Subjective Well-Being, Fertility and Partnerships: A Biodemographic Perspective

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Abstract

In this paper we propose comparative behavior genetic analyses of subjective well-being, fertility and partnerships from a biodemographic perspective using the 2002 Danish twin omnibus survey and the U.S. National Longitudinal Study of Youth (NLSY). Our preliminary analyses of the Danish data suggest a systematic positive association between the genetic components of variation in subjective well-being and of variation in fertility/partnership behaviors. For males, for instance, genetic dispositions that tend to increase subjective well-being—say, dispositions towards a "happy personality"—are associated with a higher number of partnerships, a higher probability of being currently in a partnership, and a larger number of children. Similar patterns are obtained for females in the Danish twin data. The analyses of the NLSY wiil augment these analyses in two dimensions: first, the analyses reveal whether the results vary across socioeconomic contexts (the U.S. versus Denmark), and second, the longitudinal data in the NLSY allow analyses of changes in happiness, fertility and partnerships over time, which is impossible in the cross-sectional twin data.

1 Introduction

Despite this centrality of subjective well-being for understanding the motivation to have children or form partnerships, there are very few empirical tests of the relation between subjective well-being, partnerships and fertility.[1] Moreover, there are virtually no behavior genetic analyses that analyze the subjective well-being jointly with fertility and partnership formation, which are among the central demographic behaviors in early adulthood, within a biodemographic perspective. In the proposed paper we fill this niche by conducting behavior genetic analyses of subjective well-being, partnerships and fertility using a multivariate Choleski model. The analyses are based on two datasets. First, our analyses utilize the 2002 Danish Twin omnibus comprising about 10,000 individuals in complete monozygotic or dizyogitic twin pairs. Second, we propose to augment the analyses of the Danish twin data with the National Longitudinal Survey of Youth (the NLSY). The NLSY was originally collected as a national probability sample of 3000 households of 14-21 year old youth in 1979, along with a separate military sample. There are over 12,000 individual respondents from the NLSY, followed yearly or bi-yearly from 1979 until 2002. Because of the household structure of the NLSY, there are many siblings, half siblings, and a few cousins and twins who live together in these households. The zygocity of these kinship pairs is not explicitly defined, but a linking algorithm has been

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[1]Exceptions, sometimes with only minor discussions of this aspect, include Argyle (2001); Blanchflower and Oswald (2004); Clark and Oswald (2002); Diener et al. (1999); Easterlin (2001); Hilleras et al. (2001); Kahneman et al. (1999); McLanahan and Adams (1987); Myers (1993); Nomaguchi and Milkie (2003); Rogers and White (1998) and Waite and Gallagher (2000).

used to obtain valid and reliable zygocity indicators. While the Danish data provide the advantages of twin data for behavior genetic analyses, the NLSY is nationally representative for the U.S., and in combination with the imputed kinship relations, it allows to conduct longitudinal behavior genetic analyses that include much more detailed information about fertility, partnership formation and well-being as is available for the Danish twins. In summary, the comparative analyses of data from Denmark and the United States is likely to provide important insights of the relation between subjective well-being, partnerships and fertility, including its variation across different socioeconomic contexts and cohorts.

In this abstract we can already provide preliminary results based on the Danish twin data. These analyses reveal for males aged 25–45 a systematic positive association between the genetic components of variation in subjective well-being and of variation in fertility/partnership behaviors: genetic dispositions that tend to increase subjective well-being—say, dispositions towards a "happy personality"—are associated with a higher number of partnerships, a higher probability of being currently in a partnership, and a larger number of children. For females aged 25–45 and for males and females aged 50–70 the correlations tend to be weaker and less uniform, and the correlations for closely related partnership behaviors—such as currently in partnership and the total number of partnerships—can even be in opposite directions. Moreover, because of the generally small relevance of shared environmental effects for well-being and partnership/fertility indicators, our analyses suggest that genetic dispositions are a particularly important aspect of endowments. In particular, these genetic endowments result in (*i*) correlations of happiness, fertility and partnership outcomes within twin pairs due to the genetic relatedness of MZ and DZ twins, and (*ii*) correlations in happiness and fertility/partnership indicators within individuals due to overlapping genetic influences on these variables.

The analyses of the NLSY data is not yet completed. The proposed analyses of the NLSY will include a bivariate biometrical analysis linking happiness indicators with fertility outcomes and partnership measures at different points in time (or, alternatively, at different ages of the respondent). This will both replicate and extend the study of the relationship between happiness and fertility in the Danish twin data.

2 Happiness and the Biodemography of Fertility and Partnerships

A number of recent studies indicate that (*i*) well-being is very stable over the life course and remarkably insensitive to income once income exceeds some "minimally sufficient" level, (*ii*) "happiness" is much more similar to a trait rather than to a state, and (*iii*) happiness is related to stable personality characteristics that have a substantial genetic etiology (for recent summaries of this literature, see for instance Argyle 2001; Frey and Stutzer 2002; Kahneman et al. 1999; Lykken 1999). A substantial fraction of variation in well-being and related personality traits across individuals is therefore likely to be due to social or biological endowments that are unobserved in social science data sets. For example, Lykken and Tellegen (1996) report that variation in the well-being component of the Multidimensional Personality Questionnaire (MPQ) for twins in the Minnesota Twin Register in the 1980s is primarily associated with genetic variation: genetic effects account for about 50% of the variation in one-time survey reports of well-being, and up to 80% of the variance in happiness indicators obtained by averaging repeated measures of well-being. Moreover, neither socioeconomic status, schooling, family income, marital status, nor religious commitment account for more than 3% of the variance in these averaged measures of well-being.

In the most general sense, the recent research on the motivations to have children has lead to a re-

newed interest in the value of children approach of the 1970s that argues that children (and also marriage) contribute to individuals' well-being (e.g., Fawcett 1988; Friedman et al. 1994; Hoffman and Manis 1979; Hoffman et al. 1978; Jones and Brayfield 1997; Schoen et al. 1997). In a recent review paper on "Why have children in the 21st century?", for instance, Morgan and King (2001) relate the motivations to have children in contemporary societies to three areas: biological predispositions, social coercion and rational choice. They conclude that humans are likely to have *evolved* preferences for children, and Morgan and King emphasize the opportunity that evolutionary theories and behavioral genetics provide for improving our understanding of human preferences for children. The arguments in Morgan and King are thus closely related to other work that has tried to interpret the preferences for children and related behaviors, such as sexual intercourse and changing fertility rates, in an evolutionary perspective. For instance, Foster (2000) draws on evidence from evolutionary biology, ethology, quantitative genetics, developmental psychobiology, and psychology, and argues that humans' evolved biological predisposition is toward nurturing behaviors, rather than having children per se. In her view, humans also have the unique ability to be aware of such biological predispositions and translate them into conscious, but nevertheless biologically-based, fertility motivation or preferences for children. Consistent with these findings, Kohler et al. (1999) and Rodgers et al. (2001) have interpreted their findings of heritability patterns in fertility and fertility precursors as evidence for systematic genetic influences on fertility motivations and preferences. Several other studies also have proposed relations between evolved dispositions/preferences and desires for children. Carey and Lopreato (1995), for instance, suggest a "two-child psychology" that implies a strong desire for two surviving children. Potts (1997), on the other hand, emphasizes humans' evolved desire to have sexual relations, rather than children per se. In contemporary modern societies with effective contraception, Potts then argues, these inherited predispositions mix with unconscious physiological mechanisms working towards optimal birth spacing to make modern humans seek personal wealth and health rather than large families.

Reproduction is also at the core of many evolutionary explanations for marriage or long-term unions (for recent reviews, see for instance Daly and Wilson 2000; Gangestad 2003; Hrdy 1999; Kaplan and Lancaster 2003). In the context of sexual reproduction, however, evolutionary models also predict marked male-female differences in fertility behavior and motivations to engage in partnerships. A husband is seen as gaining sexual access to his wife and the ability to sire her children, while women obtain support in raising their children. As a consequence, youth and the ability to reproduce is often associated with increased value of women in the marriage market, while social status and wealth enhance the desirability of males. Conflicts over reproduction and resource allocation to children are hence seen as one of the prime causes of tensions within marriage and divorce. For instance, men are profoundly concerned that the children in whose welfare they invest are their own, and infertility is frequently a reason to divorce. Sexual jealousy is also found to be different, with male jealousy more focused on the sexual act and female jealousy focused on the alienation of the partner's attention and material resources. From an evolutionary perspective, these dissimilarities between males and females are rooted in the asymmetrical efforts of males and females in producing egg and sperm cells, and they result in different short- and long-term mating strategies, differences in attachment to children and willingness to invest in offspring. For instance, females commonly invest vastly more time and energy in nurturing each offspring than do males, who can "disappear" after conception and still gain the evolutionary fitness benefit from a successfully raised biological child. This often stronger attachment of women to their offspring puts women at the risk of being "prisoners of love" (England and Folbre 2002):

men can exploit the stronger maternal attachment to children in bargaining within the household or in divorce settlements because mothers are likely to take care of their common children even if their mates withdraw resources from the partner or child.

Despite the strong evolutionary arguments linking the motivation for children and partnerships to evolved preferences and associated levels of subjective well-being, with possibly important differences across gender, studies of the contribution of children and partnerships to happiness are few. For instance, several studies on subjective well-being—including one by a leading economic demographer—do often not address the contributions of fertility to well-being in detail (e.g., Argyle 2001; Diener et al. 1999; Easterlin 2001; Kahneman et al. 1999; Myers 1993). Exceptions include McLanahan and Adams (1987) who conclude that adults with children at home often report lower levels of happiness and life-satisfaction than other groups, and these reports of lower happiness are associated with increased worries and higher levels of anxiety and depression. In similar vein, Nomaguchi and Milkie (2003) find that becoming a parent is both detrimental and rewarding. On the one hand, unmarried parents tend to report lower self-efficacy and higher depression than their childless counterparts; on the other hand, married mothers' lives are marked by more housework and more marital conflict but less depression than their childless counterparts. Parental status is also found to have little influence on the lives of married men. Further indirect evidence on the contribution of children to well-being is obtained from several psychological studies: Rogers and White (1998), for instance, find that own children give more satisfaction with parenting than adopted children; Buss (2000) argues that humans have evolved mechanisms for mating bonds and close kinship that produce "deep sources of happiness" (see also Miller and Rodgers 2001); and Hilleras et al. (2001) show that having children contributes to the well-being and happiness of the elderly (see also Pinquart and Sörensen 2000). In addition to these studies on overall well-being, there has been an active research on associations between having children and marital satisfaction (e.g., Bradbury et al. 2000; Mizell and Steelman 2000; Russell and Wells 1994), which indicate associations, but at times positive and at time negative ones. Since parents also may derive direct utility from their offspring, however, these negative associations need to be distinguished from associations of children with overall well-being. It is possible that children affect marital satisfaction and overall happiness in different directions.

In contrast to the relatively scant evidence on associations between having children and happiness, the literature on associations of marriage with subjective well-being is extensive. Married individuals consistently report greater subjective well-being than never-married individuals, who in turn report greater subjective well-being than previously married individuals (i.e., divorced, separated or widowed) (e.g., Argyle 2001; Diener et al. 1999; Waite and Gallagher 2000). Various reasons for positive associations of marriage with reported well-being, besides the reproductive aspect emphasized in evolutionary theories, have been offered. Marriage may fulfill basic and universal human needs, provide companionship and freedom from loneliness, and confiding in a spouse lesses the strains encountered in life and increases one's ability to cope with these strains. The intimacy and interpersonal support provided within marriage also tends to increase well-being, as do the positive sense of identity and self-esteem that is often associated with marriage. Marriage is also associated with better health, lower mortality and higher levels of wealth (Waite and Gallagher 2000). The implications of these factors on well-being may be substantial. Recent estimates of the monetary value of the happiness gains resulting from marriage, for instance, assess the value of a lasting marriage at $100,000 a year (Blanchflower and Oswald 2004).

3 Data

3.1 The Danish Twin-Omnibus-Survey 2002

Twins studies long have been used to assess the multiple roles of endowments on demographic and socioeconomic outcomes and on estimates of effects of various variables net of such endowments in both the psychological/behavior-genetic and the socioeconomic literatures. Our analyses are based on the Danish Twin Registry that was established in 1954 as the first nationwide twin registry in the world (see Hauge 1981; Hauge et al. 1968; Kyvik et al. 1996, 1995; Skytthe et al. 2002). This registry covers twins born during the period 1870–1982. Data from this twin registry have extensively been used for analyses of health, mortality and aging (e.g., see Christensen 2001), psychological phenotypes (McGue and Christensen 1997, 2001) and fertility (Kohler and Rodgers 2003; Kohler et al. 1999; Rodgers et al. 2001).

In the summer of 2002, the Danish Twin Register conducted a Twin-Omnibus Survey of all registered male and female twins born in 1931-82, resulting in a response rate of 75.4% and a total of 34,944 completed questionnaires. This 2002 survey used a multipurpose omnibus questionnaire addressing issues of health (e.g., diseases, physiological characteristics such as height, weight, etc.), socioeconomic characteristics (e.g., schooling attainment), health relevant behaviors (such as smoking), fertility (e.g., number of biological children for both the twin and the current partner/spouse, age at first birth, and sex of the first child) and partnership behaviors (e.g., number of different marriages/cohabitations, age at first marriage/cohabitation, schooling attainment of partner).

The survey also included a measure of subjective well-being, or "happiness", that was obtained through the question "How satisfied are you with your life, all things considered?" with responses ranging from very satisfied to not satisfied at all. In contrast to other investigations focusing on satisfaction with some particular aspects of life such as marriage or work, this survey question attempts to elicit *overall* well-being. In making this evaluation of their life satisfaction, individuals are thought to examine the tangible aspects of their lives, weigh the good against the bad, and arrive at a judgment of overall satisfaction. This happiness measure based on the above single question has four main advantages that render it particularly useful for the analyses in this paper: (*a*) the global nature of this judgment makes it a relatively stable evaluation that is not strongly dependent on the affective state the person is in at the time of judgment (Lucas et al. 1996); (*b*) despite the fact that subjective well-being is a complex construct, reliability studies indicate that reported subjective well-being is moderately stable and sensitive to life circumstances (Ehrhardt et al. 2000), including with respect to demographic outcomes; (*c*) the above measure of well-being is widely used and hence comparable across many studies, countries and time periods (for instance, the identical question about well-being has also been implemented in the U.S. General Social Survey and the European Euro-Barometer surveys for about 15 years);[2] and (*d*) it requires only a minimal amount of survey time and questionnaire space, which was critical for allowing its implementation in the 2002 twin omnibus survey.

The responses to the question "How satisfied are you with your life, all things considered?" for the twins aged 25–45 and 50–70 in complete same-sex pairs are summarized in Table 1. We report these responses

[2]Recent analyses of variable usage in the General Social Survey also report that 341 publications have used this question about subjective well-being during the period 1972–93, making the above happiness indicator by far the most frequently used GSS variable about personal evaluations in publications (Smith and Heaney 1996). Moreover, the second and third most frequently used GSS variables in publications are job satisfaction and family satisfaction, which use an almost identical wording as the general question about happiness.

Table 1: Subjective well-being in Danish twins

	Females		Males	
	MZ twins	DZ twins	MZ twins	DZ twins
Age 25–45				
Not particularly satisfied / not satisfied	4.9%	5.1%	4.8%	4.0%
Rather satisfied	44.4%	46.3%	43.7%	46.0%
Very satisfied	49.7%	47.5%	50.1%	49.1%
n/a	1.0%	1.1%	1.5%	0.9%
Mean	1.45	1.43	1.46	1.46
Overall std. dev	(0.59)	(0.59)	(0.59)	(0.57)
Within-twin pair std. dev	(0.52)	(0.55)	(0.52)	(0.55)
Within-twin pair correlation	0.21	0.13	0.21	0.07
N	2,114	2,216	1,314	1,456
Age 50–70				
Not particularly satisfied / not satisfied	3.7%	4.4%	2.6%	4.0%
Rather satisfied	46.0%	47.4%	43.1%	46.0%
Very satisfied	48.8%	45.8%	53.3%	48.4%
n/a	1.5%	2.5%	0.9%	1.7%
Mean	1.46	1.42	1.51	1.45
Overall Std. Dev	(0.57)	(0.58)	(0.55)	(0.57)
Within-twin pair std. dev	(0.49)	(0.54)	(0.48)	(0.54)
Within-twin pair correlation	0.25	0.13	0.24	0.11
N	1,112	1,866	874	1,418

Notes: Data are for twins in complete same-sex twin pairs only. Means, standard deviations and within-pair correlations are calculated by converting the responses into a single happiness indicator using 0 = not satisfied or not particularly satisfied, 1 = rather satisfied and 2 = very satisfied. Within-twin pair standard deviation is estimated using a one-way analysis of variance (ANOVA) of this happiness.

separately for these two age categories that represent different broad stages of the life cycle during which children and partners may contribute to individual's well-being for different reasons. The first category, twins aged 25–45, includes individuals who are still in childbearing years. The second category, twins aged 50–70, includes individuals who mostly have completed reproduction and may have begun to rely on children for social and possibly also economic support.[3] For both age groups partnerships and children may constitute important sources of social support. The responses in Table 1 show that males and females in Denmark are generally quite satisfied with their life, with remarkably small differences in overall satisfaction with life by gender, age or zygosity (for similar findings of high levels of subjective well-being in Denmark

[3]There are relatively more females in the younger than in the older age group due to differential survey response rates. While survey response rates are about equal for men and women in the cohorts born 1931–52 (75–77%), the response rate for women is about 10 percentage points higher than that of males in younger cohorts (80% vs. 69%). In addition, there has been a decline in the twinning rate over time, which is also reflected in the total number of MZ and DZ pairs in the two cohorts in Table 1, from about 15 per 1000 around 1945 to 10 per 1000 around 1975. This decline has primarily occurred for DZ twinning, whereas the MZ twinning rate has remained stable throughout the period (Kyvik et al. 1995). This finding is confirmed in hospital data where zygosity is determined clinically. Moreover, this decline in the DZ twinning rate is not specific to Denmark, but a relatively widespread pattern that has also been found in other countries. The reasons are currently not well-known (James 1995; Kyvik et al. 1995).

Table 2: Descriptive statistics for partnership and fertility behavior in Danish twins

	Females		Males	
	MZ twins	DZ twins	MZ twins	DZ twins
Age 25–45				
Prop. with at least one partnership	0.86	0.86	0.79	0.77
# of partnerships	1.36	1.40	1.27	1.16
	(1.13)	(1.37)	(1.54)	(1.12)
Prop. currently in a partnership	0.74	0.75	0.71	0.69
Prop. with at least one child	0.60	0.65	0.54	0.55
# of children	1.17	1.32	1.05	1.07
	(1.15)	(1.15)	(1.15)	(1.14)
First birth before or at age 21	0.11	0.13	0.06	0.05
N	2,114	2,212	1,312	1,453
Age 50–70				
Prop. with at least one partnership	0.93	0.92	0.95	0.91
# of partnerships	1.21	1.20	1.29	1.23
	(0.97)	(0.69)	(0.76)	(0.81)
Prop. currently in a partnership	0.76	0.74	0.84	0.83
Prop. with at least one child	0.89	0.87	0.86	0.84
# of children	1.99	2.01	1.97	1.86
	(1.10)	(1.15)	(1.17)	(1.13)
N	1,112	1,865	874	1,418

Notes: Means with standard deviation in parentheses. Data are for twins in complete same-sex twin pairs only. The variable "first birth before or at age 21" is only reported for respondents with at least one child.

and other Nordic countries, see Argyle 2001). The comparison of the overall and within-twin pair standard deviation of subjective well-being indicates that in the age group 25–45 years, between 7–13% (DZ twins) and 22% (MZ twins) of the overall variation in well-being occurs between twin pairs, reflecting the between-twin pair variation in the social and genetic endowments that affect happiness.[4] This relevance of common endowments slightly increases in the age group 50–70 years to 11–13% (DZ twins) and 24–25% (MZ twins) of the total variance in well-being. At the same time, the within-twin pair correlation in subjective well-being is approximately twice as high in monozygotic twin pairs as compared to dizygotic twin pairs for both sexes and in both age categories. This pattern of within-twin pair correlations, to be further explored in Section 4, suggests an important influence of genetic dispositions on the variation in happiness across individuals, and a small relevance of shared environmental influences resulting from parental households and other common socialization experiences.

In Table 2 we additionally report summary statistics for several measures of partnership and fertility behavior. Because the distinction between marriage and cohabitation has increasingly lost importance in Denmark and other Scandinavian countries, the twin-omnibus survey—and hence all our analyses in this paper—does not distinguish between these two union types. For instance, the proportion of out-of-wedlock

[4]The fraction of variance between twin pairs is calculated as $1 - (\text{within std. dev})^2/(\text{overall std. dev})^2$; for female MZ twins, for instance, the between twin pair variation accounts for $1 - .52^2/.59^2 = .22$ of the total variance in subjective well-being.

births increased from 7.8 per cent to 44.6 per cent during the period from 1960 to 2001, cohabitation prior to marriage has become commonplace in recent decades, and more than 50 per cent cent of first births are born to women outside of marriage in recent cohorts (Carneiro and Knudsen 2001; Council of Europe 2002). We therefore use to the term "partnership" in this paper to refer to *both* marriage and cohabitation, excluding only non-cohabiting and/or non-marital relations.[5]

Table 2 shows that the vast majority of twins aged 25–45 and 50–70 report at least one partnership prior to the survey, and the mean number of partnerships ranges from 1.16 to 1.40. Because cohabitation and divorce have become more common over time, twins aged 50–70, despite their older age, do not report more partnerships than twins aged 25–45. The fraction of twins who are in partnerships at the time of the 2002 survey ranges from .69 to .84. Females are more likely to be in partnerships at the time of the survey in the younger cohorts aged 25–45, while males are more frequently found in partnerships in the older cohorts aged 50–70 (resulting, most likely, from differential male-female survivor probabilities and the lower probability of men to become widowers). The fertility questions in the survey asked explicitly for *biological* children of the respondent and his/her current partner, leaving aside any adopted children or step-children. Between one half and two thirds of twins aged 25–45 have at least one biological child, and the mean number of children is between 1.17–1.32 for females and 1.05–1.07 for males. The fraction of respondents who have children increases to .84–.89 in twins aged 50–70, and the average number of children increases to 2 for females and 1.86–1.97 for males. These fertility and partnership patterns for the twins in Table 2 agree with the corresponding patterns for the overall population (e.g., see Carneiro and Knudsen 2001; Council of Europe 2002). There are also no relevant differences between MZ and DZ twins with respect to their fertility and partnership behaviors (see also Kohler et al. 2002).

3.2 The National Longitudinal Study of Youth

The NLSY was originally collected as a national probability sample of 3000 households of 14-21 year old youth in 1979, along with a separate military sample. There are over 12,000 individual respondents from the NLSY, followed yearly or bi-yearly from 1979 until 2002. Because of the household structure of the NLSY, there are many siblings, half siblings, and a few cousins and twins who live together in these households. The zygocity of these kinship pairs is not explicitly defined, but a linking algorithm has been used to obtain valid and reliable zygocity indicators.

There is an excellent fertility history available for the NLSY data. Number of children can be used as a fertility measure. The measure is only slightly truncated for the 2002 NLSY data, in which respondents were 17-44 years old; well over 90% of all children who will be born to women in the NLSY had been born by 2002.

Longitudinal measures of happiness are available from specific items on the Center for Epidemiological Studies Depression Scale (the CESD). Data are available for the CESD in 1992, 1994, 1998, 2000, and 2002, with specific items that address sadness and depression in every year, and items that address happiness and enjoyment of life in a subset of the years. In addition, several other indicators of general satisfaction and happiness are available through other variables, including ones indicating happiness with spouse relationships, general friendliness during the survey, and a self-esteem question in 1987 scaling agreement with "I

[5]The survey asked "How many times have you been married or cohabited with different partners?," and respondents were asked to give the number of marriages/cohabitations. Similarly, the respondents were asked about their current partnership status with the question "Are you married or living together with a partner today?"

take a positive attitude toward myself."

4 Preliminary behavioral genetic analyses of fertility, partnerships and happiness using the Danish twin data

In our preliminary analyses using the Danish twins data, we combine information for both monozygotic and dizygotic twins to estimate a behavioral genetic model illustrating the relevance of biological and social endowments for variation in subjective well-being, fertility and partnership behavior. In particular, the twins design allows a decomposition of the within-population variation in well-being, fertility and partnership measures across individuals into three components: (*a*) variance that is consistent with influences of genetic factors; (*b*) variance that is consistent with shared environmental factors; and (*c*) variance that is consistent with individual-specific influences that are not common to twins within a pair. It is important to note, despite interpretations that often are given in the literature, that these variance decompositions do *not* reveal causality. If, for example, genetic heritability is high, that does *not* mean that environmental changes might not have important causal effects. Our motives in presenting such estimates are not to permit inferences about causality, but to situate our study in the literature and to explore whether there are likely biases in estimates that attempt to identify the causal impact of partnerships and fertility on happiness without controlling for genetic and other family background endowments.

Shared-environment associations arise because individuals who grow up in the same household are subject to similar processes of socialization, socioeconomic conditions of parents, and similar family environments, all of which are thought to affect important demographic, socioeconomic and psychological outcomes. Non-shared environmental associations reflect the individual-specific conditions that affect these outcomes, while genetic associations originate through influences of inherited traits and genetic predispositions on behavior and traits. The standard behavioral genetic model assumes that many genes contribute to a phenotype. This model is often denoted as an ACE model since it additively accounts for genetic (*A*), common environmental (*C*), and non-shared environment/error sources (*E*) of variance. The decomposition resulting from this model then factors the observed within-population variance into a genetic component (heritability, h^2) and a shared environmental component (c^2). The former measures the proportion of total phenotypic variance related to (additive) genetic variation across individuals, and the latter reflects the proportion of the total variance related to differences in shared-environmental conditions between twin pairs.

In this section we estimate a bivariate extension of the standard additive behavioral genetic model. The goal of this extended analysis is to discern not only the relevance of genetic and shared environmental factors for variation in subjective well-being and fertility/partnership behaviors, but to identify also the degree to which genetic and shared environmental factors are common to happiness on the one and fertility/partnership behaviors on the other side. These bivariate models can therefore reveal overlapping sources of variation that affect well-being as well as fertility or partnerships. The bivariate behavioral genetic model for fertility and well-being, for instance, uses four variables for each twin pair: fertility of twin 1, subjective well-being of twin 1, and the corresponding data for twin 2 in the same pair. The analysis of bivariate twins data then entails fitting a structural model to the 4×4 covariance matrices that are computable from these four variables for each MZ and DZ twin pair. Because subjective well-being is an ordered categorical variable and our measures of fertility and partnership behaviors are either binary or concentrated on a few realiza-

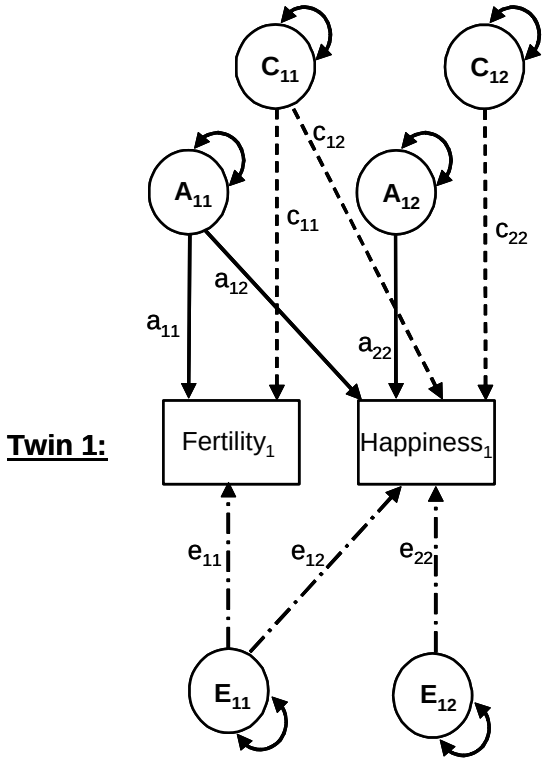

Figure 1: Path diagram for bivariate behavioral genetic analyses of fertility and subjective well-being.
Note: The genetic factors A_{11} and A_{12} of twin 1 in a twin pair are connected to the genetic factors of twin 2, with coefficients depending on the zygosity of the twin pair (.5 for DZ and 1 for MZ twins); similarly, the shared environmental factors C_{11} and C_{12} of twin 1 are connected to the shared environmental factors of twin 2 with a coefficient of 1.

tions, we estimate a categorical version of the behavior-genetic model instead of the standard continuous variable model. Similar to the approach taken in (ordered) probit or (ordered) logit models, this categorical behavioral genetic model assumes a continuously distributed bivariate propensity that generates the different realizations of the observed variables according to thresholds (e.g., see Neale and Cardon 1992; Neale and Maes 2002).[6]

We implement our analyses separately for the two age categories used above: twins aged 25–45 years ("reproductive age") and 50–70 years ("post-reproductive age"). Within each of these age groups, we estimate three bivariate models for the variable combinations (*a*) number of partnerships and subjective well-being, (*b*) currently in partnership and well-being, and (*c*) number of children and well-being.[7,8] The path diagram implied by this bivariate ACE model for the analyses of fertility and happiness is depicted in Figure 1. This diagram presents the paths through which the genetic factors (A_{11} and A_{12}), shared environments (C_{11} and C_{12}), and individual-specific (non-shared) environments (E_{11} and E_{12}) affect fertility and happiness for twin 1 within a twin pair. Twin 2 is modeled accordingly with connections to the genetic and shared environment components of twin 1.

[6]The categories for our analyses are as follows. For subjective well-being: 0 = not satisfied or not particularly satisfied, 1 = rather satisfied, and 2 = very satisfied; for the number of children and the number of partnerships: 0, 1, 2, and 3 or more; for currently in partnership: 0 (no) and 1 (yes).

[7]The bivariate behavioral genetic models were estimated in the structural equation program Mx using a Cholesky decomposition of the co-variance matrix (e.g., see Neale and Cardon 1992; Neale and Maes 2002).

[8]The alternative to estimating three bivariate models would have been to estimate a trivariate behavioral genetic model that simultaneously includes subjective well-being, the number of partnerships and the number of children. However, this trivariate model was numerically intractable due to the categorical nature of the data.

The results of the bivariate ACE models are summarized in Table 3. The first lines below the labels "Age 25–45" and "Age 50–70" show the average heritability h^2 (top panel) or the average shared environmental effect c^2 (bottom panel) that have been obtained from the three bivariate behavioral genetic models estimated for the twins in each age group.[9] The subsequent lines below these labels report the heritabilities h^2 (top panel) or the shared environmental effect c^2 (bottom panel) obtained for the variables "number of partnerships", "currently in a partnership" and "number of children" in these bivariate behavioral genetic models. In addition, the top panel reports the correlation between (*i*) the genetic factors contributing to the variation in each of these three variables and (*ii*) the genetic component of subjective well-being. This correlation is positive if the coefficient a_{12} in Figure 1 is positive, and it is negative if this coefficient is negative. The bottom panel reports the corresponding correlations between the shared environmental factors, which are positive (negative) if the path c_{12} in Figure 1 is positive (negative).

The results in Table 3 reveal a moderate heritability of .23–.32 for subjective well-being for male and female twins aged 25–45 and 50-70. This heritability is somewhat below that found in many psychological studies based on more elaborate multi-item measures of subjective well-being, particularly if the analyses focus on the stable component of well-being (e.g. Lykken and Tellegen 1996).[10] Similar moderate heritabilities of .17–.40 are also estimated for the partnership indicators of twins aged 25–45 years, but these heritabilities tend to be substantially lower at ages 50–70. As in our earlier studies (Kohler et al. 1999, 2002), Table 3 reveals relatively high heritabilities of .52 for the fertility of female twins aged 25–45, while the heritabilities for males and for female twins aged 50–70 years are more moderate (and indeed for the latter age range the heritabilities are smaller for females than for males). Moreover, consistent with psychological studies and the within-twin pair correlations in Table 1, our analyses in Table 3 find only a small relevance of shared environmental effects for subjective well-being, with estimates ranging from zero to .06. Shared environmental effects for the fertility and partnership indicators in Table 3 are also found to be quite small, with estimates ranging from zero to .27.

The primary interest for this paper of this behavioral genetic analysis, however, is not in these heritabilities but in the potential relevance of common sources of variation between subjective well-being and measures of fertility and partnership behaviors. The most important aspect of Table 3 therefore pertains to the correlation of endowments—either genetic dispositions or shared environments—that contribute to the variation in subjective well-being and fertility or partnership indicators. These correlations, reported in the second and fourth columns of Table 3, are due to the paths a_{12} (or c_{12}) in Figure 1 that measure the extent to which genetic factors (or shared environmental factors) that affect fertility outcomes (or partnership indicators) also influence levels of subjective well-being. Positive correlations point to the existence of common sources of variation—either due to genetic factors or shared environments—that simultaneously tend to influence subjective well-being and the partnership/fertility indicators in the same direction. Negative correlations indicate that these endowments affect the variables in opposite directions. In either case, the correlations are most important when the estimated heritabilities (h^2) or shared environmental effects (c^2) suggest a relatively high contribution of endowments to variation in well-being or partnership/fertility outcomes, and they are less relevant if these contributions are small.

[9] We report only the average since the estimates for the h^2 and c^2 coefficients for subjective well-being differ by less than .015 among the three different models.

[10] The fact that our measure of well-being is based on a single question about overall satisfaction with life (see Section 3.1) implies our measure is potentially subject to larger measurement error than (longitudinal) psychological multi-item measures of well-being. Such measurement error will tend to reduce the estimates of heritability.

Table 3: Results of bivariate ACE model: heritabilities (h^2), shared environment effects (c^2) and correlation of genetic/shared environment components

	females		**males**	
Genetic effect	h^2	correlation of genetic components of well-being with	h^2	correlation of genetic components of well-being with
Age 25–45				
subjective well-being	0.23	—	0.26	—
# of partnerships	0.38	-0.17	0.20	0.29
currently in partnership	0.40	0.23	0.17	0.16
# of children	0.52	0.19	0.35	0.27
Age 50–70				
subjective well-being	0.27	—	0.32	—
# of partnerships	0.06	0.19	0.25	0.06
currently in partnership	0^a	n/a	0^a	n/a
# of children	0.10	0.00	0.26	0.33
Shared environment effect	c^2	correlation of shared env. components of well-being with	c^2	correlation of shared env. components of well-being with
Ages 25–45				
subjective well-being	0.06	—	0^a	—
# of partnerships	0^a	n/a	0.16	n/a
currently in partnership	0^a	n/a	0.22	n/a
# of children	0.16	-0.83	0.27	n/a
Age 50–70				
subjective well-being	0.06	—	0^a	—
# of partnerships	0.27	-0.36	0^a	n/a
currently in partnership	0.18	0.04	0.10	n/a
# of children	0.20	0.51	0^a	n/a

Note: (*a*) For increased numerical stability of the results, the estimates of h^2 and/or c^2 were constrained to zero if the initial point estimates were below 0.01 (or below 0.05 for males aged 50–70); correlations between variables of genetic or shared environment components are not estimated in these cases.

In general, the correlations in Table 3 are moderate in magnitude with a range from -.17 to .33 for genetic components of variation and a range from -.83 to .51 for shared environments. For males aged 25–45, the results reveal a consistent positive correlation between the genetic factors contributing to subjective well-being and fertility/partnership behaviors. For females aged 25–45, and for males and females aged 50–70, the results are more mixed. The genetic contributions between well-being and number of partnerships, for instance, are negatively correlated for females aged 25–45 while the genetic contributions to well-being and current partnership status or fertility are positively correlated. At older ages, the overlapping sources of variation tend to be further diminished for females, and while important overlapping sources of variation remain between fertility and happiness for males.

The bivariate behavioral genetic analyses in Table 3 therefore reveal for males aged 25–45 a systematic positive association between the genetic components of variation in subjective well-being and of variation in fertility/partnership behaviors: genetic dispositions that tend to increase subjective well-being—say, dispositions towards a "happy personality"—are associated with a higher number of partnerships, a higher probability of being currently in a partnership, and a larger number of children. For females aged 25–45 and for males and females aged 50–70 the correlations tend to be weaker and less uniform, and the correlations for closely related partnership behaviors—such as currently in partnership and the total number of partnerships—can even be in opposite directions. Moreover, because of the generally small relevance of shared environmental effects for well-being and partnership/fertility indicators in Table 3, our analyses suggest that genetic dispositions are a particularly important aspect of endowments. In particular, these genetic endowments result in (*i*) correlations of happiness, fertility and partnership outcomes within twin pairs due to the genetic relatedness of MZ and DZ twins, and (*ii*) correlations in happiness and fertility/partnership indicators within individuals due to overlapping genetic influences on these variables.

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