Marital Satisfaction and Physical Health : Evidence for an Orchid Effect

Susan C. South and Robert F. Krueger

Psychological Science 2013 24: 373 originally published online 28 January 2013
DOI: 10.1177/0956797612453116

Research Report

Psychological Science
24(3) 373–378

DOI: 10.1177/0956797612453116
http://pss.sagepub.com

Marital Satisfaction and Physical Health: Evidence for an Orchid Effect

Susan C. South[1] and Robert F. Krueger[2]
[1]Purdue University and [2]University of Minnesota

Abstract

Marital distress and conflict are linked to poor physical health. Here, we used behavior genetic modeling to determine the etiology of this association. Biometric moderation models were used to estimate gene-by-environment interaction in the presence of gene-environment correlation between marital satisfaction and self-reported health. Using a sample of 347 married twin pairs from the Midlife in the United States study, we found that genetic influences on the variation in self-reported health were greatest at both high (h^2 = .30) and low (h^2 = .38) levels of marital satisfaction, with the lowest levels of heritability estimated for participants at the average level of marital satisfaction (h^2 = .10). These findings are evidence of the *orchid effect*: the idea that genetic influences on a phenotype such as physical health are enhanced in nonnormative—both unusually positive and unusually negative—environmental contexts.

Keywords

health, relationship quality, behavior genetics

Received 10/27/11; Revision accepted 5/29/12

The quality of relationships with significant others is linked with one's physical health (Holt-Lunstad, Smith, & Layton, 2010). Until recently, most research on marriage and health focused on marital status, finding that marriage is associated with reduced mortality and morbidity (Kiecolt-Glaser & Newton, 2001). Gradually, research has shifted to emphasize how the quality of the marital relationship affects physical health (Whisman & Uebelacker, 2003). Marital disagreement is significantly related to physical symptoms, whereas more negative spousal behaviors are also related to disability and lower subjective ratings of health (Bookwala, 2005).

Researchers have also examined specific biological pathways from marital quality to physiological outcomes. Marital distress is linked to cardiovascular stress (Baker et al., 2000) and cardiovascular disease (De Vogli, Chandola, & Marmot, 2007), possibly because of cardiovascular reactivity to relationship conflict (Smith et al., 2009). Marital conflict, often measured through spousal behaviors during an interaction task, is associated with endocrine- and immune-system functioning (e.g., Kiecolt-Glaser et al., 1993; Malarkey, Kiecolt-Glaser, Pearl, & Glaser, 1994). Other research has shown that cortisol responses to marital-conflict discussions can be moderated by spousal support (Heffner, Kiecolt-Glaser, Loving, Glaser, & Malarkey, 2004) and patterns of communication (Heffner et al., 2006).

Despite literature linking marital quality and physical health, there is one area that has been relatively unexplored. Many indices of health are at least moderately heritable, including both health behaviors (e.g., smoking) and health outcomes (e.g., heart disease; Komaroff, 1999). Still unknown are the ways in which marital quality interacts with genetic influences to affect health outcomes. Behavior genetic methods, particularly biometric modeling of twin-study data, may be particularly useful for better understanding the etiology of the link between marital quality and physical health.

Biometric modeling can be used to examine several different forms of gene-environment interplay in the association between marital quality and physical health (Rutter, Moffitt, & Caspi, 2006). The two most well-known forms are gene-environment correlation and gene-by-environment interaction. Gene-environment correlation refers to how genetically influenced factors predict the environment that an individual encounters, thus making those environments at least partially heritable. There are several different types of gene-environment correlation (see Jaffee & Price, 2007), but biometric modeling with cross-sectional twin-study data is not ideally suited to teasing these apart. Instead, biometric models can estimate genetic (r_A) and environmental correlations (r_C, r_E) that range from −1.0 to +1.0 and that index the amount of

Corresponding Author:
Susan C. South, 703 Third St., West Lafayette, IN 47907
E-mail: ssouth@purdue.edu

overlap between two or more phenotypes. The association between marital quality and physical health may be genetically mediated (i.e., there is a significant genetic correlation, r_A), which means that the same genetic influences operate on both marital quality and physical health. Alternatively, the relationship between marital quality and physical health may be environmentally mediated, with the same exogenous stressors that lead to distressed marriages also leading to poor physical health.

In addition to a gene-environment correlation, a gene-by-environment interaction is also possible. Gene-by-environment interactions occur when genetic influences on a phenotype, such as physical health, are expressed only in the presence of a specific environmental factor (such as poor marital quality). Previously, we reported evidence of a gene-by-environment interaction for personality traits and parent-child relationship quality (Krueger, South, Johnson, & Iacono, 2008). We also found that genetic influences on internalizing psychopathology are sensitive to environmental contexts such as marital quality (South & Krueger, 2008) and socioeconomic status (South & Krueger, 2011). It may be that the marital relationship is an environmental context that also moderates a latent genetic diathesis for physical health.

In the current study, we examined gene-environment interplay in the association between marital satisfaction and self-reported physical health. Using a nationwide sample of twin pairs from the Midlife in the United States (MIDUS) study, we estimated the relative influence of genes, the shared environment, and the nonshared environment on self-reported health at differing levels of marital quality. We hypothesized that the genetic and environmental components of variance of self-reported physical health would differ depending on the quality of an individual's marital relationship (evidence of a gene-by-environment interaction) and that there would be overlap between genetic and environmental influences on marital satisfaction and physical health (evidence of gene-environment correlation).

Method

Sample

In the current analyses. we used the twin sample from the MacArthur Foundation Survey of Midlife Development in the United States (MIDUS). The full MIDUS sample consists of a nationally representative group of individuals aged 25 to 74 years drawn from the noninstitutionalized civilian population of the continental United States. The MIDUS sample also consists of a twin subsample (Kessler, Gilman, Thornton, & Kendler, 2004), ascertained by screening members of approximately 50,000 households via a telephone survey to determine whether an immediate relative was a twin (Kessler et al., 2004). All twin participants completed the full MIDUS data-collection process, which consisted of a computer-assisted telephone interview and two mailed questionnaire booklets (Kendler, Thornton, Gilman, & Kessler, 2000).[1]

The MIDUS twin sample consisted of a total of 1,996 individuals from 998 twin pairs. Zygosity was determined using a brief twin screener (cf. Lykken, Bouchard, McGue, & Tellegen, 1990). A total of 16 pairs were excluded because of missing or indeterminate zygosity data. Additionally, we excluded the 263 opposite-sex twin pairs, which resulted in a sample of 719 pairs. Given the focus on marital quality, we eliminated individual twins who were discordant for marital status (n = 435 persons, or approximately 30% of the sample, equivalent to the percentage of individuals who were married in the main MIDUS sample; see Marks, Bumpass, & Jun, 2004) and 254 individuals for whom cotwin data were not available because of discordant marital status. This left a sample of 379 twin pairs; the moderation model we used in the current study requires that both twins have data for the moderator variable (in this case, marital satisfaction). Thus, we had a final sample of 347 twin pairs: 89 monozygotic (MZ) male pairs, 99 MZ female pairs, 75 dizygotic (DZ) male pairs, and 84 DZ female pairs. Average age was 46 years (SD = 11.92, range = 25–74), and mean relationship duration was 23 years (SD = 13, range = 0–56).

The final sample was slightly older than the full sample (M = 45.97 years vs. M = 44.27 years, respectively) and reported slightly better mean health ratings than the full sample (M = 7.81 vs. M = 7.58, respectively), although the corresponding effect sizes were small (ds = 0.14 and 0.15, respectively) for both comparisons; there were no notable differences in the distribution of male versus female pairs (57% female in the total twin sample, 53% in the final sample). All participants provided informed consent, and the current study was approved by the authors' local institutional review boards.

Measures

Marital satisfaction. The MIDUS questionnaire inquired about the quality of each participant's marriage using 21 items assessing a variety of aspects of the marriage, including risk of separation, level of disagreement in several areas, how often they make decisions together, and amount of empathy/criticism. Items were summed to create an overall marital quality score (α = .93). The average score in this sample was 80.20 (SD = 11.89, range = 24–97).

Physical health. For the current analyses, we used a self-report measure of overall health from MIDUS that asked participants to rate their current state of health on a scale from 0, *the worst possible health*, to 10, *the best possible health*. This type of subjective self-report evaluation of health has been widely used to predict health status, functional ability, and mortality above and beyond other objective indices of health (DeSalvo, Bioser, Reynolds, He, & Muntner, 2005; Idler & Benyamini, 1997; Idler & Kasl, 1995). Scores on this variable were available for 693 of the twins (M = 7.81, SD = 1.46). The self-rated physical-health variable was moderately skewed (−.88). We thus squared the health variable to separate its level from its variance as would be expected in a normal regression model.

Data analysis

Biometric modeling with twin samples takes advantage of the differences in MZ twins, who share 100% of their genes, and DZ twins, who share 50% of their independently segregating genes, to decompose the variance in a phenotype into the amount due to genetic effects (A), common environmental influences (C), and unique environmental influences (E). A standard univariate *ACE* model estimates variance components that apply to the entire sample. Biometric moderation models (Purcell, 2002) estimate genetic and environmental influences on one specific phenotype (here, physical health) as a function of a second variable (marital satisfaction). Thus, this model can determine the presence of gene-by-environment interactions or whether an environmental risk factor moderates the genetic influences on a phenotype. This biometric moderation model also estimates genetic and environmental correlations that differ depending on level of marital satisfaction.

We began by fitting the moderation model without moderation parameters. Moderation parameters were then added, and the fit of the full moderation model that included all moderating effects was compared with the no-moderation model. Model fitting was conducted with the raw data in Mx (Neale, Boker, Xie, & Maes, 2003) using full-information maximum-likelihood estimation, a procedure that can handle missing data as part of the model-fitting procedure. Standard procedures were followed to correct for potential biases in model fitting, such that the marital quality and self-reported physical-health scores were regressed on the linear and quadratic effects of age and gender (age, age^2, Age × Gender, and Age^2 × Gender; see McGue & Bouchard, 1984). Model fit was evaluated using the likelihood-ratio test (LRT) and the Akaike information criterion (AIC; Akaike, 1987). The LRT is used as a goodness-of-fit index; it is computed as the change in the −2 log-likelihood values for two nested models and distributed as χ^2, which can be used to determine how model fit improves as a result of adding or omitting parameters. We used the AIC, an information-theoretic fit statistic, to identify the best-fitting model with the fewest number of parameters. Lower AIC values indicate better-fitting models (Markon & Krueger, 2004).

Results

Self-rated physical health was significantly correlated with total marital-quality score (r = .22, p < .0001). As a first step, self-rated health and marital satisfaction were entered into a bivariate model with no moderation parameters estimated. This is roughly comparable with the bivariate decomposition (Cholesky) model, with differences in the degrees of freedom and −2 log likelihood as a result of the data-entry method required for the moderation model. As Table 1 shows, the heritability (proportion of total variance due to genetic effects) of self-rated health was .16, the proportion of variance due to shared environmental effects was .19, and the proportion of variance due to nonshared environmental effects was .65. The genetic and shared environmental effects were perfectly correlated, which indicates that the same genetic influences and the same common environmental influences affected marital satisfaction and self-rated physical health. In contrast, the nonshared environmental correlation indicated that there was essentially no overlap in the unique environmental influences on health and satisfaction.

Next, we added the moderation parameters to fit the full model estimating gene-environment correlation and gene-by-environment interaction. The full moderation model (−2 log likelihood = 3,819.03, df = 1,370, AIC = 1,079.03) improved

Table 1. Results from Models Predicting Self-Rated Physical Health: Estimates of Variance Components and Correlations Between Marital Satisfaction and Physical Health

Model and level of moderator	Variance component (unstandardized)			Total variance (unstandardized)	Proportion of variance (standardized)			Correlation with moderator (standardized)		
	A	C	E		A	C	E	r_A	r_C	r_E
No-moderation model	0.16	0.19	0.64	0.99	.16	.19	.65	1.00	1.00	−.01
Moderation model										
Marital satisfaction: −2 *SD*	0.45	0.09	0.64	1.18	.38	.08	.54	.47	1.00	.00
Marital satisfaction: −1 *SD*	0.18	0.16	0.61	0.95	.19	.17	.64	.73	1.00	.10
Marital satisfaction: 0 *SD*	0.10	0.25	0.59	0.93	.10	.26	.63	1.00	1.00	.21
Marital satisfaction: 1 *SD*	0.19	0.35	0.58	1.12	.17	.31	.52	.70	1.00	.32
Marital satisfaction: 2 *SD*	0.46	0.47	0.59	1.52	.30	.31	.39	.45	1.00	.42

Note: For the moderation model, results are shown at five levels of marital satisfaction relative to the mean. A = genetic variance, C = shared environmental variance, E = nonshared environmental variance, r_A = genetic correlation, r_C = shared environmental correlation, r_E = nonshared environmental correlation.

on the baseline no-moderation model (−2 log likelihood = 3,847.79, *df* = 1,376, AIC = 1095.79) according to the AIC and LRT (change in −2 log likelihood = 28.76, p = .0001). The variance components from the moderation model were plotted for five levels (−2, −1, 0, 1, and 2 standard deviations from the mean) of the moderator, marital satisfaction (see Table 1 and Fig. 1). Heritability of self-reported health displayed a curvilinear pattern, ranging from .38 at the lowest levels of marital satisfaction to .10 at the average levels to .30 for people with highly satisfying marriages. Nonshared environmental effects were stronger for average to low (e^2 = 54–64%) levels of satisfaction, but declined at high levels of satisfaction (e^2 = 39%). Shared environmental influences rose from low (c^2 = 8%) to high (c^2 = 31%) levels of satisfaction. Similar to heritability estimates, the genetic correlations between marital quality and health displayed a curvilinear pattern, with lower values at low (r_A = .47) and high (r_A = .45) levels of marital satisfaction and the highest correlation at the average level of satisfaction (r_A = 1.00). The correlation between nonshared environmental influences on satisfaction and self-reported physical health increased from .00 (low satisfaction) to .42 (high satisfaction).[2]

Discussion

In the current study, we replicated the long-standing finding that marital satisfaction is significantly positively correlated with self-reported physical health. We were most interested, however, in exploring one possible mechanism connecting marital quality and physical-health outcomes. Along with other researchers (e.g., Reiss, 2010), we argue that social relationships have a substantial impact on health variables through moderation of genetic influences. For instance, research has shown that 5-HTTLPR (a functional polymorphism in the promotor region of the SLC6A4 serotonin transporter gene) may moderate the effect of both positive and negative social influences on health (Way & Taylor, 2010). The quality of the marital relationship may also enhance or suppress the effect of genetic influences on physical health. Examining moderation of heritability has the potential to inform future gene-hunting efforts with measured genes and measured environmental contexts.

Using biometric moderation models with a nationwide twin sample, we examined the presence of a gene-by-environment interaction between marital satisfaction and self-reported health in the presence of gene-environment correlation. Genetic influences demonstrated a curvilinear effect, with the highest heritability at low and high levels of marital satisfaction. Shared environmental effects were greatest and unique environmental effects were lowest at the highest levels of marital satisfaction. To date, findings from our work and other work using biometric moderation models have identified primarily linear effects; that is, genetic influences on a phenotype are greatest at one level of the moderator and drop in a linear fashion going toward the other level of the moderator (e.g., Hicks, South, DiRago, Iacono, & McGue, 2009; Racine, Burt, Iacono, McGue, & Klump, 2011; South & Krueger, 2008, 2011). The results from the current study, with a distinct curvilinear pattern, are evidence for what has been called an "orchid effect" or a biological sensitivity to context (Belsky & Pluess, 2009; Ellis & Boyce, 2008). It has been suggested that developmental plasticity is heritable, and individuals who are the most genetically vulnerable to the damaging effects of stressful environments (e.g., a bad marriage) may also reap the highest rewards from the most advantaged environments (e.g., a good marriage).

Our findings also revealed changes in the amount of overlap between the genetic and environmental influences on marital satisfaction and physical health. At the highest and lowest levels of marital adjustment, the genetic correlation was still substantial but much lower than at the average levels of marital quality. In a model that did not account for gene-by-environment interaction, results suggested that there was essentially no overlap between the unique environmental influences on marital satisfaction and health. The moderation model that incorporated the gene-by-environment interaction, however, found a linear increase in the unique environmental correlation from low to high levels of marital quality. Considered together with the findings for the change in the variance components, these results suggest a complex portrait of unique environmental influences on health at different levels of marital satisfaction. Perhaps in the most distressed marriages, partners are simply spending less time together, and the situations

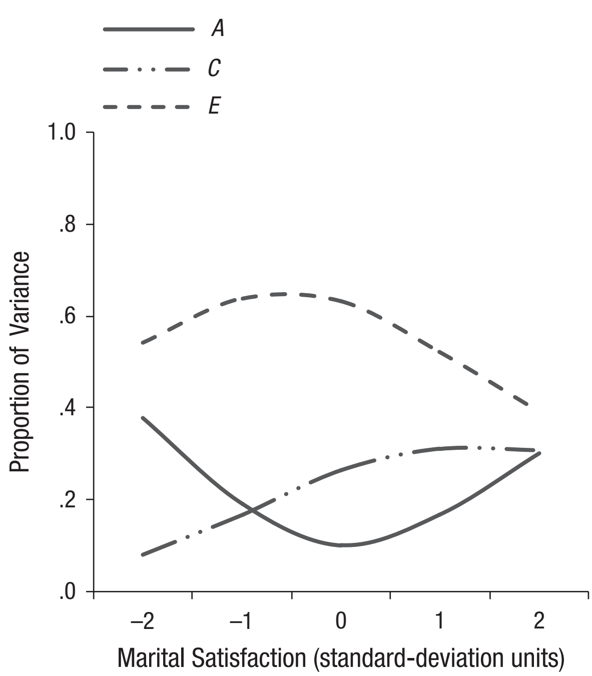

Fig. 1. Proportion of variance in self-rated physical health as a function of marital satisfaction and type of variance. Results are shown for standardized genetic variance (*A*), standardized shared environmental variance (*C*), and standardized nonshared environmental variance (*E*).

they are encountering without their spouse in turn negatively affect physical health. Alternatively, there could be spousal effects on health behaviors that do not affect perceptions of marital satisfaction. In the most satisfying marriages, there was much higher overlap between the unique environmental influences on satisfaction and health, which suggests that in high-quality marriages, the relationship itself may be a protective factor against health problems.

There were at least four limitations of the current study. First, although the MIDUS twin sample is unique in being one of the few nationwide twin samples, it is relatively modest in size and less racially and culturally diverse than the broader contemporary U.S. population. Our findings should be replicated in larger and more diverse samples. Second, even though self-report measures of health have been widely utilized, they are generally broad and nonspecific, and findings may change if different, more objective indices of health are used. Additionally, self-reports of marital quality may miss important associations with health that are captured by spouse-report or behavioral observations (Smith, Uchino, Berg, & Florsheim, 2012). Finally, the wide age range of the sample and the fact that we controlled for age may have collapsed effects that were specific to a certain developmental period. Despite these limitations, this study has the potential to inform psychologists' understanding of the mechanisms connecting physical health and marital quality. In the future, molecular genetics researchers may wish to examine both extremely satisfying marriages and extremely unsatisfying marriages as a context for the expression of genetic effects on physical health.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development and by a grant from the National Institute on Aging (No. AG20166).

Notes

1. There is also a second wave of data available for MIDUS from 2005. We chose to use only the original MIDUS data set for two reasons. First, the sample size was much larger at the first wave than at the second wave of MIDUS data collection, and by the second wave, there was some attrition, particularly among dizygotic male twins. Second, it is also difficult to precisely determine changes in marital status using data from the second wave. It is possible to infer whether participants have divorced or remarried on the basis of other questions, but only imperfectly. Thus, we felt it would be unwise to try and perform any type of longitudinal analysis (i.e., marital satisfaction at the first wave of MIDUS data collection moderating physical health at the second wave).

2. It is possible that the transactions between marital quality and physical health are, in fact, bidirectional. To address this question, we also ran a biometric moderation model with self-rated physical health as a moderator of genetic and environmental influences on marital satisfaction. The full moderation model (−2 log likelihood = 3,845.08, df = 1,382, AIC = 1,081.08) improved on the baseline no-moderation model (−2 log likelihood = 3,878.88, df = 1,388, AIC = 1,102.88) according to the AIC and LRT (change in −2 log likelihood = 33.81, $p < .0001$). The fact that the moderation model fit better than a model without moderation in both directions supports a mutual-transaction relationship between marital satisfaction and physical health.

References

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika*, *52*, 317–332.

Baker, B., Paquette, M., Szalai, J. P., Driver, H., Perger, T., Helmers, K., . . . Tobe, S. (2000). The influence of marital adjustment on 3-year left ventricular mass and ambulatory blood pressure in mild hypertension. *Archives of Internal Medicine*, *160*, 3453–3458.

Belsky, J., & Pluess, M. (2009). Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin*, *135*, 885–908.

Bookwala, J. (2005). The role of marital quality in physical health during the mature years. *Journal of Aging and Health*, *17*, 85–104.

DeSalvo, K. B., Bioser, N., Reynolds, K., He, J., & Muntner, P. (2005). Mortality prediction with a single general self-rated health question: A meta-analysis. *Journal of General Internal Medicine*, *20*, 267–275.

De Vogli, R., Chandola, T., & Marmot, M. G. (2007). Negative aspects of close relationships and heart disease. *Archives of Internal Medicine*, *167*, 1951–1957.

Ellis, B. J., & Boyce, W. T. (2008). Biological sensitivity to context. *Current Directions in Psychological Science*, *17*, 183–187.

Heffner, K. L., Kiecolt-Glaser, J. K., Loving, T. J., Glaser, R., & Malarkey, W. B. (2004). Spousal support satisfaction as a modifier of physiological responses to marital conflict in younger and older couples. *Journal of Behavioral Medicine*, *27*, 233–254.

Heffner, K. L., Loving, T. J., Kiecolt-Glaser, J. K., Himawan, L. K., Glaser, R., & Malarkey, W. B. (2006). Older spouses' cortisol responses to marital conflict: Associations with demand/withdraw communication patterns. *Journal of Behavioral Medicine*, *29*, 317–325.

Hicks, B. M., South, S. C., DiRago, A. C., Iacono, W. G., & McGue, M. (2009). Environmental adversity and increasing genetic risk for externalizing disorders. *Archives of General Psychiatry*, *66*, 640–648.

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, *7*(7), e1000316. Retrieved from http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000316

Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*, *38*, 21–37.

Idler, E. L., & Kasl, S. V. (1995). Self-ratings of health: Do they also predict change in functional ability? *Journals of Gerontology B: Psychological Sciences and Social Sciences*, *50B*, S344–S353.

Jaffee, S. R., & Price, T. S. (2007). Gene-environment correlations: A review of the evidence and implications for prevention of mental illness. *Molecular Psychiatry*, *12*, 432–442.

Kendler, K. S., Thornton, L. M., Gilman, S. E., & Kessler, R. C. (2000). Sexual orientation in a national sample of twin and sibling pairs. *American Journal of Psychiatry*, *157*, 1843–1846.

Kessler, R. C., Gilman, S. E., Thornton, L. M., & Kendler, K. S. (2004). Health, well-being, and social responsibility in the MIDUS twin and sibling subsamples. In O. G. Brim, C. D. Ryff, & R. C. Kessler (Eds.), *How healthy are we? A national study of well-being at midlife* (pp. 124–152). Chicago, IL: University of Chicago Press.

Kiecolt-Glaser, J. K., Malarkey, W. B., Chee, M. A., Newton, T., Cacioppo, J. T., Mao, H.-Y., & Glaser, R. (1993). Negative behavior during marital conflict is associated with immunological down-regulation. *Psychosomatic Medicine*, *55*, 395–409.

Kiecolt-Glaser, J. K., & Newton, T. L. (2001). Marriage and health: His and hers. *Psychological Bulletin*, *127*, 472–503.

Komaroff, A. L. (Ed.). (1999). *Harvard Medical School family medical guide*. New York, NY: Simon & Schuster.

Krueger, R. F., South, S. C., Johnson, W., & Iacono, W. (2008). The heritability of personality is not always 50%: Gene-environment interactions and correlations between personality and parenting. *Journal of Personality*, *76*, 1485–1522.

Lykken, D. T., Bouchard, T. J., McGue, M., & Tellegen, A. (1990). The Minnesota Twin Family Registry: Some initial findings. *Acta Geneticae Medicae et Gemellologiae*, *39*, 35–70.

Malarkey, W. B., Kiecolt-Glaser, J. K., Pearl, D., & Glaser, R. (1994). Hostile behavior during marital conflict alters pituitary and adrenal hormones. *Psychosomatic Medicine*, *56*, 41–51.

Markon, K., & Krueger, R. F. (2004). An empirical comparison of information-theoretic selection criteria for multivariate behavior genetic models. *Behavior Genetics*, *34*, 593–610.

Marks, N. F., Bumpass, L. L., & Jun, H. (2004). Family roles and well-being during the middle life course. In O. G. Brim, C. D. Ryff, & R. C. Kessler (Eds.), *How healthy are we? A national study of well-being at midlife* (pp. 514–549). Chicago, IL: University of Chicago Press.

McGue, M., & Bouchard, T. J. (1984). Quality of twin data for the effects of age and sex. *Behavior Genetics*, *14*, 325–343.

Neale, M. C., Boker, S. M., Xie, G., & Maes, H. H. (2003). *Mx: Statistical modeling*. (Available from Department of Psychiatry, School of Medicine, Virginia Commonwealth University, Richmond, VA 23298)

Purcell, S. (2002). Variance components models for gene-environment interaction in twin analysis. *Twin Research*, *5*, 554–571.

Racine, S. E., Burt, S. A., Iacono, W. G., McGue, M., & Klump, K. L. (2011). Dietary restraint moderates genetic influences on binge eating. *Journal of Abnormal Psychology*, *120*, 119–128.

Reiss, D. (2010). Genetic thinking in the study of social relationships: Five points of entry. *Perspectives on Psychological Science*, *5*, 502–515.

Rutter, M., Moffitt, T. E., & Caspi, A. (2006). Gene-environment interplay and psychopathology: Multiple varieties but real effects. *Journal of Child Psychology and Psychiatry*, *47*, 226–261.

Smith, T. W., Uchino, B. N., Berg, C. A., & Florsheim, P. (2012). Marital discord and coronary artery disease: A comparison of behaviorally defined discrete groups. *Journal of Consulting and Clinical Psychology*, *80*, 87–92.

Smith, T. W., Uchino, B. N., Berg, C. A., Florsheim, P., Pearce, G., Hawkins, M., . . . Olsen-Cerny, C. (2009). Conflict and collaboration in middle-aged and older couples: II. Cardiovascular reactivity during marital interaction. *Psychology and Aging*, *24*, 274–286.

South, S. C., & Krueger, R. F. (2008). Marital quality moderates genetic and environmental influences on the internalizing spectrum. *Journal of Abnormal Psychology*, *117*, 826–837.

South, S. C., & Krueger, R. F. (2011). Genetic and environmental influences on internalizing psychopathology vary as a function of economic status. *Psychological Medicine*, *41*, 107–117.

Way, B. M., & Taylor, S. E. (2010). Social influences on health: Is serotonin a critical mediator? *Psychosomatic Medicine*, *72*, 107–112.

Whisman, M. A., & Uebelacker, L. A. (2003). Comorbidity of relationship distress and mental and physical health problems. In D. K. Snyder & M. A. Whisman (Eds.), *Treating difficult couples: Helping clients with coexisting mental and relationship disorders* (pp. 3–26). New York, NY: Guilford Press.