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Genetic and Environmental Contributions to Relationships and Divorce Attitudes

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One of the primary causal factors of increasing rates of divorce in Democratic countries has been more accepting attitudes toward divorce within broader society (Thornton & Young-DeMarco, 2001). Traditionally, sources of attitudes on divorce have been located in social and environmental factors, such as the sum total of personal divorce experience, religious beliefs, or upbringing, including being raised in a divorced home (Amato, 2010; Kapinus, 2004; Sieben & Verbakel, 2013). However, as the study of human behavior has become more interdisciplinary, another stream of research has emerged, suggesting that, in addition to social and economic factors and the environmental precipitants surrounding these influences, a genetic component may contribute to differences in how individuals see, engage in, and react to, the world, thereby contributing to the variation in divorce attitudes and outcomes (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990; Eaves, Eysenck, & Martin, 1989; Jockin, McGue, & Lykken, 1996; Olson, Vernon, Harris, & Jang, 2001; Spotts, et al., 2004).

Regarding pro-divorce attitudes, these two lines of inquiry, social and genetic, have remained largely independent of one another, and the interplay between the m is only beginning to be explored. Such continued exploration is important because if social, environmental and genetic factors all play some role in contributing to relational styles and outcomes, however large or small, proximal or distal, through attitudes or other factors, then investigating their integration may enlighten our understanding of the ways people enter relationships, the reasons why those relationships often dissolve, and how individuals differ in selecting into, experiencing and reacting to such events.

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Here, we examine the interplay between genetic and environmental influences on divorce attitudes and relationship life-events. Within estimates of genetic and environmental influences resides the potential for an individual's genes to be correlated with, or conditional upon, environmental stimuli. Certain people may be more likely, based in part on genotypic factors, to enter into particular environments than others. As a result, due to one's particular genotype, some people may experience multiple doses of an environmental stimulus that lead to pro-divorce attitudes and divorce itself, while others may receive none at all. This occurrence may be labeled gene-environment correlation. In addition, more genetically similar individuals may also react more similarly to certain experiences such as getting a divorce. Thus, we also explore the possibility of a gene-environment interaction, in which the life event of a divorce may moderate genetic influences on attitudes toward divorce.

We proceed with a brief review of the sociological and behavior-genetic literature on divorce and divorce attitudes. We then present our analysis of the correlation between relationship risk events such as divorce and marital separations, and attitudes toward divorce. We provide evidence of gene by environment correlation and interaction between attitudes and life experiences, noting important sex differences in our findings. We conclude with a discussion of the importance of including underlying biological factors for developing comprehensive and accurate models of how attitudes toward divorce and divorce itself affect each other.

Where do Divorce Attitudes Come From?

The literature on divorce identifies an important relationship between attitudes toward divorce and experiencing divorce. In this view, the risk for divorce is partly attributed to intergenerational transfer of attitudes, whereby experiences in the home, including having divorced parents, affect a child's attitudes toward divorce and their eventual risk for divorce in adulthood (Cunningham & Thornton, 2006; Thornton, 1985). That is, "attitudes toward marriage and divorce are partially pre-formulated beliefs individuals carry into their relationships" (Miles & Servaty-Seib, 2010, p. 209). Adult children's acceptance of divorce is also affected by their own marriages: marriage without prior cohabitation decreased divorce approval, while divorce from a first marriage increased it. Longitudinal studies revealed that those who had experienced divorce themselves developed more favorable attitudes toward divorce, and remarried individuals held more positive attitudes toward divorce, which in turn increased the risk of undergoing a subsequent second divorce (Amato & Booth, 1991; Whitton, Stanley, Markman, & Johnson, 2013). Similar results have been found in Australia and Europe (Sieben & Verbakel, 2013). In summary, attitudes toward divorce constitute an important independent risk factor because they influence the risk of divorce itself (Kapinus, 2004; Kurdek & Siesky, 1981; Sieben & Verbakel, 2013).

The effect of parental divorce on attitudes toward divorce differs by sex. Females whose parents are tolerant of divorce, who feel their parents should divorce, or who are not close to their fathers have the most positive attitudes toward divorce, while males who share the first two characteristics but who are not themselves married are most likely to endorse divorce (Kapinus, 2005). Additional indicators suggest that different attitudes toward divorce may be driven, at least in part, by women's education and economic independence. Examining

changing attitudes toward divorce from 1974–2002, S. P. Martin and Parashar (2006) find that women with college degrees have moved from being the most permissive in their attitudes toward divorce to becoming much more intolerant of divorce. The commitment to high-investment parenting in the face of modern societal pressures and a global economy is believed to be the reason. On the other hand, women with no high school degree have become increasingly permissive in their attitudes toward divorce.

Behavior Genetic Research – Why People Differ

A separate stream of research focuses on behavior-genetic techniques and the source of variance has found that the tendency to get married and divorced is partly heritable (Jerskey, et al., 2010; McGue & Lykken, 1992). These genetic influences, however, can also be mediated through certain behaviors and personality traits (Jockin, et al., 1996). Trumbetta, Markowitz, and Gottesman (2007), building upon earlier works elucidated the role of genes and environment for marital status, find that genetic factors have a role in stable marriages, but environmental factors play the primary role in the propensity to wed more than once. Furthermore, genetic and environmental influences on marriage itself change in response to life events. For example, Spotts and colleagues found that genes have little role in explaining perceived marital quality and satisfaction (Spotts, et al., 2004; Spotts, Prescott, & Kendler, 2006). Rather, the overwhelmingly amount of variance could be attributed to environmental factors.

Attitudes toward divorce have also shown to be heritable (Bouchard & McGue, 2003; Eaves & Eysenck, 1974; N. G. Martin, et al., 1986). Extant studies report that roughly 52–58% of the variance on divorce attitudes can be attributed to unique experiences, 0–23% to shared familial experiences, and 25–47% to genetic influences. However, such univariate estimates represent only an initial approximation. They do not include the potential for genetic influences to have a role in how individuals select into, modify, construct and reconstruct their experiences. This is important because if attitudes toward divorce are genetically influenced, as is the risk for divorce itself, it may be that people with such liability may self-select into environments, or partners, and also information differentially, which place them at higher risk for divorce, and this factor may become inadvertently conflated in estimates of genetic influences on other social and genetic forces. For example, people with more tolerant attitudes toward divorce may be more likely to enter a wide variety of relationships that provide incentives, reinforcements and rejections that make them more likely to marry, even when they are not confident that their relationship will endure. They may also prove more likely to seek exit rather than work on a challenging relationship. These are only a few possibilities that may influence how environmental and genetic forces can interact to differentially influence liability for divorce. Thus, there may be shared genetic factors, which influence both divorce attitudes as well as risk for divorce itself. On the other hand, and equally important, environmental factors may mediate or moderate genetic influences.

Given that genetic and environmental influences are found for both attitudes toward divorce as well as divorce itself, parents may transmit a double dose of risk to their offspring. In addition, empirically, the two may be conflated in univariate estimates. That is, the actual experience of divorce may itself shift the relative contribution of genetic and environmental

factors in constituting subsequent attitudes toward divorce, and thus may, in turn, affect the risk of actual divorce as well.

We begin our analysis by exploring if attitudes toward divorce differ between people who have been divorced or separated and those who have not been divorced or separated. We then seek to affirm that these attitudes and the likelihood of experiencing a divorce are in part genetically influenced, and do so using a very large sample of twins and relatives. These preceding steps are necessary to test our main hypotheses, that *genetic factors, which influence attitudes toward divorce, are correlated with the actual life event of getting divorced or experiencing a marital separation. In addition, we expect genetic and environmental influences on divorce and cohabitation attitudes are moderated by experiencing a divorce, marital separation or broken relationship.*

Methods

The sample consists of a large study of twins ($n=14,781$), aged 18–96 years ($\mu=49.5$, $\sigma=17.6$). Complete twin pairs include 1,885 female monozygotic (MZ) twin pairs, 1,183 female dizygotic (DZ) twin pairs, 790 male MZ pairs, 583 male DZ pairs, and 1,134 female-male twin pairs. A large questionnaire on “Health and Life Styles” (HLS) was first administered to the population in the late 1980s (for details on the sample, and data collection procedures see Lake, Eaves, Maes, Heath, & Martin, 2000). The response rates were 70% for the twins (Truett, et al., 1994).

Relationship attitudes were measured using a subset of a 28-item Wilson and Patterson (1968) inventory of contemporary social attitudes. Our main interest resides on the measured attitudes toward *Divorce*. For completeness, we also include the one additional measure on relationships in the study, *Living Together* (unmarried).

The study assessed life events through the Holmes and Rahe (1967) stressful life events (SLE) inventory, which asked respondents to answer if they had experienced certain life events within the last 12 months. In this study, we used three events directly associated with relationships (*Divorce*, *Marital Separation* and *Broken Engagement*). This measure has high test-retest reliability and is consistent with independently rated measures derived from semi-structured interviews (Brugha & Cragg, 1990). Because *Divorced* and *Marital Separation* result in similar outcomes, and respondents could respond yes to both, an additional measure was constructed (*Combined - Divorced and/or Separated*), and scored 0 if neither event was experienced, or 1 if either event was experienced. The Supplementary Information (SI) provides the exact format for the attitude and life events questions. Table 1 provides the population frequency for the life events of “*Divorce*”, “*Marital Separation*”, “*Combined*” and “*Broken Engagement*.”

Analysis and Results

Table 2 provides the frequency of endorsement for attitudes toward *Divorce* and *Living Together* under each of the relationship life-event conditions. Note a significant and substantial shift in attitudes supporting divorce when individuals experienced a divorce, marital separation or broken engagement within the last 12 months. Table 3 compares the

means and standard deviations between the populations who experienced divorce, marital separation or broken relationship and those who did not (see SI 2 for correlations between attitudes, life events and logistic regression analyses). Because the measures are ordinal, we rely on the Wilcoxon procedure to test if the populations are significantly different from one another. The Wilcoxon Z test can be considered a non-parametric version of a t-test but it compares the mean ranks of the two groups. Table 3 confirms that there are significant differences in attitudes between individuals exposed to marital separation life events and those who were not.

Sources of Variation

Twin and kinship designs have been widely used in behavioral genetic models of social attitudes to disentangle genetic and environmental effects. Twin designs derive their explanatory power from the difference in the genetic similarity of MZ co-twins, who share identical chromosomal DNA sequences, and DZ co-twins, who share on average half of their differentiating DNA sequence. Phenotypic (trait of interest) variance (V_p) is most often decomposed into three latent variables ($V_p = A^2 + C^2 + E^2$): additive genetic variance (A), which is the sum of all genetic influence; shared environmental variance (C), and unique person-specific environmental variance, (E), which also includes error (Neale & Cardon, 1992).

Hatemi, Medland, and Eaves' (2009) univariate twin analyses of the HLS found that genetic influences accounted for 25% and 42% of the variance on attitudes toward *Divorce* for females and males respectively, while 23% and 0% of the variance was attributed to shared experiences, and 52 and 57% to person-specific idiosyncratic experiences. The results of univariate ACE models for attitudes toward *Living Together* were quite different however; for females, 51% of the total variance could be attributed to genetic similarity, 16% to shared environmental experiences, and 33% to unique experiences. No significant genetic influence was found on male attitudes toward *Living Together*, and 48% and 52% of the total variance was explained by shared and unique environmental influences respectively (see Table 4 for univariate genetic and environmental estimates of all attitudes). Similar findings were reported in other twin studies of relationship attitudes (N. G. Martin, et al., 1986).

Testing for Gene-Environment Covariation

A co-twin control method is used to investigate whether the “genes” that influence divorce attitudes and exposure to divorce life events are correlated (see Middeldorp, Cath, Beem, Willemsen, & Boomsma, 2008). This design makes use of three groups: (1) MZ twin pairs discordant for the life event (one twin has experienced the life event and the other has not); (2) DZ twin pairs discordant for the life event; and (3) a group of unrelated individuals, some of whom were exposed and some of whom were not exposed to the life event. Based upon the different degree of genetic relationship between the three groups, scores of the exposed and the non-exposed subjects will show different patterns in the absence and presence of gene–environment correlation (see SI 3 for further explanation).

For *Living Together* attitudes, there was no evidence of active gene-environment correlation (rGE) with the life events of divorce, marital separation or broken engagement. That is, the attitude scores of participants were similar whether they were exposed or not to these particular life events, regardless of their genetic relationship (see SI 4). However, there was evidence of gene-environmental correlation for the attitude-life event combination of getting a divorce and attitudes toward *Divorce* (see SI 5). The differences between exposed and non-exposed subjects were larger in the discordant DZ twin pairs and in the unrelated subjects than in the discordant MZ twin pairs. The pattern shows non-exposed subjects scoring highest in the discordant MZ twin pairs, lowest in the unrelated subjects, and in-between in the discordant DZ twin pairs. The significance of this effect was confirmed by regressing divorce attitudes on zygosity group membership. For the non-exposed subjects, zygosity group was significant. Thus, gene-environment correlation for divorce attitudes and experiencing a divorce is accounted for and considered in interpretation of the $G \times E$ structural models below.

Gene-Environment Interaction

In classical twin designs (CTD), each of the variance components are independent of one another, and any interactions between genes and environments are subsumed within the distinct A, C and E estimates. To investigate the possibility that genetic and environmental influences on divorce and cohabitation attitudes are moderated by experiencing a divorce, marital separation or broken relationship, a model in which the variance components vary as a function of the event experienced is required. Thus, we modify the univariate linear equation shown above to allow the variance associated with each of the three ACE components to be expressed as a linear interaction with the life events: $V_p = (A + \beta_a * Life\ Event)^2 + (C + \beta_c * Life\ Event)^2 + (E + \beta_e * Life\ Event)^2$. In this equation, the β estimates allow the latent ACE variance components for each attitude to differ across exposure to the life events. This model is illustrated in Figure 1. Model specifics and algebraic proofs are detailed by Purcell (2002). We rely on a re-parameterization for ordinal data provided by Medland, Neale, Eaves, and Neale (2009).

Analyses of twin data were conducted using maximum likelihood estimation of the structural equation model fit to raw data as operationalized in the statistical package Mx (Neale et al. 2003). Model fit was assessed using the likelihood ratio comparison of $-2LL$ likelihood statistics, which is distributed as χ^2 . A series of interaction models was fitted to each of the attitude and life event combinations, separately by sex, given the significant sex differences found in the extant literature. Exposure to the life events was included as a moderator on the variance paths A, C and E to the phenotype. The full model in this design includes the interaction terms. In Figure 1, “a” represents the effect of additive genetic variance independent of the life event; β_a represents the effect of additive genetic variance dependent on the life event; the same goes for c, beta c, e and beta e. These betas were subsequently constrained to zero in nested models in which each of these models was compared to the fit of the full model using a likelihood ratio test to test for the significance of their effects. For further assurance that rGE does not confound findings of $G \times E$, the life events were included as a covariate in the means model to remove all variance shared with the divorce attitudes.

The model-fitting statistics for the gene-environment interaction models are shown in Table 5 for the two attitudes measured. The main effects model includes estimates of additive genetic, shared and unique non-shared environmental influences; the interaction effects model (full model) included the main effects as well as the genetic and environmental interaction parameters on each ACE path. Gene-environment interaction effects could be dropped without significant deterioration in model fit (by comparing both the change in χ^2 between the main effects model and the model with the interaction terms unconstrained) for the life event of a “*broken engagement*” (see Table 5). The life events of divorce and marital separation, however, had a significant influence on the genetic and environmental estimates of attitudes toward “*divorce*” and “*living together*”.

The parameters in the main-effects are interpreted as in any other classical twin design (the estimated values of ACE when the life event was not experienced). However, interaction parameters can be better understood graphically, by plotting the variance in the attitudes accounted for by A, C, and E when experiencing or not experiencing the life events. Based upon the results of the structural models, Figure 2 presents the four attitude/life events relationships where G×E interaction provided a better model fit.

The influence of getting a divorce on divorce attitudes differed by sex. As males experience a divorce, the relative import of genetic influences accounting for individual difference on divorce attitudes drops from 0.40 to less than 0.05 (on a scale from 0–1.00), while the common environmental influence moves from insignificance to over 0.40. In females, genetic variance decreases following divorce, while unique environment increases substantially and common environmental influence increases modestly.

Thus, it appears that the similarity in divorce attitudes remains a greater function of genetic similarity when one has not experienced a recent divorce. However, when the “divorce” environment changes, and a person has actually experienced a divorce, shared and unique environmental influences become overwhelmingly important for explaining why individuals differ in attitudes on the subject. We also find the divorce experience itself has a profound influence on the relative importance of the type of environment exerting why men and women differ in their attitudes toward divorce.

Discussion

There are several novel and important aspects to these analyses. We find that the heritability of relationship attitudes is significantly moderated by experiencing the actual life event of a divorce or marital dissolution, reflecting a gene by environment interaction between such attitudes and actual life events. That is, for every negative relationship condition, the relative import of genetic influences on attitudes decreases. However, this relationship is more complex for the divorce life event, because we find evidence of gene-environment correlation: the same genetic factors appear to contribute to both attitudes toward divorce, as well as the risk of divorce itself. Thus, we find support for an underlying genetic element to be partially and indirectly driving the relationship between attitudes toward divorce and actual divorce.

Genetic factors have a meaningful influence on attitudes to divorce prior to experiencing negative relationship life events, but in the wake of enduring a divorce, the influence of genetic factors decreases for both sexes. However, we find notable sex differences in the relative import of shared and unique environmental experiences on attitudes subsequent to experiencing negative relationship life events. Specifically, we find that for women undergoing a divorce, the relative importance of unique environmental factors on attitudes increases, while for men the import of common environmental factors increases. This difference might occur because historically women have had and relied upon other friends for emotional *and* financial support following divorce (Baumeister & Vohs, 2004), and at the same time, women have had, historically on average, relatively fewer financial resources and options for financial support outside marriage (Antonucci & Akiyama, 1987; Gerstel, Riessman, & Rosenfield, 1985). For men, historically, economic factors tended to be less pronounced, but in general, men tended to rely more exclusively on their partners for social support, rendering them relatively more isolated in the face of marital dissolution (unless they find another partner quickly, as some do), and thus the relative importance of family support, parental upbringing (C) and attitude imprinting re-emerge as critical indicators for why men differ in their responses (Amato, 2000). This may be changing as more women become more financially independent, but economic class also influences the larger likelihood of divorce overall, such that wealth provides some protection against divorce (Aughinbaugh, Robles, & Sun, 2013). More recent examinations indeed reinforce the notion that social, as opposed to financial, motivations provide better explanations for why individuals remarry after divorce, also helping to explain why women, as the traditional holders of family networks, may be more willing to file for divorce than in the past (Brinig & Allen, 2000; Kalmijn, 2007).

Our analysis demonstrates that a comprehensive and accurate explanation for attitudes toward divorce, believed to be a critical predictor of divorce, should incorporate not only dispositional and environmental factors, but the interplay between them. In this way, we can recognize the multiple channels through which parents transmit relationship skills, values, and divorce risk to their children, while gaining insight on the import of individual differences in reaction to life circumstances. Environment and biology both contribute to the attitudes toward divorce, but life events such as divorce itself, in turn, affect those biological and social influences that operate on attitudes as well. Individuals self-select into environments and relationships that feel comfortable and familiar, and those interactions are built on both inherited tendencies as well as patterns modeled and reinforced by familial and friendship networks, both positive and dysfunctional. Personal relationships hold ubiquitous importance and significance in people's lives. Given that such bonds can create both suffering and joy, achieving a more complete and accurate view of how such bonds form and dissolve presents a goal of great urgency and significance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We model the relationship between attitudes and relationship outcomes
- We gene-environment interaction and gene-environment correlation
- Genetic influences on attitudes toward divorce and divorce outcomes are correlated
- Genetic influences on relationship attitudes are moderated by negative relationship life events

Figure 1. Path Diagram of Variance Components Analysis with G×E interaction

Notes: E is Unique Environment, A is Additive Genetic, and C is common Environment. T1 is twin 1 and T2 is twin 2. β_a represents the effect of additive genetic variance dependent of the life event; the same applies to c and e.

Attitudes on Divorce and Life Event of "Getting a Divorce"

Attitudes on Divorce and Life Event of "Marital Separation"

Figure 2. Gene-Environment interactions between Attitudes on Divorce and Getting a Divorce or Marital Separation

Notes: %A is percent of variance due to genetic influence, %C is percent of variance due to shared environmental influence, %E is percent of variance due to unique environmental influence.

Table 1

Prevalence of Relationship Life Events

Life Events	Experienced in Last 12 months	Did Not Experience in Last 12 months
Marital Separation	2.3	97.7
Divorced	1.1	98.9
Combined (Divorce and/or Separated)	2.8	97.2
Broken Engagement	4.3	95.7

Notes: Percentages shown; sample sizes range from 29,030–29,674.

Table 2

Endorsement of Divorce and Living Together Attitudes under Each Life Events

Attitude	Life Event	Support	Don't know	Do Not Support
Divorce (all)		43.5	19.5	36.9
	Divorced	60.2	15.6	19.1
	Marital Separation	58.9	16.4	24.7
	Broken Engagement	55.9	16.8	27.4
Living Together (all)		38.7	15.3	45.9
	Divorced	60.6	12.8	26.5
	Marital Separation	62.9	12.3	24.8
	Broken Engagement	70.0	11.2	18.8

Notes: Percentages shown; sample sizes range from 29,030–29,674.

Table 3

Differences in Attitude Scores between the Unaffected Population and the Affected Populations

Attitude	Not Affected Population	Marital Separation	Divorce	Broken Engagement
	M (SD)	M (SD)	M (SD)	M (SD)
Divorce	1.93(.90)	1.66(.85) ***	1.64(.85) ***	1.72(.87) ***
Living Together	2.07(.92)	1.62(.86) ***	1.66(.87) ***	1.49(.79) ***
N	28,993–29,100			

Notes: Statistical significance is calculated by Wilcoxon Z,

p .001,

**
p .01,

*
p .05; attitude scores range from 1 to 3 (1=yes, 2= don't know, 3 = no); M=mean, SD=standard deviation.

Table 4

Genetic and Environmental Estimates of Attitudes in this sample

Attitudes	Additive genetic	Shared Familial Environment	Unique Environment
Divorce -Females	.25 (.16–.29)	.23 (.08–.38)	.52 (.47–.57)
Divorce-Males	.42 (.31–.42)	.00 (.00–.07)	.57 (.53–.65)
Living Together -Females	.51 (.41–.68)	.16 (.10–.24)	.33 (.30–.37)
Living Together -Males	.00 (.00–.34)	.48 (.21–.54)	.52 (.52–.58)

Notes: The variance components estimates presented here are the best fitting models of classic twin design (see Hatemi, et al., 2009). Confidence intervals (95%) enclosed with parentheses.

Table 5

Model-fitting statistics for the gene-environment interaction models of Attitudes and Life Events

Attitude	Life Event	Removal of Interaction	
		-2LL	p value
Divorce	Divorce	6.862	0.031
Living together		6.102	0.107
Divorce	Marital Separation	11.489	0.009
Living together		3.704	0.295
Divorce	Broken Engagement	2.042	0.564
Living together		2.325	0.508

Notes: Attitudes in bold denote a significant change in model fit. -2LL is likelihood ratio test to freely estimated G×E model. All models have 3 degrees of freedom, one for each interaction (A,C,E)