988

| Variable Name | Description | Metric | Mean | SD | *N* | Source |
|---|---|---|---|---|---|---|
| Measures of Parental Investment: | | | | | | |
| Economic investment in child's future: | | | | | | |
| Started saving for child's education | Whether parent(s) have begun saving for their child's education after high school | 0 = no, 1 = yes | .50 | .50 | 18,417 | Parent |
| Money saved for college | Amount of money parents have saved for child's future education | Thousands of dollars | 5.52 | 5.26 | 8,542[a] | Parent |
| Private school | Child attending a private school in eighth grade | 0 = child in public school<br>1 = child in private school | .20 | .40 | 21,188 | School |
| Educational objects in home[b] | Presence in home of (1) place to study, (2) daily newspaper, (3) regular magazine, (4) encyclopedia, (5) atlas, (6) dictionary, (7) more than 50 books, (8) pocket calculator, (9) typewriter | Number of items | 6.95 | 1.67 | 19,874 | Student |

| | | | | | | |
|---|---|---|---|---|---|---|
| Parental involvement in child's education: | | | | | | |
| Talk with child about school[b] ..... | Frequency child talks to parents about (1) school activities, (2) course selection, (3) things studied in class, and talks to (4) mother or (5) father about planning high school program | 0 = has not talked to parents about any of these to 10 = has talked more than three times this year to parents about each of these | 6.67 | 2.38 | 20,188 | Student |
| Involvement with child's school ..... | In the current school year, parents have (1) attended a school event, (2) attended a school meeting, (3) spoken with child's teacher or counselor, (4) visited child's classes | 0 = parent has not done any of these to 4 = parent has done each of these | 2.15 | 1.21 | 15,417 | Student |
| Parent-teacher organization[b] ..... | Parent (1) belongs to PTO, (2) attends PTO meetings, (3) takes part in PTO activities | 0 = parent does none of these to 3 = parent does each of these | .98 | 1.13 | 20,280 | Parent |
| Supervision of child's activities: | | | | | | |
| Monitoring of child's behavior[b] ..... | Parents try to find out (1) who child's friends are, (2) how child spends free time, (3) where child goes after school, (4) where child goes at night, (5) how child spends her/his money | 0 = parents try "not at all" to find out any of these to 15 = parents try "a lot" to find out each of these | 9.78 | 3.74 | 12,555 | Student[c] |
| Investment in social capital: | | | | | | |
| Knows child's friends ..... | No. of eighth grader's friends parent know by first name or nickname | No. of friends known (maximum 5) | 3.56 | 1.69 | 20,305 | Parent |
| Knows child's friends' parents ..... | No. of friends' parents child's parent knows | No. of friends' parents known (maximum 5) | 2.67 | 1.69 | 20,305 | Parent |

TABLE 1 (*Continued*)

| Variable Name | Description | Metric | Mean | SD | *N* | Source |
|---|---|---|---|---|---|---|
| Investment in cultural capital: | | | | | | |
| Cultural classes[b] | Student has attended classes outside school in (1) art, (2) music, (3) dance, (4) language, (5) computers | 0 = no classes to 5 = classes in all of these areas | .49 | .76 | 19,245 | Parent |
| Cultural activities[b] | Student has gone to (1) art, (2) science, (3) history museums | 0 = has not visited any museums to 3 = has visited each type of museum | 1.51 | 1.26 | 19,723 | Parent |
| Key independent variables: | | | | | | |
| Family income | Family income from all sources, 1987 | Dollars × 10,000 | 4.16 | 3.79 | 21,188 | Parent |
| Parents' education | Educational level of most highly educated parent | 0 = did not finish high school to 4 = at least an M.A. or equivalent | 2.07 | 1.15 | 21,188 | Parent |
| Male | Child's sex | 0 = female, 1 = male | .50 | .50 | 21,188 | Student |

[a] Item asked only of those parents who indicated that they had saved some money for their child's future education.

[b] Items were factor analyzed. Alphas (standardized): talk about school = .72, parent-teacher organization = .73, monitoring behavior = .84, parental control = .82, educational objects = .62, cultural classes = .53, cultural activities = .80, evaluation of parents = .82.

[c] Items from NELS follow-up questionnaire, 1990 (sophomore year).

educational benefits in its own right (see also Lee and Brinton 1996; Teachman, Paasch, and Carver 1996, 1997). When parents know their children's friends, they are better able to judge the merits of the child's peer group and may also have an additional source of information about the child's feelings and possible problems. When the parents of adolescent friends know one another, they are able to exchange information about their children's activities, help one another enforce family rules, and share responsibility for monitoring and supervision. We measure social capital both as the number of the child's friends that the parent can identify by first name or nickname and the number of these friends' parents that the child's parent knows.

*Cultural investments.*—Finally, parents who regularly provide their children with the opportunity to participate in elite culture activities (e.g., theatre, museums) are considered to be investing in the "cultural capital" of their children (Bourdieu 1977). As elite tastes and cultural knowledge are socially valued, children with high cultural capital are theorized to be more likely to enjoy educational and occupational success and are more likely to marry a high-status partner. Studies have largely supported this thesis (DiMaggio 1982; DiMaggio and Mohr 1985; Kalmijn and Kraaykamp 1996). We operationalize Bourdieu's investment in cultural capital in terms of the child's enrolling in art, music, dance, language, or computer classes outside of school and in terms of the child's visiting art, science, or history museums.

## Measures of Socioeconomic Status and Additional Controls

Although Trivers and Willard (1973) contend that their results may be applied to humans in terms of position on a "socioeconomic scale," they do not specify how to measure socioeconomic position within a society. Because socioeconomic status has long been considered a function of a family's income and parents' education, we use both as measures of status. Family income is measured as the total income (in dollars) earned by the family from all sources in 1987, the year before the survey was given. Education is measured on a scale of progressive achievement indicating whether the most highly educated parent graduated from high school, attended college, graduated from college, or received an advanced professional degree.

We included four additional controls in our model so that possible Trivers-Willard effects are not obscured by potentially confounding variables.[13] First, we control for the number of siblings the child has (including

[13] As it turns out, the substantive conclusions of our paper are unchanged by the inclusion or exclusion of these control variables.

all full-, half-, and stepsiblings), as it is conceivable that favoritism toward males or females may be affected by family size. Second, we control for the age of the child's mother. Steelman, Powell, and Carini (1999) show that children tend to benefit from having older parents; including mother's age in the model controls for the possibility that these benefits are unequally distributed between sons and daughters. Third, to take into account the family structure effects on investment described above, we include a control for whether the child resides with both of her or his original parents. Fourth, because both parental investment and gender preferences may vary by race/ethnicity, we include dummy variables indicating the racial/ethnic background of the child (white, black, Latino, Asian, or Native American).

Because our measures of socioeconomic status are taken from the parents' questionnaire, we could use only those cases in the data set for which both student and parent questionnaires are available, which excluded 1,948 of the original 24,599 cases (7.9%). Another 1,463 cases (5.9%) were dropped because parents either did not complete the income or education questions or their questionnaires were missing information on one of the control variables.[14] This left 21,188 cases in our sample. In the models estimated below, cases were also deleted if respondents did not complete any of the questions used to construct the measure of parental investment used as the dependent variable; consequently, sample sizes for the regressions are usually less than 21,188.

## Supplemental Analyses

To ensure that our findings are not idiosyncratic to one data set, we supplement our analysis of NELS data with an examination of the 1980 High School and Beyond (HSB) study. Also conducted by the National Center of Educational Statistics, HSB is a large, nationally representative survey of adolescents that uses a format and sampling procedure similar to NELS, with three important differences. First, while the base-year respondents in NELS are eighth graders, HSB interviews high school sophomores and seniors. Our analysis of HSB here uses the tenth-grade respondents only.[15] Second, whereas NELS attempted to interview parents of all student respondents, in HSB only a randomly selected subsample of

[14] Because there is a comparatively large number of missing cases in NELS for mother's age, missing values on this variable were imputed from other independent variables.

[15] Analyses using the twelfth-grade sample yield no additional support for the hypothesis.

parents was interviewed. Third, because HSB does not contain information on the sex of the child respondents' siblings, we were unable to conduct all of the supplementary analyses for HSB that we present for NELS.

All of the measures of economic investment that we tested from NELS have clear counterparts in HSB. Three measures—whether parents had started saving for their child's future education, how much parents had saved, and whether parents have enrolled their child in a private school—are based on virtually identical phrasing in HSB and NELS; the remaining measure, educational objects in the home, differs only in that HSB asks about fewer objects. To examine interactional and supervisory investments, we include measures of how frequently parents talk with their child and how closely they monitor their child's activities. Although substantively similar to measures we use from NELS, these are based on different questionnaire items. HSB, unfortunately, does not contain any measures of social or cultural capital comparable to those in NELS. Means, standard deviations, and descriptions of the HSB measures of parental investment are provided in table 2. Sample sizes of these measures vary widely because we rely on the much smaller sample of parent questionnaires for our two measures of savings for college.

In our analysis of HSB, measures of parents' income and education are drawn from the student surveys rather than parents' reports. This was done so that the full sample could be retained when analyzing the measures of investment drawn from student or school information. In auxiliary analyses in which the sample was restricted to only those cases in which parent interviews were available, substantively identical results were obtained regardless of whether student or parent reports were used to measure education and income.

## RESULTS

### Main Effects of Sex, Education, and Income

Table 3 presents OLS and logistic regression estimates for two models of parental investment. The main-effects model estimates the effects of child's sex and parents' status on parental investment, while the interaction-effects model tests whether the relationship between child's sex and investment varies with increased status. The Trivers-Willard hypothesis is tested by the second model, but a brief consideration of the main-effects model is worthwhile, as the results indicate that our measures of parental investment behave similarly to those used in other studies. Like Carter and Wojtkiewicz (1997), we find that girls receive a higher expected level of investment than boys for several of our dependent variables. Girls have more interactions with their parents about school, are more heavily super-

TABLE 2

DESCRIPTIVE STATISTICS FOR PARENTAL INVESTMENT AND SOCIOECONOMIC STATUS, HIGH SCHOOL AND BEYOND, 1980

| Variable Name | Description | Metric | Mean | SD | *N* | Source |
|---|---|---|---|---|---|---|
| Measures of parental investment: | | | | | | |
| Started saving for child's education | Whether parent(s) have begun saving for their child's education after high school | 0 = no, 1 = yes | .48 | .50 | 2,390 | Parent |
| Money saved for college | How much money parents have saved for their child's future education | Thousands of dollars | 3.04 | 3.28 | 1,016[a] | Parent |
| Private school | Child attending a private school in tenth grade | 0 = child in public school<br>1 = child in private school | .13 | .36 | 20,667 | School |
| Educational objects in home[b] | Presence in home of (1) place to study, (2) daily newspaper, (3) encyclopedia, (4) more than 50 books, (5) pocket calculator, (6) typewriter | Number of items | 4.60 | 1.29 | 19,387 | Student |

| | | | | | | |
|---|---|---|---|---|---|---|
| Talk with child[b] | Frequency child talks to parents about personal experiences and planning high school program | 0 = does not talk with parents about either of these to 4 = talks with parents "every day" about personal experience and "a great deal" about planning high school program | 3.45 | 1.44 | 20,152 | Student |
| Monitoring of child's behavior[b] | Parents (1) keep close track of how child is doing in school and (2) almost always know where child is and what child is doing | 0 = neither parent does either of these to 3 = parents do both of these | 2.51 | .79 | 19,954 | Student |
| Key independent variables: | | | | | | |
| Family income | Estimated family income from all sources, 1980 | Dollars × 10,000 | 2.03 | .99 | 20,667 | Student |
| Parents' education | Educational level of most highly educated parent | 0 = did not finish high school to 4 = at least an M.A. or equivalent | 1.76 | 1.22 | 20,667 | Student |
| Male | Child's sex | 0 = female, 1 = male | .49 | .50 | 20,667 | Student |

[a] Item asked only of those parents who indicated that they had saved some money for their child's future education.
[b] Items were factor analyzed. Alphas (standardized): monitoring of activities = .54, talk with parents = .63, educational objects = .54.

TABLE 3

UNSTANDARDIZED COEFFICIENTS FROM REGRESSIONS OF PARENTAL INVESTMENT MEASURES USING THE NATIONAL EDUCATIONAL LONGITUDINAL STUDY, 1988

| MEASURE OF INVESTMENT | MAIN-EFFECTS MODEL | | | INTERACTION-EFFECTS MODEL | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Education | Income | Male | Education | Income | Male × Education | Male × Income |
| Economic investment in child's education: | | | | | | | | |
| Started saving for child's education[a] | .071* | .282*** | .096*** | −.040 | .291*** | .138*** | .011 | .008 |
| | (.031) | (.017) | (.006) | (.101) | (.026) | (.014) | (.035) | (.017) |
| Total money saved for college | .266** | .456*** | .521*** | .017 | .366*** | .524*** | .082 | −.027 |
| | (.097) | (.054) | (.001) | (.337) | (.095) | (.028) | (.124) | (.039) |
| Private school[a] | −.016 | .364*** | .131*** | −.196 | .268*** | .073*** | .018 | .013 |
| | (.038) | (.019) | (.005) | (.123) | (.043) | (.012) | (.037) | (.011) |
| Educational objects in home | .032 | .371*** | .057*** | .066 | .368*** | .064*** | −.015 | .005 |
| | (.021) | (.011) | (.003) | (.069) | (.017) | (.006) | (.023) | (.008) |
| Involvement in child's school: | | | | | | | | |
| Talk with child about school | −.460*** | .394*** | .043*** | −.640*** | .375*** | .044*** | .023 | .022 |
| | (.032) | (.017) | (.005) | (.109) | (.026) | (.009) | (.035) | (.012) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Involvement with child's school | .054** | .216*** | .028*** | .271*** | .253*** | .026*** | −.072*** | .001 |
| | (.019) | (.010) | (.003) | (.059) | (.014) | (.005) | (.020) | (.007) |
| Parent-teacher organization | .013 | .183*** | .045*** | .019 | .184*** | .042*** | −.014 | .008 |
| | (.015) | (.008) | (.003) | (.040) | (.013) | (.005) | (.015) | (.006) |
| Supervision of child's activities: | | | | | | | | |
| Monitoring of child's behavior | −.949*** | .226*** | .005 | −.834*** | .299*** | −.012 | −.126 | .006* |
| | (.066) | (.035) | (.009) | (.242) | (.055) | (.018) | (.081) | (.003) |
| Investment in social capital: | | | | | | | | |
| Know child's friends | −.313*** | .248*** | .022*** | −.379*** | .235*** | .023*** | .010 | .010 |
| | (.022) | (.012) | (.003) | (.068) | (.018) | (.006) | (.022) | (.008) |
| Know child's friends' parents | −.166*** | .219*** | .036*** | −.209** | .210*** | .035*** | .010 | .007 |
| | (.022) | (.012) | (.003) | (.064) | (.020) | (.006) | (.022) | (.008) |
| Investment in cultural capital: | | | | | | | | |
| Cultural classes | −.381*** | .152*** | .028*** | .025 | .201*** | .043*** | −.097*** | −.028*** |
| | (.098) | (.005) | (.002) | (.027) | (.010) | (.004) | (.011) | (.004) |
| Cultural activities | .029 | .277*** | .034*** | .078 | .296*** | .038*** | −.025 | .003 |
| | (.017) | (.009) | (.003) | (.048) | (.013) | (.005) | (.018) | (.007) |

NOTE.—Robust SEs are in parentheses. *N*s range from 8,542 to 21,188 (see table 1). Models include additional controls for respondent's race/ethnicity, marital status of parents, mother's age, and number of siblings in family.

[a] Logistic regression of dichotomous dependent variable, all others use OLS regression.

* $P < .05$ (two-tailed test).

** $P < .01$.

*** $P < .001$.

vised by their parents, have a greater investment in social capital, and are more likely to have taken cultural classes outside of school than boys.[16] These apparent advantages do not carry over to economic investment, however: parents of boys are more likely than parents of girls to have begun saving for their child's future education, and on average they have also saved more money.

Consistent with Muller and Kerbow (1993) and Muller (1993), the results for the main-effects model also indicate that education and income strongly and positively affect the provision of many different forms of parental investment, including those not directly related to available material resources.[17] All of our measures of parental investment are positively affected by increases in parents' education. Meanwhile, the only measure of investment not positively affected by increases in family income is parents' monitoring of their children. That the effects of income on this dependent variable differ so markedly from the other measures of investment raises the possibility that monitoring (at least as operationalized here) may not be an appropriate measure of parental investment; instead, it may reflect other qualities of parents, such as a tendency toward authoritarian behavior or a more general propensity toward regulation.

## Testing the Trivers-Willard Hypothesis

The Trivers-Willard hypothesis predicts that increases in education and income should yield greater returns in parental investment for sons than for daughters. The interaction effects model in table 3 tests the Trivers-Willard hypothesis by adding interaction terms that test whether the effects of increases in parents' status differ for boys and girls. The measures of investment used here are constructed so that the coefficients of the interaction terms will be positive when effects are consistent with the hypothesis and negative when inconsistent.

As may be seen in table 3, however, very few of the interaction effects

[16] While we focus on the Trivers-Willard hypothesis, others might offer evolutionary explanations for some of the *main* effects of gender on investment that we observe. For example, parents may invest more in the cultural capital of daughters than sons because this is perceived as more important for daughters in luring a mate. Parents may supervise or invest more in the social capital of daughters to better ward off unapproved matings (which, in an evolutionary sense, have a greater cost for parents of daughters than parents of sons). None of these change the *interaction* effects between sex and status that Trivers and Willard predict.

[17] Comparing standardized coefficients (not shown), the effect of education on all the interactional, social, and cultural measures is significantly stronger than the effect of income. Education and income more equally affect economic investment; not surprising, financial investments in children are strongly impacted by parents' earnings.

are significant. Contrary to the expectations of the Trivers-Willard hypothesis, we observed few differences between boys and girls in the effect of either parents' education or income on the amount of investment received. In the interaction of sex with education, significant interaction effects were observed for only two (of 12) measures of investment, and both of these were in the direction *opposite* of that predicted by Trivers and Willard.[18] As parents' education increases, the expected increase in parental involvement in schooling is larger for daughters than sons. Likewise, increases in education also yield a larger increase for daughters than sons in the number of cultural classes taken.

The hypothesis fares only slightly better when we consider the interaction between child's sex and family income. Again only two of the 12 interactions we tested are significant; only one is consistent with the hypothesis. As Trivers and Willard would predict, income increases affect parents' monitoring of sons more positively than it affects their monitoring of daughters.[19] This is the only significant effect supporting the hypothesis we observed for our 12 measures of parental investment and two measures of status.[20] Given the number of tests we conducted, we cannot rule out the possibility that this single effect supporting the hypothesis is simply the result of chance.[21] In addition, we suggested earlier that the monitoring variable may be a poor measure of investment because, unlike the other measures, monitoring was not positively affected by income.

## Additional Tests Using NELS

Up to this point, our analyses provide strong reason to question the applicability of the Trivers-Willard hypothesis to these data. Few significant effects were observed, and those that were found were more often than

[18] A TOBIT regression of total dollars saved for college on the independent variables that treated those cases in which parents had saved no money as left-censored ($\tau = 0$) did not yield a significant Trivers-Willard effect ($P_{\text{male} \times \text{education}} = .83$, $P_{\text{male} \times \text{income}} = .53$).

[19] When income is measured in logged dollars, the interaction between child's sex and family income significantly affects the number of child's friends known by the parent in the direction predicted by the Trivers-Willard hypothesis ($\beta = .668$, $P = .048$). However, the effect of the interaction of sex and income on the monitoring of child's activities is no longer significant ($P = .214$).

[20] Analyses measuring status in terms of parents' occupation (0 = unemployed to 4 = upper professional [e.g., doctor, lawyer]; see Downey 1995, p. 753) also failed to reveal any significant interaction effects supporting the hypothesis.

[21] Moreover, it is unclear whether the observed interaction is actually consistent with what Trivers and Willard would predict. Instead, for all levels of income, parents spend more effort monitoring their daughters than their sons. The gap between daughters and sons narrows as income increases, but the difference is reduced by less than 40% from the lowest to highest income quintiles.

not opposite the direction that the model predicts. To check if these findings were robust to alternative specifications, we conducted a variety of additional tests. First, because (as discussed above) the children who face the most direct competition for parental resources are those with opposite-sex siblings, we tested the Trivers-Willard hypothesis on a NELS subsample that excluded all child respondents with either no siblings or with only same-sex siblings.[22] The results of these analyses are presented in table 4. Looking at the interaction-effects model, we find significant interactions between child's sex and parent's education for four variables: educational objects in the home, involvement in child's schooling, monitoring of the child's activities, and cultural classes taken. None of these significant interactions are in the direction predicted by the hypothesis. The only interaction between child's sex and family income that is significant is for the number of cultural classes taken, and this too is opposite the predicted direction.

Second, we considered the possibility that the Trivers-Willard hypothesis may only differentiate those at income extremes (perhaps because such a large majority of Americans perceive themselves as "middle class"). Comparing those families with the lowest annual incomes (less than $10,000) to those with the highest (greater than $75,000), we find no significant differences in investment that support the hypothesis. Along similar lines, we examined whether parental behavior is sensitive to local-level differences in status rather than national-level differences. When we compare families whose incomes are below the average of the other NELS respondents from their school to those whose incomes are above average, we again find no significant effects that support the hypothesis.[23]

Supplemental analyses also indicate that our results are not substantively affected by the inclusion or exclusion of any of the added control

[22] Information on the sex composition of sibling relationships was included only on the 1990 NELS follow-up survey. Accordingly, when restricting the sample to children with opposite-sex siblings, we could use only those cases for which 1988 and 1990 data were available.

[23] We also looked at several other measures of economic investment: the amount of money parents expected to pay for their child's education, parents' willingness to go into debt to finance their child's education, how early parents' had started saving for their child's future education, and whether parents had enrolled the child in a preschool or Head Start program prior to kindergarten. None revealed any significant interactions between parents' status and child's sex. In addition to looking at measures of parental investment, we looked at other items, which, while not measures of investment themselves, could be seen as proxies. Of these, the child's positive regard for her or his parent yields significant results in the direction opposite the hypothesis, while parents' educational expectations for the child yields significant results in the predicted direction.

variables.[24] The results do not substantively change when the sample is restricted to those child respondents who live with both of their original parents (eliminating all families with single parents or stepparents). Separate analyses of white, black, Hispanic, and Asian respondents indicate that the patterns observed in tables 3 and 4 are reasonably consistent across all of the groups.

## Supplemental Analyses Using HSB

As mentioned earlier, we investigated the possibility that our findings were idiosyncratic to the NELS data set by conducting a similar analysis of HSB. Table 5 presents the estimated effects of a main-effects and interaction-effects model on measures of parental investment from HSB. Comparing the main-effects model in table 5 with that of table 3 (in which the same regressors were examined using NELS) shows that results are generally consistent across data sets. Both data sets certainly evince strong main effects of income and education across various measures of investment. More important, however, when we look to the interaction-effects model in table 5, we see little support for the Trivers-Willard hypothesis. No significant interactions between child's sex and family income are observed. The interaction of sex and education is significant for only one variable, frequency of talk between parent and child; however, this effect is in the direction opposite of that predicted: increases in education yield a larger expected increase in frequency of talk for daughters than sons.

As with NELS, we performed a number of auxiliary analyses to check the robustness of our findings (available from the authors). Dividing the data into subsamples based on race and parents' marital status yields no additional support for the hypothesis. In a similar way, we find no support for the hypothesis when only those with the highest and lowest incomes are compared or when parents' education and income are measured relative to the mean of the other HSB respondents from the same school. Meanwhile, when parents' education is used as the only measure of status in the model (as was done with NELS in table 4, model 1), the interaction of child's sex and education is significant in the expected direction for

[24] Significant effects supporting the Trivers-Willard hypothesis may be obscured by our using the model to estimate the interaction of child's sex with two different measures of socioeconomic status. We tested this possibility by performing analyses in which the two interaction terms were estimated in separate models. For the full sample, we observed two substantively consequential divergences from results presented in table 3: the interaction between income and child's sex is significant for frequency of talk about school, but the sex-by-income interaction is no longer significant for monitoring of the child's activities. For the sample restricted to children with opposite sex siblings, the results were substantively identical to those presented in table 4.

TABLE 4

UNSTANDARDIZED COEFFICIENTS FROM REGRESSIONS OF PARENTAL INVESTMENT MEASURES FOR CHILDREN WITH OPPOSITE-SEX SIBLINGS ONLY USING THE NATIONAL EDUCATIONAL LONGITUDINAL STUDY, 1988

| MEASURE OF INVESTMENT | MAIN-EFFECTS MODEL | | | INTERACTION-EFFECTS MODEL | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Education | Income | Male | Education | Income | Male × Education | Male × Income |
| Economic investment in child's education: | | | | | | | | |
| Started saving for child's education[a] | .084 | .302*** | .102*** | −.055 | .304*** | .145*** | .017 | .022 |
| | (.047) | (.025) | (.010) | (.155) | (.037) | (.019) | (.050) | (.019) |
| Total money saved for college | .062 | .477*** | .498*** | −.078 | .363** | .508*** | .076 | −.048 |
| | (.148) | (.082) | (.022) | (.516) | (.128) | (.038) | (.187) | (.060) |
| Private school[a] | −.006 | .393*** | .146*** | −.304 | .274** | .088** | .037 | .023 |
| | (.064) | (.032) | (.008) | (.204) | (.059) | (.015) | (.059) | (.020) |
| Educational objects in home | .076* | .357*** | .058*** | .326* | .379*** | .066*** | −.090* | .012 |
| | (.031) | (.016) | (.004) | (.102) | (.024) | (.007) | (.035) | (.011) |
| Involvement in child's school: | | | | | | | | |
| Talk with child about school | −.464*** | .393*** | .035*** | −.685*** | .353*** | .040** | .044 | .014 |
| | (.048) | (.026) | (.008) | (.152) | (.038) | (.013) | (.050) | (.018) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Involvement with child's school | .054 | .204*** | .029*** | .231* | .234*** | .026*** | −.068* | .008 |
| | (.028) | (.014) | (.004) | (.090) | (.021) | (.007) | (.031) | (.010) |
| Parent-teacher organization | .052* | .180*** | .046*** | .050 | .187*** | .039*** | −.021 | .017 |
| | (.023) | (.012) | (.004) | (.065) | (.017) | (.007) | (.025) | (.009) |
| Supervision of child's activities: | | | | | | | | |
| Monitoring of child's behavior | −.927*** | .256*** | −.001 | −.547* | .355*** | −.010 | −.212* | .059 |
| | (.083) | (.043) | (.012) | (.258) | (.061) | (.022) | (.089) | (.031) |
| Investment in social capital: | | | | | | | | |
| Know child's friends | −.322*** | .243*** | .028*** | −.295* | −.243*** | .032*** | −.009 | −.001 |
| | (.033) | (.018) | (.005) | (.114) | (.026) | (.008) | (.036) | (.012) |
| Know child's friends' parents | −.192*** | −.209*** | .043*** | −.153 | .215*** | .046*** | −.001 | −.004 |
| | (.033) | (.018) | (.005) | (.107) | (.027) | (.009) | (.035) | (.001) |
| Investment in cultural capital: | | | | | | | | |
| Cultural classes | −.391*** | .165*** | .026*** | .032 | .210*** | .041*** | −.105*** | −.023*** |
| | (.015) | (.081) | (.003) | (.041) | (.013) | (.005) | (.016) | (.006) |
| Cultural activities | −.039 | .276*** | .041*** | .109 | .292*** | .049*** | −.021 | −.002 |
| | (.026) | (.013) | (.004) | (.074) | (.019) | (.007) | (.028) | (.010) |

NOTE.—Robust SEs are in parentheses. Models include additional controls for respondent's race/ethnicity, marital status of parents, mother's age, and number of siblings in family. Sample sizes range from 3,671 to 9,014.

[a] Logistic regression of dichotomous dependent variable, all others use OLS regression.

* $P < .05$ (two-tailed test).

** $P < .01$.

*** $P < .001$.

TABLE 5

UNSTANDARDIZED COEFFICIENTS FROM REGRESSIONS OF PARENTAL INVESTMENT MEASURES USING HIGH SCHOOL AND BEYOND, 1980

| MEASURE OF INVESTMENT | MAIN-EFFECTS MODEL | | | INTERACTION-EFFECTS MODEL | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Education | Income | Male | Education | Income | Male × Education | Male × Income |
| Started saving for child's education[a] | −.215* | .432*** | .245*** | −.649** | .371*** | .185* | .123 | .109 |
| | (.097) | (.047) | (.056) | (.247) | (.065) | (.081) | (.092) | (.108) |
| Total money saved for college | .249 | .349** | .531*** | −.104 | .283 | .511** | .124 | .042 |
| | (.232) | (.110) | (.128) | (.626) | (.168) | (.180) | (.218) | (.249) |
| Private school[a] | −.215* | .432*** | .245*** | −.474** | .293*** | .229*** | .090 | .073 |
| | (.097) | (.047) | (.056) | (.156) | (.034) | (.045) | (.047) | (.063) |
| Educational objects in home | −.014 | .247*** | .258*** | −.032 | .246*** | .255*** | .003 | .007 |
| | (.019) | (.008) | (.011) | (.051) | (.011) | (.015) | (.016) | (.021) |
| Talk with child | −.456*** | .178*** | .099*** | −.313*** | .199*** | .116*** | −.044* | −.031 |
| | (.022) | (.010) | (.013) | (.055) | (.014) | (.019) | (.020) | (.025) |
| Monitoring of child's activities | −.083*** | .047*** | .027*** | −.101** | .050*** | .020* | −.006 | .014 |
| | (.013) | (.006) | (.007) | (.032) | (.008) | (.010) | (.012) | (.014) |

NOTE.—Robust SEs are in parentheses. Models include additional controls for respondent's race/ethnicity, marital status of parents, and number of siblings in family. *N*s range from 1,016 to 20,667 (see table 2).

[a] Logistic regression of dichotomous dependent variable, all others use OLS regression.

* $P < .05$ (two-tailed test).

** $P < .01$.

*** $P < .001$.

whether the child attends a private school. This is the only significant result we observed in our analyses of HSB data that supported the Trivers-Willard hypothesis. Given that we tested several models with six dependent variables and two measures of status, this lone result could be due to chance.

## DISCUSSION

The study of parental investment is regularly cited as one of the areas of sociology that would profit most from an integration of sociobiological ideas (Rossi 1984; Nielsen 1994). This integration has been slowed by the frequent criticism of sociobiology as "untestable, and therefore unscientific" (Gould 1997, p. 51). Instead of dismissing the whole program on these grounds, however, we have taken the relative lack of testable theories in sociobiology as underscoring the importance of engaging those claims that can be empirically evaluated. Because sociologists have been accused of being too ideologically biased to evaluate sociobiological claims fairly, we have taken a number of precautions to make our test both as fair and as replicable as possible. We selected two publicly available and widely used data sets. We employed a broad variety of measures of parental investment that were all consistent with what has been used in previous studies (Schneider and Coleman 1993; Downey 1995; Teachman, Paasch, and Carver 1996, 1997; Carter and Wojtkiewicz 1997). We tested the hypothesis using many different model specifications and controls, and we tested for effects within different subsamples of NELS respondents. Nevertheless, our results almost uniformly fail to provide any support for the Trivers-Willard hypothesis in contemporary American society. We find little evidence that low-status parents favor daughters and high-status parents favor sons.

In the absence of the predicted interaction effects, we are left with a fairly strong set of main effects. While sociobiological explanations of these effects undoubtedly could be devised, the effects already comport well with more conventional sociological theories that focus on proximate causes. The significant effects of education and income on almost all of the variables we examined—including those not directly related to finances—are consistent with the longstanding arguments of status-attainment researchers, who maintain that the higher aspirations that middle- and upper-class parents have for their children lead them to evince greater interest than do working-class parents in the educational futures of their children (Blau and Duncan 1967; Kerchoff 1995). In recent years, status-attainment research increasingly has become interested in how the correlation between parents' and children's status is mediated by the provision of parental resources in childhood and adolescence (Teachman 1987;

Blake 1989; Downey 1995). The possible tendency for parents across all social strata to save more for the college education of their sons than daughters is consistent with the human capital argument that since the expected returns to education are higher for males than females, parents should be more willing to finance the education of their sons than that of their daughters (see Steelman and Powell 1991). At the same time, this argument is not without flaws of its own, not just because these results were observed in NELS but not HSB but also because we find that girls receive more investment than boys for our measures of parental involvement, monitoring, and social and cultural capital. Again, however, our results here were anticipated by Carter and Wojtkiewicz (1997), who speculate that parents' involvement in the education of daughters may be increasing because parents are less confident that their daughters will be able to rely on a husband for support (due to increases in the divorce rate and the number of women delaying marriage). As a consequence, although we do uncover significant effects in our data, none are new findings and all can be accommodated within existing sociological explanations; meanwhile, the novel effects predicted by the Trivers-Willard hypothesis are not found.

The failure of the Trivers-Willard hypothesis in our data may betray fundamental flaws in the application of the hypothesis to parental investment in adolescents, or it may simply indicate that the contemporary United States should be placed outside the scope conditions of the theory. The contemporary United States certainly differs in many ways from both the societies of our evolutionary past and most societies today. An important difference, discussed earlier, is the attenuation of the link between status and reproductive success.[25] Although critics of sociobiology have long argued that the severed link between status and fertility (*inter alia*) makes most sociobiological theories irrelevant to developed societies (e.g., Kitcher 1985), sociobiologists have countered by arguing that the advent of industrialized societies has been too novel and too recent to alter substantially the cognitive mechanisms that have evolved over thousands or millions of years. This position has allowed sociobiologists mostly to ignore the question of scope conditions for their theory, and instead sociobiologists have largely assumed that the theoretical mechanisms they postulate operate similarly across even those most diverse societies. Our results could be taken as suggesting that this assumption of cross-cultural applicability is ill founded, at least with regard to the Trivers-Willard

[25] Other environmental circumstances may also be cited; e.g., the relatively high degree of social mobility in contemporary American society may confuse or complicate a status-contingent mechanism like that posited by Trivers and Willard.

hypothesis, and that further consideration of the appropriate scope of the theory is warranted.

At the same time, we urge caution in interpreting our study as a test of scope conditions. We worry about the possibility that tests of sociobiological theories can be treated as "confirmations" when results support the theory and as "defining scope conditions" when the theory is contradicted. If the scope conditions of the Trivers-Willard hypothesis can only be discovered empirically, then it is unclear why the hypothesis should be considered more persuasive than whatever sociocultural explanations one could also devise post hoc. The whole reason why so many critics have considered sociobiology to be untestable is that its reasoning can be so flexible and unconstrained that few of its hypotheses seem genuinely falsifiable.[26] Without the ability to predict social patterns, sociobiological explanations have no decisive advantage over more traditional (and more proximately oriented) sociological explanations. What sociobiology needs is a more thorough framework for conceiving the scope of its ideas so that the question of whether a mechanism will affect behavior in a developed society can be predicted *in advance* of empirical study.

Barring this, we can note only that Trivers and Willard make clear that (*a*) the hypothesis is intended to apply to humans in the contemporary United States along a socioeconomic scale and (*b*) the hypothesis implies bias in long-term parental investment just as it implies bias in sex ratio. Subsequent research published in sociobiological journals has followed these assumptions about the hypothesis and has gone unchallenged; studies have applied the hypothesis to both the least and the most developed societies and to offspring ranging in age from infants to adult heirs. As a consequence—and given the lack of evidence supporting the hypothesis for investment in adolescents in other cultures—the evidentiary burden would now seem to fall upon those who might attribute our findings to the exceptional character of American society rather than to the more fundamental limitations of the theory.

Indeed, if our findings are correct, and socioeconomic status does not affect the treatment of sons and daughters in the manner that Trivers and Willard predict, then it questions the degree to which our understanding of why parents invest more in some children than others is augmented by reflections upon our evolutionary past. Instead, perhaps investment is best understood in terms of the proximate causes on which sociologists have concentrated: the resources possessed by parents, their education,

[26] With regard to the Trivers-Willard hypothesis, Sieff (1990) and Anderson and Crawford (1993) graft a number of complexities and contingencies onto the hypothesis that would seem to allow it to be reconciled with any pattern of parental investment that one might observe.

the number of other dependents extracting parental resources, and cultural norms on child rearing. Of course, our findings should not be taken as a general indictment of the sociobiological perspective, as the results here cannot speak to the many other theories that sociobiologists have offered. Nevertheless, because sociobiology has few theories with such clear and unanticipated empirical implications, the failure of the Trivers-Willard hypothesis may occasion a rethinking of where the burden of proof should reside for sociobiological ideas that either are not readily testable or have not yet received similar empirical attention. If sociobiology is to become part of mainstream social science, then it must provide theories that are empirically testable and that lead to the discovery of what Lakatos (1970) calls "new facts"—verifiable facts about the social world that would be unknown without the theory. When sociobiology provides testable hypotheses about society, it is the professional obligation of sociologists to test these hypotheses fairly and rigorously. Where our evolutionary past can be demonstrated to influence present social behaviors in a predictable fashion, the sociobiological perspective may provide sociology with an extremely powerful tool of explanation and discovery. On the other hand, if empirical tests consistently fail to support sociobiological hypotheses, then sociologists' rejection of the perspective is simply good science.

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