Brian M. D'Onofrio *Indiana University*

Eric Turkheimer, Robert E. Emery, and K. Paige Harden *University of Virginia**

Wendy S. Slutske *University of Missouri***

Andrew C. Heath and Pamela A. F. Madden *Washington University School of Medicine****

Nicholas G. Martin *Queensland Institute of Medical Research*****

A Genetically Informed Study of the Intergenerational Transmission of Marital Instability

*Environmental or genetic influences, or both could account for the increased risk of divorce among the offspring of separated parents. Previous studies have used covariates to statistically control for confounds, but the present research is the first genetically informed study of the topic. The investigation used the Children of Twins Design with twins, their spouses, and their young adult offspring (*n *= 2,310) from the Australian Twin Registry to test whether selection on the basis of genetic or shared environment factors accounted for part of the intergenerational association. The analyses also controlled for measured characteristics of both parents. The results suggest that both environmentally mediated and genetic risk account for the intergenerational transmission, supporting the roles of both selection and causation.*

Department of Psychological and Brain Sciences, Indiana University, 1101 E, 10th Street, Bloomington, IN 47405 (bmdonofr@indiana.edu).

*The Department of Psychology, University of Virginia, 102 Gilmer Hall, P.O. Box 400400, Charlottesville, VA 22904.

**Department of Psychological Sciences, University of Missouri, 210 McAlester Hall, Columbia, MO 65211.

***Department of Psychiatry, Washington University School of Medicine, Campus Box 8134, St. Louis, MO 63110.

****Royal Brisbane Hospital Post Office, Queensland Institute of Medical Research, 300 Herston Road, Q 4029, Brisbane, Australia.

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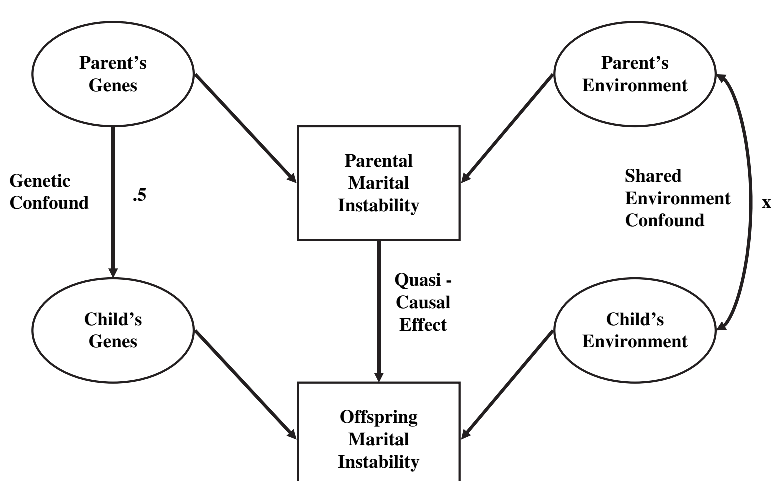
The intergenerational transmission of divorce has been found in large samples throughout the world (see Pryor & Rogers, 2001), including the United States (Greenstein, 1995) and Australia (Rodgers, 1996). In fact, research has consistently shown that parental divorce is one of the strongest predictors of marital instability (Amato, 1999). Researchers have sought to identify possible mediators of the association between parental and offspring marital instability. Various studies have examined factors such as age at first marriage and cohabitation, differences in perspectives on the costs and benefits associated with marriage, modeling of unsuccessful relationship and interpersonal skills, mate selection, and lower commitment to marriage in the offspring of divorced parents (review in Fine & Harvey, 2006). Despite their unique foci, all these efforts share one general assumption: Parental divorce increases the risk for offspring marital instability through some causal mechanisms (e.g., Amato, 2000). We refer to this view as the causal assumption.

It is possible, however, that the statistical relation between parental and offspring marital instability is not causal. Selection factors that lead to marital instability in both generations may be responsible for the association (Amato, 2000; Emery, 1999). Figure 1 presents a graphical representation of two of the main classes of confounds when studying intergenerational associations. First, common environmental factors may account for a statistical relation between a parental and an offspring characteristic. For example, couples living in poverty are more likely to separate, and socioeconomic status could be a *third variable* that explains the intergenerational association. Statistical procedures can control for possible environmental selection factors, such as socioeconomic status (reviews in Amato, 2000; Emery), but such analyses cannot control for environmental factors that have not been measured or have been measured inaccurately. Further, no study has included in-depth assessments of characteristics and psychopathology in both parents. This is a major limitation, given that parental psychopathology is associated with changes in family functioning, and the transmission of psychopathology could account for some of the intergenerational transmission of divorce. Studies of the consequences of divorce that have included measures of maternal psychopathology have underscored the important role of selection factors (Capaldi & Patterson, 1991; Emery, Waldron, Kitzmann, & Aaron, 1999). Therefore, exploring the risks for offspring relationship instability associated with the psychopathology and demographic characteristics of both parents will provide a more complete understanding of the processes responsible for the transmission of relationship instability.

Second, genetic risks might also account for the association between parent and offspring marital instability, an example of passive gene-environment correlation (Scarr & McCartney, 1983). Passive gene-environment correlation occurs when genetic factors that influence parental characteristics are passed down to the offspring and confer risk to the children. In the most extreme case of genetic confounds, the association between the familial risk factor and offspring adjustment is fully accounted for by shared genetic liability in both generations, rendering the parental variable a marker for genetic selection rather than environmental causation. Because twin studies have shown that genetic factors influence divorce (D'Onofrio et al., 2005,

FIGURE 1. ENVIRONMENTAL AND GENETIC CONFOUNDS TO INTERGENERATIONAL RELATIONS.



Note: Reciprocal effects are not considered in the current model. The direct path between the parental and the child trait is referred to as the quasicausal effect because it is consistent with a causal association but does not prove causality.

in press; McGue & Lykken, 1992), there is a possibility that genetic factors may confound the intergenerational transmission of divorce. Therefore, exploring the possible role of genetic confounds is a critical research endeavor in exploring family risk factors, such as parental divorce.

Although genes do not code for divorce, genetic factors may influence intermediate characteristics, referred to as endophenotypes (Gottesman & Gould, 2003), that increase the probability of divorce. For example, personality characteristics, such as neuroticism (Karney & Bradbury, 1995) or antisocial behavior (Emery, 1999), are associated with increased risk for divorce. Behavior genetic studies have consistently demonstrated that genetic factors account for variation in such traits (reviews in Bouchard & Loehlin, 2001; Rhee & Waldman, 2002), and a twin study illustrated that personality characteristics account for a portion of the genetic variation in divorce (Jockin, McGue, & Lykken, 1996). In light of the genetic influences on divorce, Judith Harris has claimed, "Heredity … makes the children of divorce more likely to fail in their own marriages. Parental divorce has no lasting effects on the way children behave when they are not at home" (Begley, 1998).

We are considerably more cautious, however, in drawing conclusions about the role of genetic factors explaining offspring adjustment problems associated with parental divorce. Recent behavior genetic studies have found that genetic factors play a smaller role in divorce than originally estimated (review in D'Onofrio et al., 2005). Furthermore, the source of a risk factor can be separate from the mechanisms through which a risk factor influences an offspring's adjustment (Rutter, Silberg, & Simonoff, 1993). A risk factor, such as divorce, could have an environmental effect (the risk mechanism) on children regardless of whether genetic or environmental factors account for variation in divorce (the source of the risk). Behavior genetic studies showing that genetic factors account for variability in divorce raise the possibility that genetic factors account for the relations between parental divorce and offspring adjustment, but this evidence does not substantiate the role. To our knowledge, no investigation has yet explored the possibility that genetic factors confound the intergenerational transmission of marital instability.

Because studies of the intergenerational transmission of divorce obviously cannot use experimental designs, research must use methodologies that disentangle risk factors that typically go together, especially genetic and environmental processes (Rutter, Pickles, Murray, & Eaves, 2001). The need to incorporate behavior genetic designs in studies of risk factors and intergenerational transmission has been echoed by family researchers (Booth, Carver, & Granger, 2000) and developmental psychologists (Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000). Many genetically informative designs can be used to explore environmental risk processes (review in Rutter et al., 2001). The current analyses used the Children of Twins Design, an approach that utilizes comparison groups that differ in their genetic and environmental risks associated with parental characteristics, such as divorce (D'Onofrio et al., 2003, 2005; Gottesman & Bertelsen, 1989; Heath, Kendler, Eaves, & Markell, 1985).

The Children of Twins Design

Most studies of the intergenerational transmission of marital instability have calculated the difference between offspring from intact and divorced homes, referred to as the divorce effect, by comparing offspring whose parents are divorced to unrelated offspring from intact families. Statistical controls often are used to help account for the differences between the unrelated families, but it is impossible to measure all potential selection factors. In the Children of Twins Design, offspring of adult twins who are discordant for divorce (one cotwin has divorced and the other has not) are compared. That is, offspring from divorced families are compared to their cousins who did not experience the separation of their parents, a within – twin family comparison (see Rodgers, Cleveland, van den Oord, & Rowe, 2000, for an explanation of the advantages of making comparisons at multiple levels of analysis). The comparison of cousins differentially exposed to parental divorce controls for measured and *unmeasured* risk factors that all offspring in an extended family share.

Offspring of identical twins represent a unique comparison group. Because identical (monozygotic) twins share 100% of their genetic makeup, the children of each twin are genetically related to their twin parent and their aunt/uncle similarly (i.e., the offspring share 50% of their genetic makeup with their twin parent and their parent's cotwin). The comparison of offspring of discordant identical twins, therefore, contrasts cousins who share the same degree of genetic risk associated with divorce from their twin parents. As a result, the divorce effect using children from identical twin pairs discordant for divorce is free from genetic confounds associated with divorce in the twin parents. Another important and often unrecognized advantage of the Children of Twins Design is that it controls for *environmental* (measured and unmeasured) factors in the twin family that make the twins similar because twins share their family environment as well as their genes. If the divorce effect in discordant identical families is lower than the divorce effect using unrelated comparisons, this suggests that selection factors, either genetic or shared environmental confounds, account for part of the intergenerational transmission. See D'Onofrio et al. (2005) for a graphical representation of the logic underlying the approach.

The Children of Twins Design can also help to separate common environmental and genetic processes by comparing the offspring of identical and fraternal (dizygotic) twins discordant for divorce. Offspring of identical twins are genetically related to each other as half siblings (they share approximately 25% of their genes), whereas offspring of fraternal twins are genetically related as cousins (sharing roughly 12.5% of their genes). Because genetic influences are controlled more fully in the offspring of identical twins, a larger within – twin family divorce effect (the comparison of offspring in intact and divorced households) in fraternal twin families than identical twin families suggests that *genetic* factors are partly responsible for the association. A lower divorce effect in offspring of identical twins than fraternal twins would suggest that the selection factor would be correlated with genetic risk. If there is no difference in the within – twin family divorce effects between identical and fraternal families, shared environmental factors would be most salient because the salient confounds would not correlate with genetic risk associated with divorce.

In summary, the Children of Twins Design is able to partition an intergenerational association into three processes. First, the difference among offspring of discordant identical twins provides an estimate of the processes specifically related to divorce within a nuclear family (consistent with a causal connection). Second, small divorce effects in identical *and* fraternal twin families imply that environmental factors that influence both generations account for the intergenerational transmission (supporting selection effects). Third, a small divorce effect in offspring of identical twins discordant for divorce but a larger divorce estimate in fraternal twin families suggests a shared genetic pathway is responsible for the increased divorce risk in the offspring (also supporting selection effects).

A qualification is in order. The design offers many advantages over solely relying on statistical controls to account for possible confounds, but it does not control for every possible environmental and genetic factor. The approach does not control for environmental factors that only influence one twin and their offspring (D'Onofrio et al., 2003). The influence of the spouse of the twins also is not accounted for in the design (Eaves, Silberg, & Maes, 2005). The Children of Twins Design further assumes that there is no assortative mating (Heath et al., 1985), the tendency for individuals to marry individuals who are similar to them. The assumption can limit the ability of the design to differentiate between environmental and genetic risk processes (see Discussion). Given these limitations, including measures of nonshared environments and characteristics of the nontwin parents in an attempt to account for these potential confounds and assumptions can provide a more stringent test of the causal processes that account for the intergenerational transmission (D'Onofrio et al., 2005; Rutter et al., 2001).

The current article sought to test whether the intergenerational transmission of divorce is robust to the use of a quasiexperimental approach of controlling for possible confounds, as well as the use of measured covariates. The present analyses, using a sample of adult twins, their spouses, and their offspring from Australia, included detailed measures of possible selection factors in both parents to provide a more precise examination of selection effects. The inclusion of the measured characteristics, particularly assessments of psychopathology in both parents, represents a major advance over many of the existent studies of the intergenerational transmission of divorce that have only included measures of mothers as possible selection factors. The analyses would support an environmentally mediated causal influence of parental marital instability on offspring instability if the statistical relation between parents on offspring remained when comparing offspring of identical twins discordant for divorce (a within – twin family comparison that accounts for unmeasured environmental and genetic factors) and the use of statistical covariates from both parents to account for possible confounds. If the relation between parents and offspring was reduced by the use of the genetically informed design or the covariates, characteristics of parents or their families correlated with parental divorce would partially or fully explain the intergenerational transmission. Previous analyses of the Australia data set have found that most measures of offspring adjustment related to parental divorce, such as drug, alcohol, behavior, internalizing, and adjustment problems (D'Onofrio et al., 2005), are not the consequences of genetic or environmental confounds, in as much as the design can control for these selection factors. In contrast, the association between parental divorce and cohabitation, a well-known risk factor for later relationship instability, was completely accounted for by selection factors (D'Onofrio et al., 2006). A large Children of Twins study in the United States also suggests that parental divorce may not cause increased depressive symptoms; rather, shared genetic liability in the parents and offspring may account for the association (D'Onofrio et al., in press). These findings underscore the importance of studying the intergenerational transmission of marital instability in a quasiexperimental design.

Method

Samples

Adult twins for the current analyses were drawn from the Australian National Twin Register. The twins in the current cohort were first assessed in 1980 with a self-report survey (n = 8,183 individual twins, 69% response rate; Jardine & Martin, 1984). In 1988, the twins were assessed again with a mailed questionnaire (n = 6,327 individuals, 83% response rate; Heath & Martin, 1994). Relatives of the twins (n = 14,421), including 3,318 spouses, were also assessed with a similar questionnaire (Lake, Eaves, Maes, Heath, & Martin, 2000). Finally, the twins and their spouses (86% response rate) were assessed via telephone beginning in 1992 with a semistructured diagnostic interview (Heath et al., 1997). The study included 5,889 individuals from the twin pairs and 3,844 of their spouses. The sample is primarily White, consistent with the demographics of Australia. Tests for self-selection biases in the longitudinal sample have found few detectable differences in terms of risk for abnormal behavior (Heath et al., 1997).

The Children of Twins study was designed to examine the intergenerational transmission of psychopathology and risk associated with divorce. Offspring of adult twins were selected from a control group and three at-risk subgroups: (a) twins with a history of alcohol dependence or conduct disorder, or both, (b) twins with a history of depression, and (c) twins with a history of divorce. The adult twins were required to consent for the researchers to contact their children, and the offspring also had to agree to participate. Approximately 85% (n = 1,409) of the targeted adult twins completed the screening, and 82% (n = 2,554) of the possible offspring completed the telephone interview. The offspring ranged from 14 to 39 years old (M = 25.1 years), and 51% were female. Offspring over the age of 18 years old (n = 2,334) were included in the current analyses. More details about the adult and offspring samples are found elsewhere (D'Onofrio et al., 2005).

Measures

Characteristics of twins and their spouses. A lifetime history of the adult twins' living arrangements was included in 1988 questionnaire, and all assessments included items on current marital status and duration of the current status. On the basis of these items, a lifetime history of divorce and marital separation (including separation from a cohabiting relationship longer than 6 months) was calculated for each twin. Living together as though married for 6 months or more is considered common law marriage in Australia; thus, we refer to the relationships as marriages. Twin analyses indicated that additive genetic factors accounted for 15% (95% CI = 5% – 19%) of the variation in marital instability (D'Onofrio et al., 2005). Nonshared environmental factors, environmental influences that make siblings and twins different, accounted for most of the variance (85%, 81% – 90%), with a minimal role of environmental factors that equally influenced both twins (0%, 0% – 7%).

The twins and their spouses each completed the Semi-Structured Assessment for the Genetics of Alcoholism (Bucholz et al., 1994) as part of the 1992 study. The semistructured interview, developed on the basis of previously validated psychiatric research interviews, has demonstrated moderate to high reliability (Bucholz et al., 1994), especially in Australia (Slutske et al., 1998). The interview assessed various characteristics of the adult twins and their spouses that have been shown to increase the risk of relationship instability (e.g., Fine & Harvey, 2006). These parental characteristics were included in analyses as measured covariates. Each parent's age at the birth of their first child was calculated using the twins' and their spouses' reports of all their children's dates of birth. Church attendance was measured on a five-point Likert scale ranging from *never* to *more than once a week*. Highest level of education was measured on a seven-point Likert scale ranging from *less than 7 years' schooling* to *university postgraduate training*. Parental psychopathology was measured with the number of lifetime symptoms of *DSM-III-R* diagnoses for conduct disorder, alcohol abuse, and major depression; lifetime history of ever using an illegal drug; and lifetime history of suicidality as measured on a five-point Likert scale ranging from *no thoughts or plans of suicide* to *a previous serious suicide attempt* (Statham et al., 1998). Spousal information was only included in the analyses if the spouse was the biological parent of all the offspring in the current study. The twin and spousal information was converted to maternal and paternal variables.

Offspring Relational Instability

The offspring also completed the Semi-Structured Assessment for the Genetics of Alcoholism, which included a number of items assessing current marital status and history of cohabitation. On the basis of these variables, a lifetime history of relationship instability was calculated. Similar to the adult twins, relationship instability included individuals who had divorced, separated, had more than one marriage (excluding widowers), or had ended a cohabiting relationship (defined as living with someone for over 6 months).

Sample Propensity Weights

As described above, the sample of twins for whom offspring data are available (the Children of Twins sample) was selected from a larger, volunteer twin sample (the 1992 study). To avoid bias in parameter estimates and standard errors introduced by sample selection, we constructed a set of sample propensity weights for the twin data using the procedure outlined in Heath, Madden, and Martin (1998). First, we identified predictors of whether one or both twins from a pair from the larger sample participated in the Children of Twins sample. Predictors of pairwise participation in the subsample were examined because selection occurred at the twin-pair level. Propensity weights were then constructed using the inverse probability of a pair participating in the Children of Twins sample. The ability of these propensity weights to remove bias introduced by sample selection and nonrandom attrition was tested by comparing the weighted and unweighted distributions for demographic and psychiatric traits in the subsample and the 1992 sample of the adult twins (results available upon request; Harden et al., 2007). The lifetime risk of separation and multilevel linear models described below were estimated using the sample propensity weights to approximate population-based parameters and to avoid bias in standard errors.

RESULTS

The Children of Twins Design is a three-level design (Nance & Corey, 1976). The 2,334 offspring were nested into 1,224 nuclear families, which were nested in 836 twin families. Divorce status was missing for one twin in 14 of the families, influencing 24 offspring in the study. These incomplete data, however, were not associated with offspring relationship instability (odds ratios [OR] $= 0.89, p = .90$) or parental divorce status (OR $= 0.81$, $p = .66$). As a result, the data were considered missing at random, and these twin families and offspring were removed from the analyses, leaving 2,310 offspring in the analyses.

Our approach to analyzing the adult twin and Children of Twins data involved several steps. First, survival analyses were conducted, ignoring the clustered nature of the data, to estimate the risk of marital separation for offspring in intact and divorced families. Second, the risk of relationship instability was calculated separately for offspring from twin families who were discordant for divorce, which provides a comparison of cousins differentially exposed to parental divorce. Third, the offspring of discordant twins were compared separately by zygosity status. The comparison of offspring of identical twins controls for genetic risk associated with parental divorce from the twin parents. Thus, the comparison of cousins from identical twin families provides a more stringent test of causality, although it does not account for every possible confound. No significance testing was done at this stage because the estimates of risk are purely descriptive. Formal significance testing was completed using models that could both address the nonindependence of the observations and include the sample weights. Fourth, associations between measured parental characteristics and offspring relational instability were estimated to identify covariates that would be included in subsequent genetically informed models. Finally, multilevel models were used to incorporate the measured characteristics of the parents and the quasiexperimental approach available in the Children of Twins Design, as outlined in the introduction. The multilevel models used in the current project are regression-based analyses that could account for the nonindependence of the observations in the sample (e.g., multiple offspring per nuclear family were included, which were nested under twin families). The multilevel models estimated the magnitude of the intergenerational transmission comparing unrelated individuals, offspring of all twins who were discordant for divorce, and offspring of identical twin families who were discordant for divorce. The multilevel models also allowed measured covariates to be included and weighted the analyses accordingly. Each model is explained in detail below.

Association Between Parental and Offspring Relationship Instability Using Different Comparisons

Survival analyses were used to explore the intergenerational association of marital instability because of the right-censored nature of the offspring data (all the offspring have not lived through the risk period for the outcome). These analyses, ignoring the nested nature of the data, were conducted to provide initial estimates of the intergenerational association. The offspring who experienced a divorce and separation were initially compared to individuals in the entire sample, regardless of whether they had ever entered into a cohabiting or married relationship. The analyses were also conducted on a restricted subset of the data that only included offspring who had ever been in a relationship to determine whether earlier initiation of intimate relationships accounted for the higher rate of separation in the offspring from divorced families, but the results did not change (results available upon request).

For the entire sample, 10.3% (237/2,310) of the offspring had ever separated or divorced. The weighted percentage, which was based on the propensity sampling weights, was 10.1%. The risk for marital instability, controlling for the gender of offspring, was estimated using Cox Regression Models (Allison, 1995) at the age of 32, the last age at which comparisons could be made across all subgroups. The weighted estimated risk of separating, a Kaplan-Meier nonparametric estimate, was 18.1%. Table 1 presents the risk for relationship instability, including the raw percentages, the weighted percentages, and the Kaplan-Meier estimates, using multiple comparisons. Using the entire sample, offspring from intact families had a lower risk of separating (16.0%) than offspring from divorced homes (25.2%). The results replicate the established finding that offspring from divorced families have higher rates of marital instability.

Instead of comparing offspring from unrelated families, the comparison of twins discordant for divorce contrasted cousins (one set of cousins experienced the separation of their parents but the other cousins did not), which provides a stronger test of causality because cousins share traits that could confound the intergenerational transmission. If parental divorce caused offspring

Table 1. *Risk for Relationship Instability in Offspring Using Multiple Comparison Groups*

Family Structure	Raw %	Weighted %	Weighted Estimated Risk	*n*
Entire sample				
Parents married	9.2	8.8	16.0	1,749
Parents divorced	13.6	14.5	25.2	561
Discordant twin families				
Parents married	10.3	8.7	15.5	464
Parents divorced	12.3	12.6	22.9	382
Discordant fraternal twin families				
Parents married	10.8	9.1	16.9	240
Parents divorced	9.1	12.2	24.1	176
Discordant identical twin families				
Parents married	9.8	8.3	17.1	224
Parents divorced	15.1	12.1	22.0	206

Note: Weighted estimates were based on analyses using the propensity sampling weights. Estimated risks are based on Kaplan-Meier nonparametric survival analyses at the age of 32, controlling for the gender of the offspring.

marital instability, the relation would be present at all levels of analysis (e.g., Rodgers et al., 2000). Offspring from the intact twin families had less risk of separating (15.5%) than their cousins from divorced households (22.9%), a difference that is similar in magnitude to the comparison of unrelated individuals, although perhaps a bit smaller.

The prevalence and risk for offspring relationship instability were calculated separately for offspring of identical and fraternal twins discordant for divorce. Comparison of the risks among the groups provides an initial assessment of the processes responsible for the intergenerational association between parental and offspring marital instability (for an explanation of the rationale see D'Onofrio et al., 2003; Gottesman & Bertelsen, 1989). A comparison of the offspring of identical twins discordant for divorce provides the strongest evidence of whether selection factors are responsible for the intergenerational relation. Offspring of identical twins who are discordant for divorce receive the same genetic risk associated with divorce from the twins and shared environmental experiences that make the adult twins similar. Therefore, differences between these two groups suggest that factors within twin families associated with divorce account for the association, consistent with the theory that divorce causes the difference between offspring in intact and divorced homes. In contrast, if the magnitude of the difference in the offspring of the discordant identical twins is less than the comparison of unrelated offspring, the pattern suggests that selection factors are responsible for part of the intergenerational association. A comparison of offspring of fraternal twins discordant for divorce provides a similar test, except these offspring differ from the children of identical twins with respect to genetic risk associated with divorce from the twin parents. Therefore, genetic factors are implicated if the divorce effect in the offspring of fraternal twin families is larger than in the offspring of identical twins discordant for divorce. If the magnitude of the divorce effect is equivalent in each type of twin family and lower than the divorce effect estimated using unrelated offspring, common environmental factors are implicated as selection factors.

Children of identical cotwins whose parents remained married had a 17.1% risk for divorce, whereas children of identical cotwins whose parents divorced had a 22.0% risk for divorce. The offspring of discordant identical twin pairs differed in their risk for divorce, consistent with the hypothesis that the intergenerational association is causal, although the difference is again somewhat smaller than was found in the comparison of unrelated individuals. The difference in risk in the offspring of fraternal twins discordant for divorce (16.9% vs. 24.1%) appears to be larger than the difference in the offspring of identical twins discordant for divorce. The pattern of results suggests that risk factors specifically associated with parental divorce influence offspring risk for marital instability (the difference in marital stability when comparing offspring of identical twins discordant for divorce). Genetic factors may partially contribute to the risk of relationship instability in the offspring, however, because (a) the divorce effect is smaller in identical twin families than the comparison of unrelated individuals and (b) the divorce effect is larger in offspring of fraternal twins discordant for divorce compared to offspring of discordant identical twins.

Associations Between Parental Characteristics and Offspring Relationship Instability

The Children of Twins Design cannot control for confounds that vary within *twin* families (i.e., environmental influences that influence one twin and their offspring and the effects of the spouses of the twins) and the approach assumes no assortative mating. Therefore, association between characteristics of both parents and offspring relationship instability was estimated in order to include measurements of potential confounds in subsequent genetically informed analyses. Cox regression analyses with each individual parental characteristic were conducted initially to identify characteristics of the parents associated with offspring relationship instability and to reduce the number of variables included in the genetically informative analyses. Because of the incomplete data on the mothers and fathers, the Cox regression analyses were based on data sets in which the missing scores were estimated through multiple imputation (MI) (Little & Rubin, 1987). As a result, the estimates of the standard errors using MI reflect the uncertainty of the data resulting from the missing values. More information was available for maternal versus paternal characteristics. The percentage of missing values for mothers ranged from 4.2% to 8.5%, and the percentage of missing values for fathers ranged from 11.0% to 24.5%. Because the nested nature of the data was ignored in the analyses, the significance levels are biased downward. Therefore, the analyses represent a liberal approach to identifying salient variables. Variables that were marginally related to offspring relationship instability were used in the subsequent multilevel models. The regression coefficients and OR associated with offspring relationship instability are presented in Table 2. The results suggest that parental church attendance, age at first child, history of conduct disorder, depression, and illegal drug use were associated with offspring separation. These variables from both parents were included in the subsequent genetically informed analyses.

Multilevel Models Utilizing Methodological and Statistical Controls

Multilevel models were conducted to quantify the magnitude of the association between parental and offspring relationship instability using the different comparison groups within the Children of Twins Design, as well as to control for measured characteristics of both parents. The multilevel models accounted for the nested nature of the data and estimated risk for offspring separation contingent on the offspring's age to take into account the right-censored data. The nonlinear multilevel models were fit with the HLM 6.0 software (Raudenbush, Byrk, Cheong, Congdon, & du Toit, 2004). Extensive details and algebraic models of the approach are explained elsewhere (D'Onofrio et al., 2005). We initially fit three-level multilevel models (Raudenbush & Bryk, 2002) because the sample included multiple offspring nested in nuclear families and two nuclear families nested in each twin family. The multilevel model decomposed the residual variance in offspring relational instability into *random effects* at each level. The limited variance common to all offspring in a twin family (the highest level of analysis) caused estimation problems, however, and subsequent analyses only included two levels. For simplicity, the variance component that accounted for the nested nature of the data was the only random effect estimated in each multilevel model. The fixed effect of offspring gender was included in each model. All models that incorporated statistical controls were conducted on five multiply imputed data sets. Because of the estimation procedures used to fit nonlinear multilevel models in the software program HLM, nested models cannot be compared using the standard model fitting indices, such as changes in deviance (M. Du Toit, personal communication, September 6, 2006; Raudenbush et al., 2004). Therefore, our interpretations of the models are based on the magnitude of the fixed effects associated with parental divorce, made with the unstandardized coefficients (logits). Standardized estimates do not describe invariant causal processes because they are influenced by factors unrelated to the specific relationship being explored (Kim & Ferree, 1981). Standardized estimates (OR), however, were also

Table 2. *Parental Characteristics Associated With Offspring Divorce/Separation Status*

	Mother			Father		
Variables	*b*	OR	*p*	*b*	OR	*p*
Education	−.08	0.92	.26	−.06	0.94	.45
Church attendance[a]	−.10	0.90	.15	−.12	0.89	.12
Age at first child[a]	−.08	0.92	<.01	−.07	0.93	<.01
Cigarette smoking	.07	1.07	.70	.14	1.15	.59
Conduct disorder[a]	.14	1.15	.09	.11	1.12	.16
Alcohol abuse	.06	1.06	.81	.17	1.19	.18
Depression[a]	.06	1.06	.04	.03	1.03	.47
Drug use[a]	.72	2.05	.05	.54	1.71	.10
Suicidality	.08	1.08	.26	.17	1.19	.17

Note: All analyses are based on five multiply imputed data sets. $N = 1{,}210$. The coefficients are based on Cox Proportional Hazard Models using multiple imputation, ignoring the nested nature of the data, and are distributed as logits. OR = odds ratios. See text for units of measurement for each variable.

[a]Included in subsequent multilevel models predicting offspring divorce/separation status.

reported for descriptive purposes. We interpret the divorce effects cautiously on the basis of their magnitude, rather than relying solely on statistical significance, because some comparisons, such as the offspring of identical twins discordant for divorce, rely on relatively small sample sizes (see Discussion).

Six multilevel models were fit; results are shown in Table 3. Model 1 included only the *phenotypic* effect of experiencing parental divorce, the comparison of offspring from divorced families to unrelated offspring in intact households. We refer to the estimate as phenotypic because it represents the unadjusted association between two measured characteristics and did not control for any genetic confounds. Parental divorce was significantly associated with offspring relationship instability (b = .65 logits, SE = 0.19, OR = 1.91, p < .001) in the first model, a finding that is consistent with previous research showing that offspring from divorced families are more likely to divorce than offspring from intact families. Model 2 included parental divorce (phenotypic) and measures of maternal and paternal church attendance, age at the birth of their first child, conduct disorder, depression, and use of illegal substances. The inclusion of the statistical controls for parental characteristics slightly reduced the divorce effect, which remained significant (b = .52, SE = 0.22, OR = 1.68, p < .05). The parameters associated with the parental variables are difficult to interpret because they estimate the unique contribution controlling for the presence of every covariate in the model. The estimates of the influence of divorce, the divorce effect, in each model are presented in Figure 2. The figure illustrates how using statistical controls of characteristics of both parents in the second model, the standard approach for controlling for possible confounds, slightly reduced the risk of offspring relationship instability related to parental separation. The results suggest that psychiatric and demographic characteristics of both parents account for only a minimal proportion of the intergenerational transmission of divorce.

Model 3 separated the association between parental divorce and offspring relational instability into between – and within – twin family effects. The effect of the average number of divorces in a twin family (0, .5 [one twin divorced], or 1 [both twins divorced]) approximates the between-family effect of divorce (Jinks & Fulker, 1970). All cousins in a twin family share this variable regardless of whether their parents divorced. The parameter associated with variable (between), therefore, reflects whether individuals with more divorce in their extended family have more marital instability than unrelated individuals who have less parental divorce in their extended family. In contrast, the within – twin family effect (within) compares cousins who were differentially exposed to parental divorce. The contrast code to compare cousins of discordant twins was based on the difference between each cotwin's divorce status and the twin-family average. Offspring from twin families who were either concordant for marital stability (both twins had not experienced divorce) or marital instability (both twins had been divorced) received a value of 0 for the within – twin family effect because there was no variation within twin pairs. The within – twin family variable effectively compared offspring from the nondivorced cotwin (−.5) to their cousins, the offspring of the cotwin who was divorced (.5). If parental divorce had a direct, environmentally mediated effect of their offspring's marital status, the association would be found within twin families, which measures the divorce effect using cousins instead of using unrelated individuals as the comparison group. The within-family effect of divorce (within) (b = .62, SE = 0.33, OR = 1.87, p = .06) in Model 3 was commensurate with the phenotypic association reported in the first model and the between – twin family effect (between) (b = .67, SE = 0.25, OR = 1.95, p < .05). Model 4 included the between- and within-family estimates as well as the statistical controls for the parental characteristics, and the statistical controls again reduced the association between parental and offspring relationship instability (b = .54, SE = 0.34, OR = 1.71, p = .11). Figure 2 illustrates how the intergenerational risk was slightly reduced when offspring whose parents were divorced were compared to their cousins from intact families. The models still suggest, however, that parental divorce was associated with offspring relationship instability when comparing cousins differentially exposed to parental divorce and including measured characteristics of both parents in the model.

Model 5 included the between-family estimate of divorce (the average of the number of divorces of the two twins), but the within-family estimate of divorce was calculated separately for the identical and fraternal twins. The strongest test of causality

Table 3. *Parameter Estimates From the Multilevel Models*

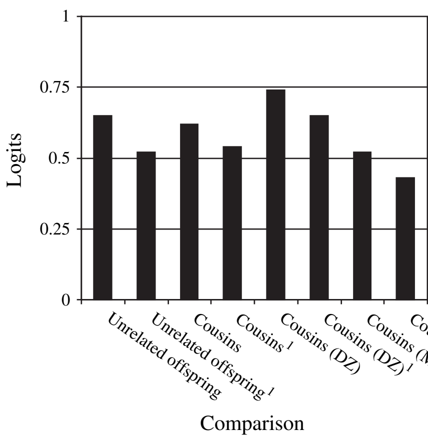
	Models											
	1		2		3		4		5		6	
Parameter	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Divorce												
Phenotypic	.65*	0.19	.52*	0.22								
Between					.67*	0.25*	.50	0.27	.68*	0.25	.50	0.27
Within					.62	0.33	.54	0.34				
Within identical									.52	0.42	.43	0.40
Within (fraternal-identical)									.22	0.65	.22	0.69
Offspring gender	−.30	0.20	−.26	0.20	−.29	0.19	−.26	0.20	−.29	0.19	−.26	0.20
Maternal variables												
Church attendance			.05	0.07			.05	0.07			.05	0.07
Age at first child			−.07	0.05			−.07	0.05			−.07	0.05
Conduct disorder			.03	0.15			.04	0.15			.03	0.15
Depression			.02	0.03			.02	0.03			.02	0.03
Illegal drug use			−.34	0.33			−.34	0.33			−.34	0.33
Paternal variables												
Church attendance			−.07	0.09			−.07	0.09			−.07	0.09
Age at first child			.01	0.04			.01	0.04			.02	0.04
Conduct disorder			−.24	0.14			−.24	0.14			−.24	0.15
Depression			.09*	0.04			.09*	0.04			.09*	0.04
Illegal drug use			−.35	0.22			−.35	0.23			−.35	0.23

Note: All parameters are unstandardized. $N = 2{,}310$. Data are weighted. Models including the measured covariates are based on five multiply imputed data sets. Model 1 compares unrelated offspring. Model 2 includes statistical covariates to the model. Model 3 separates the influence of parental divorce into between – twin families and within – twin family (offspring of discordant twins) effects. Model 4 includes statistical covariates to the model. Model 5 calculates the within – twin family effect for identical twin families and the difference between the fraternal and the identical within – twin family effects. Model 6 includes statistical covariates to the model.

*$p < .05$.

in the Children of Twins Design is the comparison of offspring of identical twins. Plus, the difference in the divorce effects measured in offspring of fraternal twins discordant for divorce compared to discordant identical twins provides information on the nature of possible confounds (a larger divorce effect in offspring of fraternal twins discordant for divorce suggests that genetic factors account for part of the intergenerational association). Therefore, Model 5 included the interaction between the within-family divorce variable and zygosity type, which was coded *identical* = 0 and *fraternal* = 1. The multilevel models thus estimated two within – twin family parameters: (a) the within – twin family effect in identical families and (b) the difference in magnitude between the within – fraternal and the within – identical twin family effects ($b_{\text{fraternal}} - b_{\text{identical}}$). The comparison of cousins in identical twin families discordant for divorce (within identical) was sizeable ($b = .52$, $SE = 0.41$, OR = 1.68, $p = .21$), consistent with a causal relation between parent and offspring relationship instability. The difference between the fraternal and the identical within estimate (within [fraternal−identical]) ($b = .22$, $SE = 0.64$, $p = .73$) suggests that genetic factors may slightly confound the intergenerational transmission of divorce, although the precision is limited by the statistical power to estimate the parameter. Model 6 estimated the divorce parameters included Model 5 and added the measures of parental characteristics. The identical within-family estimate ($b = .43$, $SE = 0.40$, OR = 1.55, $p = .27$) was slightly reduced, but the difference in the two within-family estimates ($b = .22$, $SE = 0.69$, $p = .75$) remained the same. Figure 2 shows how the within – twin family effects in fraternal twin families are slightly larger

FIGURE 2. ASSOCIATION BETWEEN PARENTAL AND OFFSPRING RELATIONSHIP INSTABILITY USING METHODOLOGICAL AND STATISTICAL CONTROLS.



Note: Cousins = offspring of twins, regardless of zygosity. DZ = dizygotic or fraternal twin families. MZ = monozygotic or identical twin families.

[1]Statistical covariates (maternal and paternal church attendance, age at first child, conduct disorder, depression, and illegal drug use) were included in the models.

than the estimates of the within – twin family effects in identical twin families, again suggesting that genetic factors partially account for the intergenerational transmission of divorce. Yet, the comparison of offspring of identical twins discordant for divorce also revealed a sizeable divorce effect.

In summary, the multilevel models illustrate how the Children of Twins Design and the use of statistical controls help account for selection factors. The magnitude of the association between parental and offspring marital instability, however, remained generally robust throughout, which is consistent with a causal relation. The initial multilevel model, which estimated the unadjusted intergenerational relation, found that offspring from divorced families had a higher likelihood of marital instability than offspring from intact homes ($b = .65$ logits, OR = 1.91). The use of statistical controls for characteristics of both parents slightly reduced the effect in Model 2. Models 3 and 4 compared cousins who were differentially exposed to parental to account for unmeasured confounds. Models 5 and 6 estimated the effect of parental divorce in offspring of identical twins discordant for divorce and whether the divorce effect was larger in fraternal twin than identical twin families. The divorce effect was slightly larger in fraternal families, suggesting that genetic factors shared by parents and offspring partially account for the intergenerational transmission, but the comparison of identical twins in the final model ($b = .43$ logits, OR = 1.55) is also consistent with a causal association. To state it in a different way, 66% (.43 logits/.65 logits) of the original, unadjusted estimate of the intergenerational transmission was not accounted for by genetic confounds associated with divorce from the twin parents, nonmeasured environmental confounds that make adult twins similar, and measured demographic and psychological traits of both parents. Additional multilevel models that also controlled for measures of parental personality factors, such as neuroticism, extraversion, and impulsivity, in addition to those presented here, resulted in similar findings (results available by request).

DISCUSSION

Consistent with extensive research on Western families (Pryor & Rogers, 2001), the current analyses found a higher rate of relationship instability among the offspring of divorced parents in a large sample of children of Australian twins, weighted to approximate population-based parameters. The unique sample allowed us to conduct the first genetically informed analysis of the intergenerational association. The current study also provides a more rigorous test of causality than most previous studies because it included measured covariates of both parents to control for selection factors, including lifetime history of psychiatric disorders assessed by semistructured psychiatric interviews.

The results support both causal and selection processes (Hetherington, 1999). The use of the Children of Twins Design revealed that parental divorce (or risk factors specifically associated with parental marital instability within twin families) accounted for approximately 66% of the initial, unadjusted estimate of the intergenerational transmission. Because our design allowed us to control for genetic and unmeasured environmental selection effects (for the twin parents) as well as measured characteristics of both parents, this is perhaps the strongest evidence to date that parental divorce directly causes an increase in offspring divorce.

Our results also suggest, however, that part of the intergenerational association (approximately 34%) results from selection effects. Does the current study shed light on the sources of the selection factors? Statistically controlling for characteristics of both parents (Model 2) slightly reduced the overall magnitude of the association. Thus, families in which both parents have higher levels of psychopathology are more likely to get divorced and have children with higher levels of marital instability. Yet, only by comparing offspring of identical twins discordant for divorce did the analyses more fully account for shared genetic risk passed from parents to their children. The selection factors that were controlled by (a) the use of the statistical covariates in Model 2 and (b) the comparison of offspring of identical twins discordant for divorce in Model 5 appear to be largely independent because the divorce effect in the model utilizing both approaches (Model 6) provided a smaller estimate than when using either approach alone. Therefore, the measured covariates that were included in the model—parental church attendance, age at first child, conduct disorder, depression, and illegal drug use—do not mediate or explain the mechanisms through which genetic selection factors account for some of the intergenerational transmission of divorce.

As such, the present analyses reveal only the broad, not the specific, genetic contributions to the increased risk of marital instability among offspring of divorced parents. Unspecified genetic factors partially account for an increased risk of divorce both in parents and in their children. These results are consistent with concerns raised earlier about refining theories of the consequences of divorce for children (Emery, 1999; Hetherington, 2003). We suspect that one reason for this is that the results are attributable to multiple genetically mediated mechanisms. These likely include personality traits, broadly construed (Emery et al., 1999; Jockin, McGue, & Lykken, 1986), and also physical characteristics such as early menarche, a highly heritable developmental landmark (Mustanski, Viken, Kaprio, Pulkkinen, & Rose, 2004). Genetic selection effects also may be partially mediated through the environmental experiences. For example, adolescent girls whose early menarche is attributable to genetics may develop secondary sexual characteristics that attract the attention of older, perhaps manipulative men who are less stable or reliable romantic partners, and this experience, in turn, leads to more divorce. Future research will need to explore the precise environmental and genetic processes that mediate the intergenerational association by examining the traits and personality characteristics of the offspring.

Concerns about genetic selection are not merely academic. Whether parental divorce is causal or merely correlated with offspring marital stability is tremendously important not just conceptually but also practically, especially given the increase in divorce rates in the United States and in other Western countries in the past 50 years (Pryor & Rogers, 2001) and the current debate over government involvement to promote marriages and reduce divorces (McLanahan, Donahue, & Haskins, 2005). The present results imply that reducing the incidence of parental divorce or ameliorating the risk factors that frequently accompany the separation of parents (e.g., increased financial difficulties, parenting problems, lower commitment to marriage) may reduce the risk of marital instability in offspring. A number of intervention studies with residential mothers and children from divorced families have reduced the risk of mental health problems in offspring (e.g., Wolchik et al., 2002), but no study has explored whether interventions can reduce the increased risk of relationship instability in the offspring of divorced parents.

A number of limitations must be considered when interpreting the results. Genetic and environmental effects may well differ across cultures, cohorts, and time. Historical and cross-cultural evidence clearly indicates broad environmental influences on divorce thresholds. Like others, our research shows that genetic factors influence divorce risk within, not between, culture and cohort. The proportions of the variance attributable to genetic selection and environmental causation are not fixed, especially in accounting for complex social behaviors such as divorce. Thus, the present results may, or may not, apply to intergenerational linkages found in the United States or other Western countries.

The study utilized sampling weights and statistical techniques to handle missing data (MI) so that the results would generalize to the larger population of Australia, but the present results apply only to the Australia and are limited to offspring's experience of divorce (and the break up of long-term cohabiting relationships) early in adult life. Previous research, however, suggests that the divorce rate in Australia is consistent with other non-U.S. countries (Pryor & Rogers, 2001), and results of divorce studies in Australia are generally commensurate with international studies (Rodgers, 1996). Nevertheless, the relative importance of genetic and environmental processes responsible for the intergenerational transmission of divorce may change when considering risk of marital instability throughout the entire life span. Our analytical approach of handling the right censoring may not accurately account for the intergenerational association if different factors contribute to relationship instability in early versus later adult life.

Although the study is the first to examine genetic selection and also included many other potential selection factors, the study is still based on correlational data. Therefore, the results are limited by the constraints inherent in using any nonexperimental design and cannot prove that parental divorce causes offspring relationship instability (D'Onofrio et al., 2003; Rutter et al., 2001). Parental divorce could be a proxy for other environmental risk factors that actually cause the offspring to get divorced. As discussed above, the Children of Twins Design does not control for genetic risk from the spouse of twins (Eaves et al., 2005). The analyses controlled for characteristics of both parents to address this limitation, but it is impossible to determine whether the measured covariates account for all the relevant characteristics. Furthermore, characteristics of the offspring that increase the likelihood of divorce in both generations could also explain the relation (reciprocal influences).

There are also methodological limitations to note. Some caution is warranted because the standard errors around many estimates were large. The Children of Twins Design also assumes the absence of assortative mating (Heath et al., 1985). Assortative mating, the tendency for individuals to marry similar people, may place some children at greater risk for marital separations because the offspring are exposed to *two* parents with increased levels of psychopathology and other characteristics that are deleterious for offspring. Understanding the exact mechanisms underlying assortative mating, whether driven by genetic or environmental processes, is therefore required to specify the risk mechanisms responsible for the association between parental and offspring characteristics (Heath et al., 1985). If assortative mating is driven by genetic factors (e.g., Eaves, 1979), some offspring would inherit greater genetic marital stability. Assortative mating, however, may also have environmentally mediated effects on offspring, through processes such as modeling (D'Onofrio et al., 2003). A thorough analysis of the processes responsible for assortative mating in the current sample of twins and their spouses is beyond the scope of the current manuscript, but other articles using the same sample are beginning to address the question (e.g., Agrawal et al., 2006). We are currently working with other researchers on models that can incorporate the influence of spouses and the mechanisms responsible for mate selection.

A number of recommendations can be made for future studies exploring the intergenerational transmission of divorce. Large-scale genetically informed studies need to be conducted with sizable, nationally representative samples to study divorce and other topics in marriage and families. Larger samples sizes would provide greater statistical precision around the estimates, allow comparisons among different ethnic and socioeconomic groups, enable further exploration of moderators of the intergenerational association, and include measures of relationship instability across the life span. Additional genetically informative designs, such as adoption studies, must also be used because identifying causal environmental processes will require corroborating evidence from multiple research approaches, each with its own strengths and weaknesses.

More generally, the present analyses together with additional, genetically informed studies of the consequences of divorce (D'Onofrio et al., 2005, 2006, in press), stepfather presence (Mendle et al., 2006), parental abuse (Jaffee, Caspi, Moffitt, & Taylor, 2004), parental conflict (Harden et al., 2007), parenting characteristics (Caspi et al., 2004; Neiderhiser et al., 2004), and severe parental psychopathology (Gottesman & Bertelsen, 1989), indicate that demographers, sociologists, economists, and others studying population groups need to recognize the importance of genetic selection and control for genetic effects using twin and similar family research designs (Rutter et al., 2001).

In summary, the first genetically informed study of the intergenerational transmission of divorce suggests that genetic factors, a risk factor that has not been explored in many family studies, partially account for the association between parental and offspring relationship instability. At the same time, the findings are consistent with the importance of environmentally mediated risk for offspring divorce. The findings contrast with theories that postulate that family environmental experiences in general (Harris, 1998; Rowe, 1994), and parental divorce in particular (Begley, 1998), do not influence offspring adjustment after the children leave home. Ultimately, exploring the influence of parents and family risk factors will require research that integrates the underlying genetic and environmental processes.

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REFERENCES

Agrawal, A., Heath, A., Grant, J., Pergadia, M., Statham, D., Bucholz, K., Martin, N. G., & Madden, P. A. F. (2006). Assortative mating for cigarette smoking and for alcohol consumption in female Australian twins and their spouses. *Behavior Genetics*, *36*, 553 – 566.

Allison, P. D. (1995). *Survival analysis using SAS: A practical guide*. Cary, NC: SAS.

Amato, P. R. (1999). Children of divorced parents as young adults. In E. M. Hetherington (Ed.), *Coping with divorce single parenting and remarriage: A risk and resiliency perspective* (pp. 147 – 163). Mahwah, NJ: Erlbaum.

Amato, P. R. (2000). The consequences of divorce for adults and children. *Journal of Marriage and the Family*, *62*, 1269 – 1287.

Begley, S. (1998, September 7). The parent trap. *Newsweek*, 52 – 59.

Booth, A., Carver, K., & Granger, D. A. (2000). Biosocial perspectives on the family. *Journal of Marriage and the Family*, *62*, 1018 – 1034.

Bouchard, T. J., Jr., & Loehlin, J. C. (2001). Genes, evolution, and personality. *Behavior Genetics*, *31*, 243 – 273.

Bucholz, K. K., Cadoret, R., Cloninger, C. R., Dinwiddie, S. H., Hesselbrock, V. M., Nurnberger, J. I. Jr., Reich, T., Schmidt, I., & Schuckit, M. A. (1994). A new semi-structured psychiatric interview for use in genetic linkage studies: A report on the reliability of the SSAGA. *Journal of Studies on Alcohol*, *55*, 149 – 158.

Capaldi, D. M., & Patterson, G. R. (1991). Relation of parental transitions to boys' adjustment problems: I. A linear hypothesis. II. Mothers at risk for transitions and unskilled parenting. *Developmental Psychology*, *27*, 489 – 504.

Caspi, A., Moffitt, T. E., Morgan, J., Rutter, M., Taylor, A., Arseneault, L., Tully, L., Jacobs, C., & Kim-Cohen, J. (2004). Maternal expressed emotion predicts childrens' antisocial behavior problems: Using monozygotic-twin differences to identify environmental effects on behavioral development. *Developmental Psychology*, *50*, 149 – 161.

Collins, W. A., Maccoby, E. E., Steinberg, L., Hetherington, E. M., & Bornstein, M. H. (2000). Contemporary research on parenting: The case for nature and nurture. *American Psychologist*, *55*, 218 – 232.

D'Onofrio, B. M., Turkheimer, E., Eaves, L. J., Corey, L. A., Berg, K., Solaas, M. H., & Emery, R. E. (2003). The role of the Children of Twins design in elucidating causal relations between parent characteristics and child outcomes. *Journal of Child Psychology and Psychiatry*, *44*, 1130 – 1144.

D'Onofrio, B. M., Turkheimer, E. N., Emery, R. E., Maes, H. H., Silberg, J., Eaves, L. J. (in press). A Children of Twins Study of parental divorce and offspring psychopathology. *Journal of Child Psychology and Psychiatry*.

D'Onofrio, B. M., Turkheimer, E. N., Emery, R. E., Slutske, W., Heath, A., Madden, P. A. F., & Martin, N. G. (2005). A genetically informed study of marital instability and its association with offspring psychopathology. *Journal of Abnormal Psychology*, *114*, 570 – 586.

D'Onofrio, B. M., Turkheimer, E. N., Emery, R. E., Slutske, W., Heath, A., Madden, P. A. F., & Martin, N. G. (2006). A genetically informed study of the processes underlying the association between parental marital instability and offspring adjustment. *Developmental Psychology*, *42*, 486 – 499.

Eaves, L. (1979). Use of twins in the analysis of assortative mating. *Heredity*, *43*, 399 – 409.

Eaves, L. J., Silberg, J. L., & Maes, H. H. (2005). Revisiting the children of twins: Can they be used to resolve the environmental effects of dyadic parental treatment on child behavior? *Twin Research*, *8*, 283 – 290.

Emery, R. E. (1999). *Marriage, divorce, and children's adjustment* (2nd ed.). Thousand Oaks, CA: Sage.

Emery, R. E., Waldron, M. C., Kitzmann, K. M., & Aaron, J. (1999). Delinquent behavior, future divorce, or nonmarital childbearing, and externalizing behavior among offspring: A 14-year prospective study. *Journal of Family Psychology*, *13*, 1 – 12.

Fine, M. A., & Harvey, J. H. (Eds.). (2006). *Handbook of divorce and relationship dissolution*. Mahwah, NJ: Erlbaum.

Gottesman, I. I., & Bertelsen, A. (1989). Confirming unexpressed genotypes for schizophrenia. *Archives of General Psychiatry*, *46*, 867 – 872.

Gottesman, I. I., & Gould, T. D. (2003). The endophenotype concept in psychiatry: Etymology and strategic intentions. *American Journal of Psychiatry*, *160*, 636 – 645.

Greenstein, T. N. (1995). Gender ideology, marital disruption, and employment of married women. *Journal of Marriage and the Family*, *57*, 31 – 42.

Harden, K. P., Turkheimer, E., Emery, R. E., D'Onofrio, B. M., Slutske, W., Heath, A., & Martin, N. G. (2007). Marital conflict and conduct disorder in Children-of-Twins. *Child Development*, *78*, 1 – 18.

Harris, J. R. (1998). *The nurture assumption: Why children turn out the way they do*. New York: Free Press.

Heath, A. C., Bucholz, K. K., Madden, P. A., Dinwiddie, S. H., Slutske, W. S., Bierut, L. J., Statham, D. J., Dunne, M. P., Whitfield, J. B., & Martin, N. G. (1997). Genetic and environmental contributions to alcohol dependence risk in a national twin sample: Consistency of findings in women and men. *Psychological Medicine*, *27*, 1381 – 1396.

Heath, A. C., Kendler, K. S., Eaves, L. J., & Markell, D. (1985). The resolution of cultural and biological inheritance: Informativeness of different relationships. *Behavior Genetics*, *15*, 439 – 465.

Heath, A. C., Madden, P. A. F., & Martin, N. G. (1998). Assessing the effects of cooperation bias and attrition in behavioral genetic research using data-weighting. *Behavior Genetics*, *28*, 415 – 427.

Heath, A. C., & Martin, N. G. (1994). Genetic influences on alcohol consumption patterns and problem drinking: Results from the Australian NHMRC twin panel follow-up survey. *Annals of the New York Academy of Sciences*, *708*, 72 – 85.

Hetherington, E. M. (1999). *Coping with divorce single parenting and remarriage: A risk resiliency perspective*. Mahwah, NJ: Erlbaum.

Hetherington, E. M. (2003). Intimate pathways: Changing patterns in close personal relationships across time. *Family Relations*, *52*, 318 – 331.

Jaffee, S. R., Caspi, A., Moffitt, T. E., & Taylor, A. (2004). Physical maltreatment victim to antisocial child: Evidence of an environmentally mediated process. *Journal of Abnormal Psychology*, *113*, 44 – 55.

Jardine, R., & Martin, N. G. (1984). Causes of variation in drinking habits in a large twin sample. *Acta Geneticae Medicae et Gemellologiae*, *33*, 435 – 450.

Jinks, J. L., & Fulker, D. W. (1970). Comparison of the biometrical, genetical, MAVA and classical approaches to the analysis of human behavior. *Psychological Bulletin*, *73*, 311 – 349.

Jockin, V., McGue, M., & Lykken, D. T. (1996). Personality and divorce: A genetic analysis. *Journal of Personality and Social Psychology*, *71*, 288 – 299.

Karney, B. R., & Bradbury, T. N. (1995). The longitudinal course of marital quality and stability: A review of theory, method, and research. *Psychological Bulletin*, *118*, 3 – 34.

Kim, J., & Ferree, G. D. (1981). Standardization in causal analysis. *Sociological Methods and Research*, *10*, 187 – 210.

Lake, R. E., Eaves, L. J., Maes, H. H., Heath, A. C., & Martin, N. G. (2000). Further evidence against the environmental transmission of individual differences in neuroticism from a collaborative study of 45,850 twins and relatives on two continents. *Behavior Genetics*, *30*, 223 – 233.

Little, R. J. A., & Rubin, D. B. (1987). *Statistical analysis with missing data*. New York: Wiley.

McGue, M., & Lykken, D. T. (1992). Genetic influence on risk of divorce. *Psychological Science*, *6*, 368 – 373.

McLanahan, S., Donahue, E., & Haskins, R. (2005). Marriage and child wellbeing. *Future of Children, 15*, 3 – 12.

Mendle, J., Turkheimer, E., D'Onofrio, B. M., Lynch, S. K., Emery, R. E., Slutske, W., & Martin, N. G. (2006). Family structure and age at menarche: A children of twins approach. *Developmental Psychology*, *42*, 535 – 542.

Mustanski, B. S., Viken, R. J., Kaprio, J., Pulkkinen, L., & Rose, R. J. (2004). Genetic and environmental influences on pubertal development: Longitudinal data from Finnish twins at ages 11 and 14. *Developmental Psychology*, *40*, 1188 – 1198.

Nance, W. E., & Corey, L. A. (1976). Genetic models for the analysis of data from the families of identical twins. *Genetics*, *83*, 811 – 826.

Neiderhiser, J. M., Reiss, D., Pedersen, N. L., Lichtenstein, P., Spotts, E. L., Hansson, K., Cederblad, M., & Elthammer, O. (2004). Genetic and environmental influences on mothering of adolescents: A comparison of two samples. *Developmental Psychology*, *40*, 335 – 351.

Pryor, J., & Rogers, B. (2001). *Children in changing families: Life after parental separation*. Boston: Blackwell.

Raudenbush, S., Byrk, A., Cheong, Y. F., Congdon, R., & du Toit, M. (2004). *HLM 6: Hierarchical linear and nonlinear modeling*. Lincolnwood, IL: Scientific Software International.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Rhee, S. H., & Waldman, I. D. (2002). Genetic and environmental influences on antisocial behavior: A meta-analysis of twin and adoption studies. *Psychological Bulletin*, *128*, 490 – 529.

Rodgers, B. (1996). Social and psychological well-being of children from divorced families: Australian research findings. *Australian Psychologist*, *3*, 174 – 182.

Rodgers, J., Cleveland, H., van den Oord, E., & Rowe, D. (2000). Resolving the debate over birth order, family size, and intelligence. *American Psychologist*, *55*, 599 – 612.

Rowe, D. C. (1994). *The limits of family influence: Genes, experience, and behavior*. New York: Guilford.

Rutter, M., Pickles, A., Murray, R., & Eaves, L. J. (2001). Testing hypotheses on specific environmental causal effects on behavior. *Psychological Bulletin*, *127*, 291 – 324.

Rutter, M., Silberg, J., & Simonoff, E. (1993). Whither behavior genetics? A developmental psychopathology perspective. In R. Plomin & G. E. McClearn (Eds.), *Nature, nurture, and psychology* (pp. 433 – 456). Washington, DC: American Psychological Association.

Scarr, S., & McCartney, K. (1983). How people make their own environments: A theory of genotype → environment effects. *Child Development*, *54*, 424 – 435.

Slutske, W. S., Heath, A. C., Dinwiddie, S. H., Madden, P. A., Bucholz, K. K., Dunne, M. P., Statham, D. J., & Martin, N. G. (1998). Common genetic risk factors for conduct disorder and alcohol dependence. *Journal of Abnormal Psychology*, *107*, 363 – 374.

Statham, D. J., Heath, A. C., Madden, P. A., Bucholz, K. K., Bierut, L. J., Dinwiddie, S. H., Slutske, W. S., Dunne, M. P., & Martin, N. G. (1998). Suicidal behaviour: An epidemiological and genetic study. *Psychological Medicine*, *28*, 839 – 855.

Wolchik, S. A., Sandler, I. N., Millsap, R. E., Plummer, B. A., Greene, S. M., Anderson, E. R., Dawson-McClure, S. R., Hipke, K., & Haine, R. A. (2002). Six-year follow-up of preventive interventions for children of divorce: A randomized controlled trial. *Journal of the American Medical Association*, *16*, 1874 – 1881.