Behav Genet (2009) 39:597–604
DOI 10.1007/s10519-009-9287-7

ORIGINAL RESEARCH

Genetic and Environmental Influences on Optimism and its Relationship to Mental and Self-Rated Health: A Study of Aging Twins

Miriam A. Mosing · Brendan P. Zietsch · Sri N. Shekar · Margaret J. Wright · Nicholas G. Martin

Received: 4 February 2009 / Accepted: 7 July 2009 / Published online: 18 July 2009

Abstract Optimism has been shown to be important in maintaining wellbeing into old age, but little is known about the sources of variation in optimism and its links to mental and somatic health. Optimism, mental, and self-rated health were measured in 3,053 twin individuals (501 MZF, 153 MZM, 274 DZF, 77 DZM, and 242 DZ opposite-sex twin pairs and 561 single twins) over 50 years using the life orientation test, the General Health Questionnaire and a single-item question for self-rated health. Additive genetic factors explained 36, 34, and 46% of the variation in optimism, mental, and self-rated health, respectively, with the remainder being due to non-shared environmental influences. Genetic influences accounted for most of the covariance between the variables (14–20% of the genetic variance) indicating that in older adults genes predisposing to high optimism also predispose to good mental health and self-rated health.

Keywords Optimism · Mental health · Somatic health · Aging · Twin design

Edited by Deborah Finkel.

M. A. Mosing (✉) · B. P. Zietsch · S. N. Shekar · M. J. Wright · N. G. Martin
Genetic Epidemiology Unit, Queensland Institute of Medical Research, 300 Herston Rd, Brisbane, QLD 4029, Australia
e-mail: miriam.mosing@qimr.edu.au

M. A. Mosing · B. P. Zietsch
School of Psychology, University of Queensland, Brisbane, QLD, Australia

S. N. Shekar
School of Medicine, University of Queensland, Brisbane, QLD, Australia

Introduction

A large body of work has focused on negative affective states such as anger, depression and anxiety, but very little research has been done on positive affective states such as optimism, happiness, or life satisfaction. Optimism can be defined in terms of positive generalized outcome expectancies (Scheier and Carver 1985, 1993) and is an important and stable dimension of personality correlated with, but distinguishable from, constructs such as hopelessness, depression, self-esteem and locus of control.

Previous studies have proposed that positive beliefs, such as optimism, may serve as a protective buffer against future mental and somatic health problems (Atienza et al. 2002; Giltay et al. 2004, 2006; Kubzansky et al. 2001; Maruta et al. 2002; Peterson et al. 1988; Scheier and Carver 1985, 1987, 1992; Scheier et al. 1989; Seligman 1991; Taylor 1989), enhance coping strategies (Nes and Segerstrom 2006), such as in the adjustment to stress of heart disease and its treatment (Fitzgerald et al. 1993; King et al. 1998; Mahler and Kulik 2000; Matthews et al. 2004; Rasmussen et al. 2006; Scheier et al. 1989), and are advantageous in the context of adjusting to the diagnosis and treatment of cancer (Carver et al. 1993, 2005; Johnson 1996; Trunzo and Pinto 2003). Optimism also has been found to be associated with lower levels of distress after diagnosis of Acquired Immunodeficiency Syndrome (AIDS), lower risk of mortality (Maruta 2000), lower levels of depression (Seligman et al. 1979), better psychological adjustment during pregnancy and post-partum, and may be a prenatal psychosocial predictor of higher infant birth weight (Carver and Gaines 1987; Fontaine and Jones 1997; Park and Gutchess 2006; Rini et al. 1999; Taylor et al. 1992). In addition, pessimism has been related to disease progression in women with an abnormal PAP smear test

(Antoni and Goodkin 1988) in that optimistic women (measured before diagnosis) were found to have less severe subsequent atypical neoplastic growth in the cervix compared to pessimistic women. Although these findings indicate an important role of optimism on well-being, little is known about the origins of individual differences in optimism. Due to this lack of knowledge and its predictive value on health variables, optimism merits special attention.

Seligman (1991) suggests that optimism could be learned by experiencing success and failure in situations throughout life. However, a significant amount of variance in optimism may be due to genetic factors (Plomin et al. 1992; Schulman et al. 1993), as other personality traits have been found to be influenced by genes, "e.g. the Big five, Type A and D personality, Altruism etc."(Bouchard and McGue 2003; Fulker et al. 1980; Hoekstra et al. 2007; Jang et al. 2006; Koenig et al. 2007; Kupper et al. 2007; Loehlin 1992; Plomin and Nesselroade 1990; Rebollo and Boomsma 2006a, b; Taub 1998; Yamagata et al. 2006). Unlike other personality traits, which have been thoroughly investigated with the behavioural genetic paradigm, only two studies have examined the genetic basis of optimism (Plomin et al. 1992; Schulman et al. 1993). The first study (Plomin et al. 1992) measured optimism and mental health in a relatively small sample of 500 twin pairs (mean age 60.7 years, half of them reared together and half reared apart) using the Life Orientation Test (Scheier and Carver 1985) (LOT). The LOT measures generalised outcome expectancies and, in essence, optimism and pessimism. Test–retest reliability (correlation) is estimated to be 0.76–0.79 (Scheier and Carver 1985). The study by Plomin et al. (1992) reported a correlation between optimism/pessimism measured by the LOT and several mental health measures of 0.5–0.6, and showed a heritability for optimism/pessimism of 0.25. The study also revealed that genetic factors contribute considerably to associations between optimism/pessimism and mental health. The second study (Schulman et al. 1993) administered the Attributional Style Questionnaire (ASQ), another measure of optimism, to an even smaller sample (115 MZ, 27 DZ pairs, mean age 30). An MZ correlation of 0.48 and a DZ correlation of zero were found, suggesting a substantial genetic influence on optimism, but the low power due to the small sample size did not allow for partitioning of the variance into that due to additive or dominant genetic influences.

The aim of the present study was to investigate the sources of variation in optimism, measured by the LOT, as well as sources of variance in mental and physical health in middle-aged and older twins using a large sample ($N = 3{,}053$). We used the General Health Questionnaire (GHQ), a self-administered screening test to detect psychiatric disorders and psychological distress (Goldberg and Williams 1988), and self-rated health (SRH), a subjective overall evaluation of health, as measurements for mental and somatic well-being, respectively. Previous research has found that 44% of individual differences in the GHQ, and 26–44% of individual differences in SRH can be explained by genetic factors (Christensen et al. 1999; Harris et al. 1992; Leinonen et al. 2005; Romeis et al. 2000; Roysamb et al. 2003; Silventoinen et al. 2007; Svedberg et al. 2001, 2005), but no study has explored the relationships between optimism, and mental and self-rated health. Thus, a further goal was to investigate the genetic and environmental contributions to the correlations between optimism, mental health and self-rated health.

Methods

Participants

The community-based sample consisted of 3,053 twin individuals ranging in age from 50 to 94 years ($M = 61 \pm 8.8$). This included 501 MZ female, 153 MZ male, 274 DZ female, 77 DZ male, 242 DZ opposite-sex twin pairs, and 561 single twins where the co-twin did not participate. The considerably fewer amount of male as compared to female twins seems to be due to male twins generally being less willing to participate in surveys (Lykken et al. 1987). The single twins were retained for the Maximum Likelihood analysis as they contribute to the estimation of means and covariate effects (thresholds). Participants were recruited from the Australian Twin Registry (ATR) (Hopper 2002), and completed a mailed questionnaire between 1993 and 1995. Details of the sampling methods are described elsewhere (Bucholz et al. 1998). Briefly, the study was conducted as a multi-wave mail-out with consent implied by return of the questionnaire. The study was approved by Queensland Institute of Medical Research Human Research Ethics Committee.

In addition to the assessment of optimism, general health (mental and self-rated), and demographic characteristics, the questionnaire covered a wide range of other health domains including personality, relationships and life events, family history, leisure activities, smoking and drinking patterns, vitamins intake, sun exposure, anxiety, and depression, and required approximately 1.5 hours to be fully completed; no reward was given for participation. Zygosity was determined by asking the twins to judge themselves as identical or non-identical based on their physical similarities, and on the degree to which they are/have been confused by others. With this method only 3.9% of the twin pairs are misclassified compared to zygosity typing using blood (Kasriel and Eaves 1976). For a small subset of the sample (6%), zygosity was subsequently

confirmed through genotyping micro-satellite markers across the genome (Cornes et al. 2005).

Measures

Revised life orientation test (LOT-R) of optimism and pessimism

The LOT-R (Scheier and Carver 1985) consists of ten items (three items assessing optimism, three items assessing pessimism, and four filler items). The two principles applied in its construction were to generate an equal number of positively worded and negatively worded items, and to word each item in such a way that it did not imply any specific basis for the expectancy. Factor analysis indicated that though there is some justification for examining the positive and negative halves of the scale separately, it is most reasonable to treat the scale as one-dimensional for most purposes (Scheier and Carver 1985). A three-point Likert scale ("yes", "don't know", and "no") was used for each item. The scale score was derived by simply adding the item scores (1–3) of the six items; a low total score indicating pessimism and a high total score optimism (Scheier and Carver 1985), with scores ranging from 6 to 18. For directional consistency with the other variables (below), we reversed the scale so that lower scores indicate more optimism. Since self-rated health is a categorical variable, the LOT score was converted to an ordinal variable with four categories. Participants who scored between 0 and 13 (19% of the sample) were assigned to category four, 14–15 (23%) to category three, 16–17 (29%) to category two, 18 (29%) to category one.

General Health Questionnaire (GHQ-12)

The General Health Questionnaire (GHQ) has been used to estimate severity and prevalence of psychological disorder. Numerous studies have demonstrated that the GHQ is a reliable and valid measure; more than 50 studies have shown that it correlates well with psychiatric diagnosis (Bowling 2005). Although the original version consists of 60 items, shorter versions which lose little in terms of validity and reliability are available (Goldberg and Williams 1988). The 12-item version of the GHQ was used, with participants being asked to rate present and recent complaints as "Better than usual" (0), "Same as usual" (1), "Less than usual" (2), or "Much less than usual" (3). The scale score was derived by adding up the item scores (0–3) with the total score ranging between 0 and 36. While scores may vary by study population, scores at 11–12 are typical, with scores above 15 indicating distress, and a score higher than 20 suggesting severe psychological distress and problems. For consistency with the other variables, the GHQ was also analysed as an ordinal variable, with participants scoring 0–6 (25%) assigned to category one, 7–8 (31%) to category two, 9–13 (34%) to category three, 14–36 (10%) to category four.

Self-rated health (SRH)

Participants' subjective health was assessed by a single item: "How would you describe your health at present?" Participants responded on a five-point Likert scale, ranging from "very good" (1), "good" (2), "fair" (3), to "poor" (4), and "very poor" (5). This single SRH-question has been shown to be a highly reliable and valid measure of overall health as measured by means of other indicators in all population groups (Lundberg and Manderbacka 1996). It also has been shown to be a very good predictor of mortality and the need for services (Leinonen et al. 2005) and is positively correlated with clinical assessments (Romeis et al. 2000). This strong association between SRH-question and mortality is evident throughout all studies regardless of the amount of response categories used (two- to five-point likert scales) (DeSalvo et al. 2006; Lundberg and Manderbacka 1996).Very few participants rated their health as poor (4) or very poor (5); therefore, categories 3, 4 and 5 were merged. This resulted in the assignment of 36% of the participants to category one (i.e. very good), 46% to category two (i.e. good), and 18% to category three (i.e. fair to very poor).

Statistical analysis

The classical twin design was used to partition variance in traits and covariance between traits into that due to genetic and environmental (shared within twin pairs, C, and non-shared, E) influences. This is possible as A, C, and E influences each predict different patterns of MZ and DZ twin pair correlations. As MZ twins share all their genes and DZ twins, on average, only half their segregating genes, a twin pair correlation of 1.0 would be expected for MZ pairs and 0.5 for DZ pairs if A was the only source of variance in a specific trait. Another fundamental assumption of the classical twin design is that trait-relevant environments are similar for MZ and DZ twin pairs (Kendler et al. 1993). Normally, twin correlations can be explained by a combination of these three parameters (A, C, and E) and structural equation modelling can be used to determine the combination that best explains the observed data.

Data were analysed using Maximum-Likelihood (ML) methods in Mx (Neale et al. 2002), utilising threshold modelling for ordinal data (Neale and Maes 2004). In this procedure, each twin group (MZ females, MZ males, DZ females, DZ males, and DZ opposite-sex) has two sets of

thresholds (one set for each twin) for each of the three variables included. Initially, a saturated model is fitted estimating all parameters, and then progressively more restricted models are compared to the previous model. In maximum-likelihood procedures, the minus two times log-likelihood (−2LL) statistics (distributed as χ^2) are compared between the nested models to test the significance of particular parameters, and hence test specific hypotheses regarding those parameters.

A trivariate Cholesky-model was fitted to assess genetic and environmental factors that mediate the phenotypic covariation between optimism and mental health and self-rated health. In the initial model we allowed for quantitative differences in the sources of variation of the three measured traits between sexes (common effects limitation-model). After estimating the relative magnitude of all parameters, sub-models were fitted to test the significance of specific parameters and to determine the most parsimonious model explaining the phenotypic variance in optimism, mental and self-rated health. Model reduction started with dropping the paths with the smallest parameter estimates.

Prior to genetic modeling, we tested each of the variables for equality of thresholds within twin pairs and across zygosity groups. We also tested for age and sex effects on the thresholds and for equality of correlations of MZ male and female pairs, and of DZ male and female pairs and opposite-sex DZ twin pairs.

Results

Preliminary analyses

No significant ($P < .05$) differences were found in the thresholds within twin pairs or across zygosity groups for optimism, mental health and self-rated health. Mental and self-rated health showed significant age effects on thresholds but no sex effects, whereas optimism showed a sex effect but no age effect. Therefore, age and sex were retained as covariates in subsequent modeling. In order to control for participation bias, we checked whether the thresholds for the variables were different in singletons compared to full pairs (Martin and Wilson 1982; Neale and Eaves 1993). For example, if the singletons had lower thresholds in the health variable (i.e. poorer health) than full pairs, this may indicate that their co-twins may have declined to participate due to poor health, as they are expected to be correlated on this variable. However, the analysis revealed that there was no significant difference in thresholds between full twin pairs and singletons, and between sexes, and, therefore, that dropout rates were independent of the three variables or sex.

Correlations

The phenotypic polychoric correlations between optimism and self-rated health (males: 0.19, females: 0.23), optimism and mental health (males: 0.26, females: 0.28), and self-rated and mental health (males: 0.24, females: 0.26) were similar in magnitude for males and females. MZ twin correlations were significantly higher than DZ twin correlations for female pairs in all variables, suggesting some genetic influence, but for males there were no significant differences between MZ and DZ twin correlations for any of the three traits even though there was a trend for genetic effects in SRH (Table 1).

Genetic modeling

As MZ twin pair correlations for optimism, mental, and self-rated health were significantly higher than DZ twin correlations in females but not in males, a common effects sex-limitation model was fitted, which allows for quantitative differences in the sources of variation of the traits between sexes. Subsequently, a general ACE model was fitted, in which proportions of A and C were constrained equally in males and females. Results showed no significant deterioration of the model fit (Table 2), indicating no sex differences in the effects of A, C, and E on the variance in the three measured traits. Furthermore, all shared-environmental (C) influences could be dropped without a significant loss of model-fit but the additive genetic (A) factor loadings could not be removed (Table 2).

As can be seen in Fig. 1, genetic factors explained 36% of the variance in optimism, 34% of the variance in mental health, and 46% of the variance in self-rated health, with non-shared environmental influences explaining the remainder. Twenty percent (i.e. $0.26^2/0.34*100$) of the genetic variance in mental health, and 14% of the genetic variance in self-rated health was explained by genetic factors shared with optimism. A further 16% of the genetic variance in self-rated health was explained by genetic factors in common with mental health. Only 2–7% of the variance due to non-shared environmental influences was explained by factors common between optimism, mental, and self-rated health.

However, while the most parsimonious explanation for the observed pattern of MZ and DZ twin pair correlations was a general AE model, both the twin pair correlations (Table 1) and path co-efficients from the full sex-limitation model (Table 3), pointed to possible differences in the sources of variance between sexes. The inability to detect these quantitative and qualitative differences between sexes might be a consequence of insufficient power due to the low number of MZ and especially DZ males as compared to the larger number of females.

Table 1 Twin correlations (95% confidence intervals) for optimism, mental, and self-rated health corrected for age and sex for each zygosity group

Zygosity	*N* pairs (range)	Twin correlations (95% confidence intervals)		
		Optimism	Mental health	Self-rated health
MZ females	(416–441)	0.41 (.32, .50)	0.38 (.27, .47)	0.53 (.43, .61)
MZ males	(134–140)	0.15 (−.05, .34)	0.25 (.05, .43)	0.31 (.12, .49)
DZ females	(226–240)	0.16 (.01, .31)	0.11 (−.03, .26)	0.23 (.07, .37)
DZ males	(65–70)	0.32 (.07, .54)	0.25 (−.03, .49)	0.18 (−.12, .45)
DZ opposite-sex	(210–214)	0.10 (−.06, .25)	0.15 (−.01, .29)	0.18 (.01, .34)

MZ Monozygotic, *DZ* dizygotic

Table 2 Trivariate Cholesky-model fitting results for optimism, mental and self-rated health with the best fitting model in bold

Trivariate model fitting results	−2LL	d*f*	Δ−2LL	Δd*f*	*P*-value
Common effects sex-limitation model	20,154.47	8,427			
General ACE model	20,171.72	8,445	17.252	18	0.51
Omnibus drop of all C-factors	**20,171.56**	**8,451**	**−0.161**	**6**	**0.00**
Omnibus drop of all A-factors	20,390.4	8,457	218.844	6	<0.01

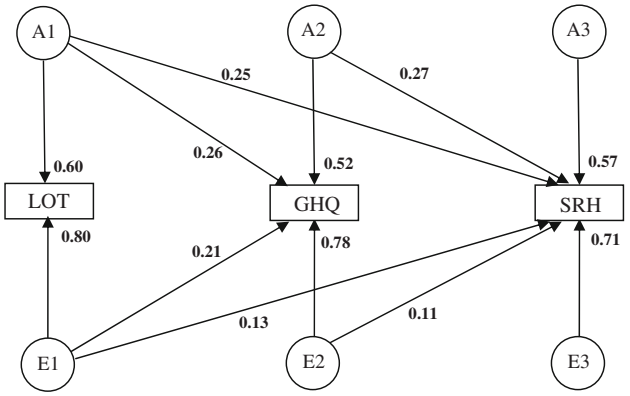

Fig. 1 Best fitting Cholesky-model with standardized path coefficients showing the relationship between optimism (LOT), mental (GHQ) and self-rated health (SRH). Path coefficients can be squared to get the percentage of variance accounted for. The Cholesky factors have been decomposed into additive genetic (A), common environmental (C), and unshared environmental (E) influences

Table 3 Model fitting results for the trivariate common effects sex-limitation model

	Females			Males		
	LOT	GHQ	SRH	LOT	GHQ	SRH
A1	**0.64**	**0.32**	**0.27**	0.28	0.02	0.03
A2		**0.50**	**0.28**		0.31	0.06
A3			**0.61**			**0.44**
C1	0.00	0.01	0.02	**0.42**	0.10	**0.26**
C2		0.10	0.03		**0.45**	**0.26**
C3			0.04			0.05
E1	**0.77**	**0.16**	**0.13**	**0.86**	**0.31**	**0.14**
E2		**0.78**	**0.11**		**0.77**	0.12
E3			**0.67**			**0.79**

Note: Separate parameter estimates are shown for females and males with the best fitting estimates in bold. Confidence intervals could not be derived due to computational limits

Discussion

This study investigated the extent to which genetic and environmental factors influenced the variance in optimism, mental and self-rated health and their inter relations. The general model revealed a moderate genetic influence in the aetiology of optimism and both mental and self-rated health, with a heritability of 0.36, 0.34, and 0.46, respectively. All environmental influences were non-shared. In addition, the phenotypic associations between traits were largely due to common genetic factors with genes predisposing to high optimism also predisposing to good mental health and self-rated health, with additional genetic influences on good mental health also predisposing to good self-rated health.

The present study is the first to investigate optimism, mental and self-rated health and their associations in a genetically informative sample. The few previous genetic studies investigating optimism, and/or mental health (Plomin et al. 1992; Rijsdijk et al. 2003; Schulman et al. 1993) found similar heritability estimates to those reported here, but the majority of them had small sample sizes. Two studies investigated heritability of optimism, while Schulman et al. (1993) does not report heritability estimates due to the extremely small sample size, Plomin et al. (1992) report a heritability of 25% for optimism in a study of 500 twin pairs.

Rijsdijk et al. (2003) (627 female MZ and 1,323 DZ) report a heritability of 44% for the GHQ which accords with our slightly lower estimate of 34%. For SRH, the finding of a heritability of 46% also accords with the more extensive literature investigating the heritability of this trait (Christensen et al. 1999; Harris et al. 1992; Leinonen et al. 2005; Roysamb et al. 2003; Silventoinen et al. 2007). Genetic factors were estimated to account for approximately 25–64% of the variance in the liability of SRH with the sample sizes ranging between $N = 434$ and 2,465.

The present analysis revealed that 14–20% of the genetic variance was due to common genes shared by the three traits measured. To date only one small study (Plomin et al. 1992) has investigated the aetiology of the covariation between optimism and mental health and found phenotypic correlations of 0.5, with genetic estimates ranging between 0.08 and 0.29 for the associations of optimism with four mental health measures. These results go in accord with our findings, suggesting genetic mediation of the phenotypic associations between optimism and mental health. It has been suggested that the association between these two variables may be due to shared covariation with neuroticism. However, Plomin et al. (1992) found that the association between optimism/pessimism and their mental health measures remained significant after controlling for neuroticism. No previous study has investigated the genetic architecture of the association between optimism and self-rated health so we cannot compare our finding of mainly genetic influences accounting for the covariation between these two variables with any previous research outcome. Finally, we found an additional genetic group factor between mental and self-rated health indicating that shared genes in mental and self-rated health independent of optimism also contribute to the associations between these two traits. While the genetic overlap between the three variables may be artifactual due to overlap in the measurement of the constructs, this is rather unlikely as there are definitional differences between the domains used. Therefore, we suggest that the phenotypic associations between optimism and health as measured here are likely due to common genes, so that genes predisposing to high optimism also predispose to good (mental and self-rated) health.

The twin correlations as well as the parameter estimates of the sex limitation model suggested possible sex differences in the genetic aetiology of all three traits. While genetic influences may account for a substantial part of the variation in and covariation between the variables in females, in males most of the variation and covariation may be largely due to shared and non-shared environmental influences. The restricted sample sizes of previous studies on optimism and mental health did not allow for investigation of sex differences. However, potential sex differences in SRH, similar to those identified here, were reported in two earlier studies (Lichtenstein and Pedersen 1995; Svedberg et al. 2001). Also, heritability estimates (39.6%) for SRH from a large ($N = 4{,}638$) all male twin sample (Romeis et al. 2000) are substantially lower than those reported for females ($h^2 = 64\%$) (Leinonen et al. 2005). Despite the large sample size of the present study ($N = 3{,}053$ individuals), the number of complete male pairs ($N = 304$–317) was lower compared to female twin pairs ($N = 747$–788), this yielding more power to detect significant effects in females than in males. Future research should address the possibility of sex differences in the aetiology of optimism, mental health, and self-rated health with a larger sample size, as a better understanding of the complex interplay between these traits is of great importance in addressing and improving the wellbeing of those entering old age.

Results of this study cannot be generalized beyond the sample used and the measures employed. The sample included middle aged to elderly Australian twins, so results may differ for other age groups and different ethnicities. One bipolar score with a high and a low end for the optimism scale (LOT) was used, as suggested by Scheier and Carver (1985, 1987). Others (Andersson 1996) have recommended the use of bivariate scoring, as a few studies found the LOT to be bi-dimensional (Chang et al. 1994; Kubzansky et al. 2001; Marshall et al. 1992; Mroczek et al. 1993; Plomin et al. 1992). However, since the majority of previous studies (approximately 50) have used bipolar scoring, and the author of the LOT-R suggests the use of the overall score (Scheier et al. 1994), we decided to use the one-factor solution captured by the bipolar score. Our findings may have differed if optimism and pessimism had been distinguished as separate dimensions. Finally, it has been shown that a boundary problem may arise for the statistical approach used (i.e. the use of a Cholesky model), but it is not clear how much this affects the analysis of ordinal variables neither has a good solution to this potential problem been suggested (Carey 2005).

In conclusion, genetic influences appear to explain a large proportion of variance in optimism, mental health and self-rated health, as well as explaining most of the covariance between these variables. These findings indicate that the frequently reported association between optimism and health (mental and self-rated) may be due to genes predisposing to high optimism also predisposing to good mental health and self-rated health.

Acknowledgments The authors gratefully acknowledge the support and funding for the Over-50 twin study by Mr. George Landers of Chania, Crete. We thank the ATR twins for participating, John Pearson for data management, Olivia Zheng, Ann Eldridge, Sue Mason, and Theresa Pangan for their work in administering the questionnaire and Meike Bartels for offering her support with the genetic analysis.

References

Andersson G (1996) The benefits of optimism: a meta-analytic review of the life orientation test. Personality Individ Differ 21(5):719–725

Antoni MH, Goodkin K (1988) Host moderator variables in the promotion of cervical neoplasia. 1. Personality facets. J Psychosom Res 32(3):327–338

Atienza AA, Stephens MAP, Townsend AL (2002) Dispositional optimism, role-specific stress, and the well-being of adult daughter caregivers. Res Aging 24(2):193–217

Bouchard TJ, McGue M (2003) Genetic and environmental influences on human psychological differences. J Neurobiol 54(1):4–45

Bowling A (2005) Measuring health: a review of quality of life measurement scales. Open University Press, Berks

Bucholz KK, Heath AC, Madden PAF, Slutske WS, Statham DJ, Dunne MP, Martin NG (1998) Drinking in an older population: cross-sectional and longitudinal data from the Australian twin registry. In: Gomberg ESL, Hegedus AM, Zucker RA (eds) Alcohol problems and aging. National Institutes of Health, Bethesda, MD, pp 41–62

Carey G (2005) Cholesky problems. Behav Genet 35(5):653–665

Carver CS, Gaines JG (1987) Optimism, pessimism, and postpartum depression. Cognit Ther Res 11(4):449–462

Carver CS, Pozo C, Harris SD, Noriega V, Scheier MF, Robinson DS, Ketcham AS, Moffat FL, Clark KC (1993) How coping mediates the effect of optimism on distress—a study of women with early-stage breast-cancer. J Pers Soc Psychol 65(2):375–390

Carver CS, Smith RG, Antoni MH, Petronis VM, Weiss S, Derhagopian RP (2005) Optimistic personality and psychosocial well-being during treatment predict psychosocial well-being among long-term survivors of breast cancer. Health Psychol 24(5):508–516

Chang EC, D'Zurilla J, Maydeu-Olivares A (1994) Assessing the dimensionality of optimism and pessimism using a multimeasure approach. Cognit Ther Res 1214:3–160

Christensen K, Holm NV, McGue M, Corder L, Vaupel JW (1999) A Danish population-based twin study on general health in the elderly. J Aging Health 11(1):49–64

Cornes BK, Medland SE, Ferreira MAR, Morley KI, Duffy DL, Heijmans BT, Montgomery GW, Martin NG (2005) Sex-limited genome-wide linkage scan for body mass index in an unselected sample of 933 Australian twin families. Twin Res Hum Genet 8(6):616–632

DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P (2006) Mortality prediction with a single general self-rated health question. J Gen Intern Med 21(3):267–275

Fitzgerald TE, Tennen H, Affleck G, Pransky GS (1993) The relative importance of dispositional optimism and control appraisals in quality-of-life after coronary-artery bypass-surgery. J Behav Med 16(1):25–43

Fontaine KR, Jones LC (1997) Self-esteem, optimism, and postpartum depression. J Clin Psychol 53(1):59–63

Fulker DW, Eysenck SBG, Zuckerman M (1980) A genetic and environmental-analysis of sensation seeking. J Res Pers 14(2):261–281

Giltay EJ, Geleijnse JM, Zitman FG, Hoekstra T, Schouten EG (2004) Dispositional optimism and all-cause and cardiovascular mortality in a prospective cohort of elderly Dutch men and women. Arch Gen Psychiatry 61(11):1126–1135

Giltay EJ, Kamphuis MH, Kalmijn S, Zitman FG, Kromhout D (2006) Dispositional optimism and the risk of cardiovascular death—the zutphen elderly study. Arch Intern Med 166(4):431–436

Goldberg DP, Williams P (1988) A user's guide to the general health questionnaire. NFER-Nelson, Windsor

Harris JR, Pedersen NL, McClearn GE, Plomin R, Nesselroade JR (1992) Age-differences in genetic and environmental-influences for health from the Swedish adoption twin study of aging. J Gerontol 47(3):P213–P220

Hoekstra RA, Bartels M, Verweij CJH, Boomsma DI (2007) Heritability of autistic traits in the general population. Arch Pediatr Adolesc Med 161(4):372–377

Hopper JL (2002) The Australian twin registry. Twin Res 5(5):329–336

Jang KL, Livesley WJ, Ando J, Yamagata S, Suzuki A, Angleitner A, Ostendorf F, Riemann R, Spinath F (2006) Behavioral genetics of the higher-order factors of the Big Five. Personality Individ Differ 41(2):261–272

Johnson JE (1996) Coping with radiation therapy: optimism and the effect of preparatory interventions. Res Nurs Health 19(1):3–12

Kasriel J, Eaves L (1976) Zygosity of twins—further evidence on agreement between diagnosis by blood-groups and written questionnaires. J Biosoc Sci 8(3):263–266

Kendler KS, Neale MC, Kessler RC, Heath AC, Eaves LJ (1993) A test of the equal-environment assumption in twin studies of psychiatric-illness. Behav Genet 23(1):21–27

King KB, Rowe MA, Kimble LP, Zerwic JJ (1998) Optimism, coping, and long-term recovery from coronary artery surgery in women. Res Nurs Health 21(1):15–26

Koenig LB, McGue M, Krueger RF, Bouchard TJ (2007) Religiousness, antisocial behavior, and altruism: Genetic and environmental mediation. J Pers 75(2):265–290

Kubzansky LD, Sparrow D, Vokonas P, Kawachi I (2001) Is the glass half empty or half full? A prospective study of optimism and coronary heart disease in the normative aging study. Psychosom Med 63(6):910–916

Kupper N, Denollet J, De Geus EJC, Boomsma DI, Willemsen G (2007) Heritability of type-D personality. Psychosom Med 69(7):675–681

Leinonen R, Kaprio J, Jylha M, Tolvanen A, Koskenvuo M, Heikkinen E, Rantanen T (2005) Genetic influences underlying self-rated health in older female twins. J Am Geriatr Soc 53(6):1002–1007

Lichtenstein P, Pedersen NL (1995) Social relationships, stressful life events, and self-reported physical health—genetic and environmental-influences. Psychol Health 10(4):295–319

Loehlin JC (1992) Genes and environment in personality development. Sage Publications, Newberry Park, CA

Lundberg O, Manderbacka K (1996) Assessing reliability of a measure of self-rated health. Scand J Soc Med 24(3):218–224

Lykken DT, McGue M, Tellegen A (1987) Recruitment bias in twin research—the rule of 2/3 reconsidered. Behav Genet 17(4):343–362

Mahler HIM, Kulik JA (2000) Optimism, pessimism, and recovery from coronary artery bypass surgery: prediction of affect, pain, and functional status. Psychol Health Med 534:7–358

Marshall GN, Wortman CB, Kusulas JW, Hervig LK, Vickers RR (1992) Distinguishing optimism from pessimism: relations to fundamental dimensions of mood and personality. J Pers Soc Psychol 62:1067–1074

Martin NG, Wilson SR (1982) Bias in the estimation of heritability from truncated samples of twins. Behav Genet 12(4):467–472

Maruta T (2000) Optimists vs pessimists: survival rate among medical patients over a 30-year period (vol 75, p 140, 2000). Mayo Clinic Proceedings 75(3):318–318

Maruta T, Colligan RC, Malinchoc M, Offord KP (2002) Optimism-pessimism assessed in the 1960s and self-reported health status 30 years later. Mayo Clin Proc 77(8):748–753

Matthews KA, Raikkonen K, Sutton-Tyrrell K, Kuller LH (2004) Optimistic attitudes protect against progression of carotid atherosclerosis in healthy middle-aged women. Psychosom Med 66(5):640–644

Mroczek DK, Spiro AIII, Aldwin CM, Ozer DJ, Bossé R (1993) Construct validation of optimism and pessimism in older men: findings from the normative aging study. Health Psychol 12:406–409

Neale MC, Eaves LJ (1993) Estimating and controlling for the effects of volunteer bias with pairs of relatives. Behav Genet 23(3):271–277

Neale MC, Maes HH (2004) Methodology for genetic studies of twins and families. Kluwer Academic Publishers B.V., Dordrecht

Neale MC, Boker SM, Xie G, Maes HH (2002) Mx: statistical modelling. VA 23298: Department of Psychiatry., VCU Box 900126, Richmond

Nes LS, Segerstrom SC (2006) Dispositional optimism and coping: a meta-analytic review. Pers Soc Psychol Rev 10(3):235–251

Park D, Gutchess A (2006) The cognitive neuroscience of aging and culture. Curr Dir Psychol Sci 15(3):105–108

Peterson C, Vaillant GE, Seligman MEP (1988) Pessimistic explanatory style is a risk factor for physical illness—a 35-year longitudinal-study. J Pers Soc Psychol 55(1):23–27

Plomin R, Nesselroade JR (1990) Behavioral genetics and personality change. J Pers 58(1):191–220

Plomin R, Scheier MF, Bergeman CS, Pedersen NL, Nesselroade JR, McClearn GE (1992) Optimism, pessimism and mental health: a twin/adoption analysis. Personality Individ Differ 13(8):921–930

Rasmussen HN, Wrosch C, Scheier MF, Carver CS (2006) Self-regulation processes and health: the importance of optimism and goal adjustment. J Pers 74(6):1721–1747

Rebollo I, Boomsma DI (2006a) Genetic analysis of anger: genetic dominance or competitive sibling interaction. Behav Genet 36(2):216–228

Rebollo I, Boomsma DI (2006b) Genetic and environmental influences on type a behavior pattern: evidence from twins and their parents in the Netherlands twin register. Psychosom Med 68(3):437–442

Rijsdijk FV, Snieder H, Ormel J, Sham P, Goldberg DP, Spector TD (2003) Genetic and environmental influences on psychological distress in the population: general health questionnaire analyses in UK twins. Psychol Med 33(5):793–801

Rini CK, Dunkel-Schetter C, Wadhwa PD, Sandman CA (1999) Psychological adaptation and birth outcomes: the role of personal resources, stress, and sociocultural context in pregnancy. Health Psychol 18(4):333–345

Romeis JC, Scherrer JF, Xian H, Eisen SA, Bucholz K, Heath AC, Goldberg J, Lyons MJ, Henderson WG, True WR (2000) Heritability of self-reported health. Health Serv Res 35(5):995–1010

Roysamb E, Tambs K, Reichborn-Kjennerud T, Neale MC, Harris JR (2003) Happiness and health: environmental and genetic contributions to the relationship between subjective well-being, perceived health, and somatic illness. J Pers Soc Psychol 85(6):1136–1146

Scheier MF, Carver CS (1985) Optimism, coping, and health—assessment and implications of generalized outcome expectancies. Health Psychol 4(3):219–247

Scheier MF, Carver CS (1987) Dispositional optimism and physical well-being—the influence of generalized outcome expectancies on health. J Pers 55(2):169–210

Scheier MF, Carver CS (1992) Effects of optimism on psychological and physical well-being—theoretical overview and empirical update. Cognit Ther Res 16(2):201–228

Scheier MF, Carver CS (1993) On the power of positive thinking: the benefits of being optimistic. Curr Dir Psychol Sci 2:26–30

Scheier MF, Magovern GJ, Abbott RA, Matthews KA, Owens JF, Lefebvre RC, Carver CS (1989) Dispositional optimism and recovery from coronary-artery bypass-surgery—the beneficial-effects on physical and psychological well-being. J Pers Soc Psychol 57(6):1024–1040

Scheier MF, Carver CS, Bridges MW (1994) Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem)—a reevaluation of the life orientation test. J Pers Soc Psychol 67(6):1063–1078

Schulman P, Keith D, Seligman MEP (1993) Is optimism heritable? A study of twins. Behav Res Ther 31(6):569–574

Seligman MEP (1991) Learned optimism. Knopf, New York

Seligman MEP, Abramson LY, Semmel A, Baeyer CV (1979) Depressive attributional style. J Abnorm Psychol 88(3):242–247

Silventoinen K, Posthuma D, Lahelma E, Rose RJ, Kaprio J (2007) Genetic and environmental factors affecting self-rated health from age 16–25: a longitudinal study of Finnish twins. Behav Genet 37(2):326–333

Svedberg P, Lichtenstein P, Pedersen NL (2001) Age and sex differences in genetic and environmental factors for self-rated health: a twin study. J Gerontol B Psychol Sci Soc Sci 56(3):S171–S178

Svedberg P, Gatz M, Lichtenstein P, Sandin S, Pedersen NL (2005) Self-rated health in a longitudinal perspective: a 9-year follow-up twin study. J Gerontol B Psychol Sci Soc Sci 60(6):S331–S340

Taub JM (1998) Eysenck's descriptive and biological theory of personality: a review of construct validity. Int J Neurosci 94(3–4):145–197

Taylor SE (1989) Positive illusions. Basic Books, New York

Taylor SE, Kemeny ME, Aspinwall LG, Schneider SG, Rodriguez R, Herbert M (1992) Optimism, coping, psychological distress, and high-risk sexual-behavior among men at risk for acquired-immunodeficiency-syndrome (Aids). J Pers Soc Psychol 63(3):460–473

Trunzo JJ, Pinto BM (2003) Social support as a mediator of optimism and distress in breast cancer survivors. J Consult Clin Psychol 71(4):805–811

Yamagata S, Suzuki A, Ando J, Ono Y, Kijima N, Yoshimura K, Ostendorf F, Angleitner A, Riemann R, Spinath FM, Livesley WJ, Jang KL (2006) Is the genetic structure of human personality universal? A cross-cultural twin study from North America, Europe, and Asia. J Pers Soc Psychol 90(6):987–998