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ORIGINAL RESEARCH

Non-random Mating and Convergence Over Time for Mental Health, Life Satisfaction, and Personality: The Nord-Trøndelag Health Study

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Abstract Earlier studies have shown evidence for various sources of observed spousal similarity regarding different traits and characteristics. We explored the relative contribution of non-random mating and convergence to spouse similarity with respect to global mental health, life satisfaction, optimism, and type A personality. We used population-based data collected for the Nord-Trøndelag Health Study (1984–1986) and prospective registry information about when and with whom people entered into marriage/cohabitation between 1970 and 2000 for 19,599 married/cohabitating couples and 1,551 future couples that entered into marriage/cohabitation during the 16 years after data collection. Couples were categorized by interval between data collection and entry into marriage/cohabitation. Age-adjusted polychoric correlations calculated for each group were used as the dependent variables in non-linear, segmented regression analysis, with time since or until marriage/cohabitation as the independent variable. Initial correlations between partners-to-be were low to moderate, typically around one-half of the values estimated in existing couples, indicating both non-random mating and early convergence. There appeared to be moderate divergence during the first 20 years of marriage/cohabitation and moderate convergence during the rest of life.

Keywords Assortative mating · Contagion · Homogamy · Life satisfaction · Mental health · Personality

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Introduction

A number of studies have been performed to explore spousal concordance in mental health and psychological variables, such as life satisfaction and personality traits. Despite considerable methodological limitations and differences (Galbaud du Fort et al. 1993), mental health research has consistently reported that partners tend to be more similar to each other than would be expected by chance, with correlations typically approaching 0.2–0.3 (for reviews see Merikangas 1982; Galbaud du Fort et al. 1998; Mathews and Reus 2001; Meyler et al. 2007). Studies of life satisfaction have generally shown spousal correlations between 0.3 and 0.5 (Tambs and Moum 1992; Bookwala and Schulz 1996; Powdthavee 2009; Schimmack and Lucas 2006). In the field of personality research, results have been less supportive of concordance. Some studies were unable to demonstrate spousal resemblance at all (Dubuis-Stadelmann et al. 2001; Watson et al. 2004), and in general the spousal correlations tend to be below 0.2 (Gattis et al. 2004; Price and Vandenberg 1980; Feng and Baker 1994; Tambs and Moum 1992; Rammstedt and Schupp 2008).

Theories of spousal similarity may be classified into two main categories: theories of non-random mating, implying initial similarity between spouses, and experiences subsequent to partnering leading to convergence over time. Non-random mating can be explained by phenotypic assortative mating, the tendency for individuals to mate based on similar phenotypes, or common phenotypic preferences. Another explanation is social homogamy, the selection of a spouse based on social background factors that correlate with the phenotype being studied (Heath and Eaves 1985). Whether resulting from phenotypic assortment or social homogamy, non-random mating implies

initial non-zero phenotypic correlation between mates, even before meeting.

Theories of convergence over time do not imply initial non-zero phenotypic correlations between mates. Based on this approach, spousal resemblance results from processes that occur after mating. Convergence can be explained by shared environment, which simultaneously affects both spouses. Partners have similar exposure to exogenous factors, including financial resources, social networks, and marital conflicts. However, the most frequently used explanation for convergence in mental health is emotional contagion, in which the mental illness of one partner is thought to have a direct impact on the mental health of the other partner (Bookwala and Schulz 1996; Maes et al. 1998; van Grootheest et al. 2008; Goodman and Shippy 2002). If one spouse is depressed, the other will likely exhibit depressive symptoms as well. This phenomenon is also used to explain spousal resemblance in life satisfaction (Powdthavee 2009). Personality traits, on the other hand, are known to be quite stable (Terracciano et al. 2006) and are less likely to converge over time.

Distinguishing between different types of non-random mating and convergence is important, both from a theoretical point of view and because of possible consequences for estimating quantitative genetic models. If pre-marital life satisfaction or mental health were genetically determined, phenotypic assortative mating for these variables would imply genetic and environmental spousal correlations. This context would entail increased genetic and shared environmental correlations between parents and offspring, between siblings, and between dizygotic twins (Fisher 1918; Evans et al. 2002). On average, siblings and dizygotic twins will share more than 50 % of their segregating genes (Heath 1987). In classical twin models, such additional dizygotic correlations would be confounded by estimates of shared environmental influences, and estimates of heritability would be biased downward.

Designing studies to test directly and conclusively for non-random mating against spousal convergence is difficult, as it can only be done through observations of the most initial stages of relationships or, preferably, before the relationships have been established. A limitation in most previous research is that spousal similarity is measured in couples that have already been married for some time. Such similarity coefficients may be due to both non-random mating and convergence. Some studies take similarity observed during the first year of the relationship or marriage as an indication of initial similarity (Galbaud du Fort et al. 1998; Anderson et al. 2003; Luo and Klohnen 2005); however, even in these studies there is a chance that spouses converge substantially during the years before they enter marriage or in the very early years of marriage. One study demonstrated convergence of emotions in early dating couples (Anderson et al. 2003). Furthermore, evidence that spousal concordance for mental health does not increase with relationship duration is often interpreted as support of the theory of non-random mating (Feng and Baker 1994; McLeod 1993).

Previous evidence of convergence has been inconsistent. Increased spousal resemblance with relationship duration has been observed for mental health (Butterworth and Rodgers 2005; Goodman and Shippy 2002), life satisfaction (Schimmack and Lucas 2006; Anderson et al. 2003; Powdthavee 2009), and personality (Rammstedt and Schupp 2008). Longitudinal data have shown that a change in one person's depressive symptoms is associated with a change in their partner's symptoms (Bookwala and Schulz 1996; Siegel et al. 2004; Idstad et al. 2011). However, other studies on mental health and life satisfaction (van Grootheest et al. 2008; Feng and Baker 1994; McLeod 1993; Galbaud du Fort et al. 1994) and the majority of studies in the field of personality research (Humbad et al. 2010; Luo and Klohnen 2005) have failed to support the convergence hypothesis.

To the best of our knowledge, this study is the first to include data obtained from both partners' years before they enter into marriage/cohabitation. Thus, initial similarities observed in our data would yield stronger support for non-random mating than earlier observations. Another paper using the same data material has already demonstrated initial similarity and pre-marital convergence in alcohol consumption, smoking, and exercise (Ask et al. 2011). Both of these studies are follow-ups to a large study from 1992 that compared spousal similarity among couples married for various lengths of time (Tambs and Moum 1992). With updated registry information about marital status and date of marriage, we observed a resemblance between future spouses up to 16 years prior to entering into marriage/cohabitation. Spousal similarity within pre-marital groups was compared with similarity within newlywed and married couples. Our main objective was to explore the relative contribution of non-random mating and convergence to the observed spousal similarity with regard to four different measures: global mental health, life satisfaction, optimism, and type A personality.

Methods

Sample population

In 1984–1986, the adult population (≥20 years of age) of Nord-Trøndelag County, Norway, was invited to take part in a health screening survey known as the Nord-Trøndelag Health Study (HUNT). People from the same household were usually invited to participate at the same date. The

participants completed two questionnaires: one a short time before the screening (Q1) and a second that was handed out at the screening, which was asked to be returned by mail (Q2). In most cases, Q2 was returned a few days after the examination. Of 84,675 invited individuals, 91.2 % returned Q1. Among this group of participants, 82.8 % returned Q2. The cross-sectional questionnaire data were combined with longitudinal registry information about when and who people married, registered every year from 14 to 16 years before data collection to 14–16 years after data collection (1970–2000). In addition, registry information about cohabitation without marriage from 1992 to 2000 was available for couples that had children. Cohabitating couples without children were not registered before 1992. The governmental statistics agency, Statistics Norway, used the personal identification number assigned by the authorities to every Norwegian citizen to identify the couples, and data about marriage and partners were matched with the questionnaire data.

Our sample included participants that were either married (24,530 couples) or cohabitating (292 couples) at the time of data collection, or that were to enter into marriage (1,331 future couples) or into cohabitation (835 future couples) the same year as data collection or during the following 14–16 years. Table 1 shows the number of invited and participating couples for both questionnaires (Q1 and Q2). For all measures except life satisfaction, data from Q2 were required. These analyses included data from 19,599 existing couples (19,402 married and 197 cohabitating couples) and 1,551 future couples (963 later married and 588 later cohabitating).

Relationship duration (D) was estimated for all existing couples. The D of cohabitation that started before data collection (and before our first available registration in 1992) was estimated based on the age of the oldest child. For example, a couple with a 10-year-old child in 1992 would be coded as entering into cohabitation in 1982. The D of the marriages was calculated by subtracting the year of entry into marriage from the year of testing. The exact years of entry into marriage for 13,920 couples already married in 1976 were not registered. Therefore, the D of these marriages was estimated based on the woman's age, calculated as the woman's age minus the mean age of women entering into marriage in Nord-Trøndelag from 1974 to 1975 (Statistics Norway 2011, 24 years). The woman's age is a good indicator of D for these cohorts in Norway (Ask et al. 2011). The mean estimated D was 30.8 years (SD = 8.5), while the mean D for couples married after 1975, with exact registry information on year of marriage, was 8.2 years (SD = 4.0). The mean age for married/cohabitating Q1 respondents was 51.8 years for men (range = 21–95 years, SD = 15.1) and 48.6 years for women (range = 21–101 years, SD = 14.8). The corresponding mean ages for Q2 respondents were 52.6 years for men (range = 22–95 years, SD = 15.1) and 49.4 years for women (range = 21–101 years, SD = 14.9).

Values of D were also estimated for future couples. The values were negatively scored to indicate years until entry into marriage/cohabitation. For example, couples that married 10 years after data collection were scored −10. The mean interval from data collection to entry was 5.4 years, ranging from 0 to 16 (SD = 3.7). Mean age at the time of data collection was 30.3 years for men (range = 20–76 years, SD = 7.6) and 27.5 years for women (range = 20–74 years, SD = 6.8).

The total D for both marriage/cohabitation duration (positive values) and interval until entry into marriage/cohabitation (negative values) was categorized into 16 intervals: eight groups measured before the year of entry into marriage/cohabitation and eight groups measured from this year on. Hereafter, the year of entry into marriage/cohabitation will be referred to as "year of entry". Table 2 shows descriptive statistics for the categorized duration data.

Measures

Life satisfaction was measured as the mean value of two identical items included in both Q1 and Q2. The item was phrased: "When you think about your life at the moment, would you say that by and large you are satisfied with your life or are you mostly dissatisfied?" Seven response

Table 1 Nord-Trøndelag population and sample characteristics

Description	NT population	Q2 participants (Q1 participants)			
	Total individuals	Total individuals	Complete couples	Incomplete couples	Single individuals
Total population/sample	84,675	63,977 (77,230)	21,150 (26,988)	9,085	12,592
Married at examination time	56,786	44,210 (52,716)	**19,599 (24,822)**	5,012 (3,072)	
Married/started cohabitating after examination time	10,094	7,175 (9,452)	**1,551 (2,166)**	4,073 (6,544)	

Bold indicates a sample included in our analysis

Table 2 Couple characteristics

Range of years until or since the year of entry into marriage/cohabitation at the time of data collection (DC)	Mean years until (−) or since entry (SD)	N of couples in Q1 (Q2)	Male age mean (SD)	Female age mean (SD)
Entry 10–16 years after DC	−12.0 (1.7)	330 (166)	32.3 (9.1)	29.9 (8.1)
Entry 8–9 years after DC	−8.3 (0.4)	305 (183)	29.4 (7.0)	26.8 (5.7)
Entry 7 years after DC	−7 (0.0)	457 (284)	29.5 (6.9)	27.0 (6.4)
Entry 5–6 years after DC	−5.7 (0.5)	405 (251)	29.7 (7.1)	27.2 (6.3)
Entry 4–3 years after DC	−3.5 (0.5)	314 (202)	29.2 (6.6)	26.3 (5.7)
Entry 2 years after DC	−2.0 (0.0)	188 (129)	29.4 (6.7)	25.7 (5.5)
Entry 1 year after DC	−1.0 (0.0)	208 (140)	29.7 (6.6)	27.0 (5.5)
Entry same year DC	0.0 (0.0)	264 (187)	30.9 (8.8)	27.9 (8.4)
Entry 1 year before DC	1.0 (0.0)	362 (238)	31.5 (9.3)	28.4 (8.5)
Entry 2 years before DC	2.0 (0.0)	366 (251)	32.0 (8.2)	28.4 (7.2)
Entry 3–5 years before DC	4.0 (0.8)	1312 (902)	32.6 (7.5)	29.6 (6.9)
Entry 6–9 years before DC	7.6 (1.1)	2247 (1616)	35.4 (8.3)	32.5 (7.6)
Entry 10–15 years before DC[a]	12.3 (1.7)	4175 (2991)	37.9 (4.1)	34.8 (2.9)
Entry 16–25 years before DC[a]	20.1 (2.9)	5348 (3959)	46.7 (5.5)	43.1 (3.0)
Entry 26–35 years before DC[a]	31.0 (3.0)	5024 (4014)	58.2 (5.4)	54.2 (3.4)
Entry >35 years before DC[a]	39.0 (1.9)	6602 (5628)	70.4 (6.9)	68.0 (6.2)

[a] Estimated duration for couples married before 1976 are estimated based on the woman's age

categories ranged from "extremely dissatisfied" to "extremely satisfied" (scored 1–7). In 1.4 % of couples, one or both spouses had answers missing on both questionnaires and were excluded. If respondents had a missing value in Q2, the score from Q1 was used. In 77 % of couples, both partners entered valid data on both Q1 and Q2; in 10 % of couples, both partners entered data on Q1 only. In the remaining 13 % of couples, one partner had entered Q1 data only and the other had entered data on both Q1 and Q2. The test–retest correlation, in most cases with a few days time lag, was 0.68. Other studies have reported that responses to such questions are both valid and highly reliable (Scherpenzeel 1995).

Global mental health was a weighted sum of eight items from Q2. The weights were obtained using data material from 5,999 additional subjects described in detail elsewhere (Tambs and Moum 1993). The material included items identical to those included in the present global mental health score, together with the Hopkins Symptom Checklist-25 (SCL-25) (Winokur et al. 1984). The latter is a well-validated and widely used checklist for symptoms of anxiety and depression. To estimate weights, the SCL-25 sum score was logarithmically transformed owing to a skewed distribution, and then regressed on the eight global mental health items. The eight items predicted 66 % of the variance in SCL-25 (correlation of 0.81), indicating good validity for the global mental health indicator. B-values obtained from the regression were used as weights when constructing the indicator of global mental health. Table 3 summarizes the eight items and corresponding B-values. Cronbach's alpha for the scale was 0.79 for men and 0.82 for women. A total of 22.8 % of respondents had missing values on only one of the eight items, and 8.8 % had missing values on two or more of the items. Data sets missing four or fewer of the eight items (29.2 %) were imputed using the SPSS missing value analysis (MVA), expectation maximization (EM), to allow the items with valid data to predict values replacing the missing values. A total of 2.4 % of the respondents, 4.3 % of the couples, were left with missing data about global mental health. A subsample of 4,621 persons (response rate 79 %) completed a follow-up questionnaire containing identical items 10–38 months after HUNT. Collapsing the eight items into two summative indicators of nervousness and life satisfaction, respectively (as opposed to a single measure of global mental health), the correlations between the indicators based on the original and follow-up scores were 0.71 and 0.68 (Tambs and Moum 1992).

Type A personality was observed as the sum of three items in Q2 weighted by factor scores: "Do you have a tendency to take your duties more seriously than other people?" (Responses: "No, on the contrary", "No, usually not", "Yes and no", "Yes, very often", "Yes, that's exactly the way I am", scored 1–5); "Would you say that over the last year you have pushed yourself or steadily urged yourself forward?" ("Don't know", "No", "Yes", scored 0, 0, and 1); and "Are you constantly short of time even when it comes to day-to-day tasks?" ("Never", "Sometimes", "Always or almost always", scored 1–3). In 15.2 % of couples, one or both partners were missing values for at least one item. Data sets missing only one of the three items were imputed using EM, leaving 7.1 % of

Table 3 Global mental health items and relative contributions (B)

Item	Response categories (score)	B
1. Do you suffer from any long-term illness, injury, or complaints of a psychological nature which impair your functions in your day-to-day life? (Long-term means that it has lasted or will last for at least 1 year)	No (1), slight (2), moderate (3), or heavy (4) impairment due to psychological complaints	2.150
2. How often have you taken analgesics during the last month?	Never (1), not as often as every week (2), weekly but not every day (3), daily (4)	0.846
3. How often have you taken tranquilizers/sedatives or sleeping medicine over the course of the last month?	Identical as above	0.064
4. Over the past month have you suffered from nervousness (felt anxious, tense, or restless)?	Never (1), now and again (2), often (3), almost all the time (4)	3.630
5. Have you had any problems falling asleep or sleep disorders over the course of the last month?	Identical as above	1.554
6. Do you by and large feel calm and good about yourself?	Identical as above	1.335
7. Would you say you are usually cheerful or dejected?	7 Categories ranging from "very happy"(1) to "very dejected" (7)	0.660
8. At present do you mostly feel strong and energetic or tired and worn out?	7 Categories ranging from "very strong and healthy" (1) to "very tired and worn out" (7)	1.249

couples with missing data. A subsample (4,621 persons) completed a follow-up questionnaire containing identical items 10–38 months after HUNT, and the correlation between the original and follow-up type A three-item summed score was 0.55 (Tambs and Moum 1992).

Optimism was measured with three items on Q2 that were weighted by factor scores and summed. The items were phrased "Do you believe it is important to try to be happy with one's lot?", "Do you believe it is important to be able to lower sights?", and "Do you believe it is important to be cheerful at all times?" Response categories were "particularly important", "important", "yes and no", "not so important", and "of no importance whatsoever" (scored 1–5). Cronbach's alpha for the scale was 0.65 for men and 0.67 for women. In 5.8 % of couples, at least one value was missing from at least one spouse's responses. Records with only one of the three items missing were imputed using EM, leaving 3.5 % of couples with missing data.

Data analysis

The analyses in this study follow five steps. First, polychoric correlations between partners for the various measures were computed using the PRELIS computer program (Jöreskog and Sörbom 1988). This program was used because it also calculates asymptotic standard errors of the estimates. Correlations were observed for the total sample, separately for existing and future couples, and for each of the 16 groups of couples with various D. The survey variables may vary systematically with respect to age. To remove a possible spurious effect of age, the contribution of male age at participation in HUNT was partialled out by regression analysis.

Second, the age-adjusted correlations obtained for various D were transformed by Fisher's z-transformation: $z = 0.5 \times (\ln(1 + r) - \ln(1 - r))$. The z-transforms of the correlations were entered as data points for the dependent variable in non-linear segmented regression analysis, with time until or since the year of entry as the independent variable using the computer program R, version 2.13.2 (R Development Core Team, 2011). To reflect the accuracy of each data point, the inverse of the asymptotic standard error was used to weight the z-transformed correlation. The values estimated by the regression analyses were transformed from z-values back to r-values.

Third, we expected the type of association between time before year of entry and spousal similarity to differ from the association between time after entry and spousal similarity. Therefore, the independent variable D was partitioned into two intervals: years before (D_{neg}) and years after (D_{pos}) entry. The zero point separating these two intervals was couples that entered marriage/cohabitation during the same year as data collection. By segmenting the models into two, only one part of the function would influence each prediction along the *x*-axis. Three alternative mathematical models were specified that differed for the two ranges (Fig. 1). For future couples (D_{neg}) we expected the probability that the partners knew each other well enough to influence each other, and thus the similarity between them, to increase exponentially with decreasing time to entry into relationship. Therefore, an exponential function was specified for the expected similarity between future spouses. Three alternative functions were specified for the time after starting the relationship (D_{pos}). Convergence has been observed to be steepest at the beginning of the relationship and to flatten out later (Tambs and Moum 1992). Therefore, one might expect a logarithmic curve explaining the

$$\textbf{F1: } y = b_0 \exp(b_1 D_{neg}) + b_2 \ln(1 + b_3 D_{pos}) + b_4$$

$$\textbf{F2: } y = b_0 \exp(b_1 D_{neg}) + b_2 D_{pos} + b_3$$

$$\textbf{F3: } y = b_0 \exp(b_1 D_{neg}) + b_2 (D_{pos} - b_3)^2 + b_4$$

Constraints: $b_0 > 0, \quad b_1 > 0$

$$D_{neg} = \begin{cases} D & if \quad D \le 0 \\ 0 & if \quad D > 0 \end{cases} \qquad D_{pos} = \begin{cases} D & if \quad D > 0 \\ 0 & if \quad D \le 0 \end{cases}$$

D_{neg}=Years until entry into marriage/cohabitation
D_{pos}= Years since entering into marriage/cohabitation

Fig. 1 Three alterative functions describing spouse similarity

similarity across D (Fig. 1, F1). Another possibility is a linear increase in similarity across D (Fig. 1, F2). Because different studies have reported various levels of similarity using samples with dissimilar marital duration, another possibility is that the effects of convergence/divergence differ across duration. To allow for convergence reaching a possible apex with subsequent divergence, or conversely, divergence with later convergence, a quadratic function or parabola was specified as a third alternative (Fig. 1, F3). Although all three models include an exponential component for D_{neg}, they will be referred to hereafter as the logarithmic (F1), linear (F2), and quadratic (F3) functions. The three full models were tested for the four study variables (life satisfaction, global mental health, optimism, and type A personality). In cases when at least one of the parameters was non-significant, we chose to simplify the model. A linear effect for $D < 0$ was specified (by fixing b1 at zero), because it proved to be difficult to specify an exponential function without including both b0 and b1.

Fourth, because the HUNT sample only includes individuals aged 20 years or older, people who started a relationship many years after data collection generally entered marriage/cohabitation at a later age than the remaining sample. If age at year of entry is associated with spouse resemblance, this variable might confound the effect of D. For the portion of the sample with known age at the time of marriage (married after 1976), analyses were run to test whether the age at the start of the relationship was related to spousal correlations. Women's scores for mental health, life satisfaction, optimism, and type A personality were used as dependent variables, and age at marriage (mean age for the two spouses) and men's scores were used as independent variables in multivariate ANOVA (SPSS general linear models (GLM), Unianova). The possible relationship between spousal resemblance and age at marriage was tested as an interaction term between men's scores and age at marriage. The analyses showed no significant interaction effects between male variables and age at the start of the relationship on female scores.

We also a priori could not rule out the possibility of systematic differences between marriage and cohabitation, which might also confound the effect of D on spousal similarity. Therefore, as the 5th step, the interaction term between men's scores and a dichotomous marriage/cohabitation variable on women's scores, adjusted for D, was tested in separate analyses for existing and future couples. Because there were few cohabitating couples with $D > 20$, all couples with $D > 20$ were excluded from these analyses. None of the possible interaction effects between male scores and marriage versus cohabitation were significant. Therefore, data from married couples and cohabitating couples were treated as the same data in the later analyses.

Results

Partner similarity and life satisfaction

The total age-adjusted polychoric partner correlation for life satisfaction was 0.40 (95 % CI = 0.39–0.42). The age-adjusted correlations for existing and future couples were 0.42 (95 % CI = 0.40–0.43) and 0.26 (95 % CI = 0.21–0.30), respectively. The observed correlation for the group with lowest D, measured 10-16 years before entry into marriage/cohabitation, was 0.21 (95 % CI = 0.04–0.37). Trends in partner similarity for life satisfaction, measured as correlations within 16 groups of spouses categorized according to D, were estimated based on the three alternative full models in Fig. 1. The proportion of variance between the correlations explained by time before (D_{neg}) and after (D_{pos}) entry into marriage/cohabitation was 69 % for both the logarithmic and linear functions. The quadratic function explained most of the variance in observed spousal correlations (92 %). R^2 refers to the explained variance for the aggregated data, in which each data point is an observed correlation, and not the total variance in couple similarity in the population. An R^2 value of 0.92 means that the estimated function does not account for 8 % of the variance between the data points in Fig. 2. The expression for the best-fitting full model including parameter estimates, with 95 % CIs in parentheses, is:

$$\begin{aligned} F3: y &= \underset{(-0.175 - 0.504)}{0.165} * \exp\Big(\underset{(-0.706 - 1.105)}{0.200} * D_{neg}\Big) \\ &+ \underset{(0.000198 - 0.000513)}{0.000355} * \Big(D_{pos} - \underset{(17.57 - 22.91)}{20.63}\Big)^2 \\ &- \underset{(-0.380 - 0.302)}{0.039} \end{aligned}$$

Observed and predicted correlations in life satisfaction between partners based on F3 are shown in Fig. 2. The real

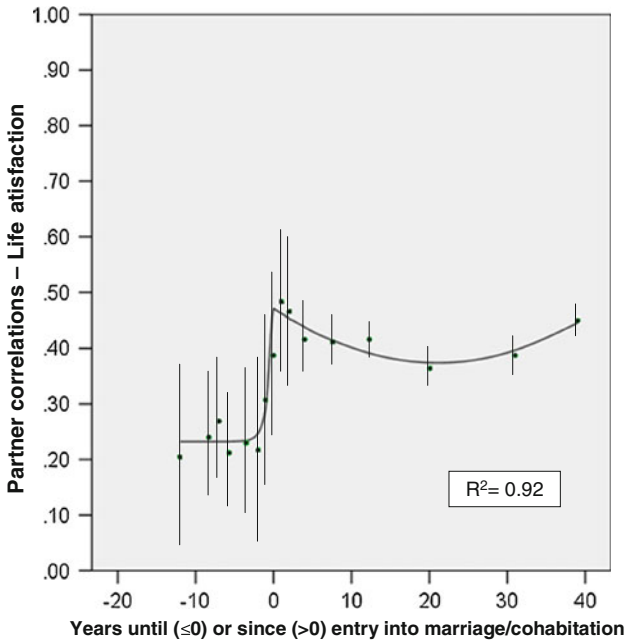

Fig. 2 Non-linear regression analysis of spouse similarity in life satisfaction. Data points are polychoric partner correlations adjusted for male age. *Bars* indicate 95 % CI. The *fit line* indicates correlations predicted from function *F3* in Fig. 1

observed data points are z-transforms of the correlation, while Fig. 2 shows the results for estimates back-transformed from z-values to correlation values. According to F3, the expected spousal correlation in life satisfaction 12 years before entry into marriage/cohabitation is 0.23. No increase in similarity during the following 10 years was predicted; however, similarity was predicted to increase to 0.47 during the final 2 years before entry. After entry, similarity is predicted to decrease by 0.10 (to 0.37) during the first 20 years, and subsequently increase to 0.45 after 39 years in a relationship. However, there is some uncertainty within the first two parameters of the full model, and only b0 was significant. A linear model (fixing b1 at zero) gave a significant increase ($t = 4.346$, $p < 0.001$) in similarity in the time before the year of entry.

$$y_{b0=0} = \underset{(0.015 - 0.045)}{0.030} * D_{neg} + \underset{(0.000003 - 0.000353)}{0.000178} * (D_{pos} - \underset{(12.51 - 24.76)}{20.63})^2 - \underset{(0.365 - 0.437)}{0.039}$$

This model indicates that over a 12-year period before the year of entry, couple correlations would increase with 0.36. Initial predicted similarity in this simplified model was 0.10.

Partner similarity and global mental health

The age-adjusted polychoric partner correlation for mental health was 0.26 (95 % CI = 0.24–0.27) for the total sample, 0.26 (95 % CI = 0.25–0.28) for existing couples, and 0.20 (95 % CI = 0.15–0.25) for future couples. Observed correlation for the group with lowest D, measured 10–16 years before entry into marriage/cohabitation was 0.22 (95 % CI = 0.07–0.37). F1 and F2 led to approximately the same solution, explaining 30 % of the variance in spousal correlations. The logarithmic function asymptotically approached a linear function as b_3 approached zero and b_2 was an extremely high absolute value. The quadratic function explained most of the variance in the observed spousal correlations (74 %). The expression for the best-fitting full model including parameter estimates, with 95 % CIs in parentheses, is:

$$F3 : y = \underset{(0.047 - 0.273)}{0.160} * \exp(\underset{(-0.813 - 1.820)}{0.504} * D_{neg}) + \underset{(0.000128 - 0.000391)}{0.000259} * (D_{pos} - \underset{(15.74 - 22.57)}{20.02})^2 + \underset{(-0.058 - 0.181)}{0.062}$$

Predicted spousal similarity in global mental health based on F3 is shown in Fig. 3. The initial correlation, 12 years before entry, was predicted to be 0.16. From this point, an exponential increase to 0.31 was predicted during the year of entry. By the time D equaled 20 years, the expected correlation decreased to 0.22, with a subsequent increase to 0.31 after a D of 39 years. The exponential parameter b1 was not significant. A simplified linear model gave a significant linear increase ($t = 3.001$, $p < 0.05$) in similarity in the time before the year of entry.

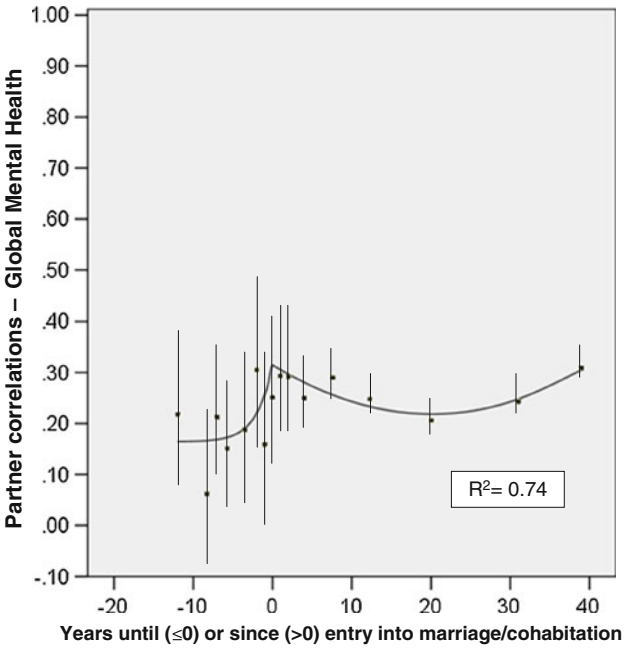

Fig. 3 Non-linear regression analysis of spouse similarity in global mental health. Data points are polychoric partner correlations adjusted for male age. *Bars* indicate 95 % CI. The *fit line* indicates correlations predicted from function *F3* in Fig. 1

$$y_{b0=0} = \underset{(0.0046-0.0292)}{0.0169} * D_{neg} + \underset{(0.000094-0.000361)}{0.000227} * (D_{pos} - \underset{(12.99-22.23)}{19.19})^2 + \underset{(0.197-0.252)}{0.224}$$

This model indicates that over a 12-year period couple correlations would experience an increase of 0.24. Initial predicted similarity in this model was 0.10.

Partner similarity regarding type A personality

The age-adjusted polychoric partner correlation for type A personality was 0.20 (95 % CI = 0.19–0.22) for the total sample, 0.20 (95 % CI = 0.19–0.22) for existing couples, and 0.18 (95 % CI = 0.13–0.23) for future couples. Observed correlation for the group with lowest D, measured 10–16 years before entry into marriage/cohabitation, was 0.17 (95 % CI = 0.01–0.33). The quadratic function was the best-fitting full model, explaining 72 % of the variance. The expression for the best-fitting model including parameter estimates, with 95 % CIs in parentheses, is:

$$F3 : y = \underset{(0.047-0.273)}{0.165} * \exp(\underset{(-0.706-1.105)}{0.200} * D_{neg}) + \underset{(0.000198-0.000513)}{0.000355} * (D_{pos} - \underset{(17.57-22.91)}{20.63})^2 - \underset{(-0.380-0.302)}{0.039}$$

The observed and predicted correlation values are shown in Fig. 4. The initial correlation, 12 years before entry into marriage/cohabitation, was predicted to be 0.13. From this point, the predicted correlation increased exponentially to 0.27 by the year of entry. Across D, divergence occurs for the first 20 years (to 0.13), with subsequent convergence to 0.24 after 39 years. Neither of the first two parameters of the full model were significant. A linear model gave a significant linear increase ($t = 2.45$, $p < 0.05$) in similarity in the time before the year of entry. Initial predicted similarity in this model was 0.09.

$$y_{b0=0} = \underset{(0.0016-0.0279)}{0.0148} * D_{neg} + \underset{(0.000194-0.000487)}{0.000341} * (D_{pos} - \underset{(17.43-22.67)}{20.42})^2 + \underset{(0.097-0.157)}{0.127}$$

Partner similarity regarding optimism

The age-adjusted polychoric partner correlation for optimism was 0.32 (95 % CI = 0.31–0.34) for the total sample, 0.33 (95 % CI = 0.31–0.35) for existing couples, and 0.23 (95 % CI = 0.18–0.29) for future couples. The observed correlation for the group with lowest D, measured 10–16 years before entry into marriage/cohabitation, was not significant (0.02, 95 % CI = −0.18–0.21). F1 and F2 led to the same solution, explaining 41 % of the variance in aggregated group correlations. The logarithmic function asymptotically approached a linear function as b_3 approached zero, and b_2 had an extremely high absolute value. F3 explained most of the variance in similarity (73 %). The exponential part of the function (for $D < 0$) asymptotically approached a linear solution. Therefore, the first part of F3 is linear in the expression for the best-fitting model (including parameter estimates, with 95 % CIs in parentheses):

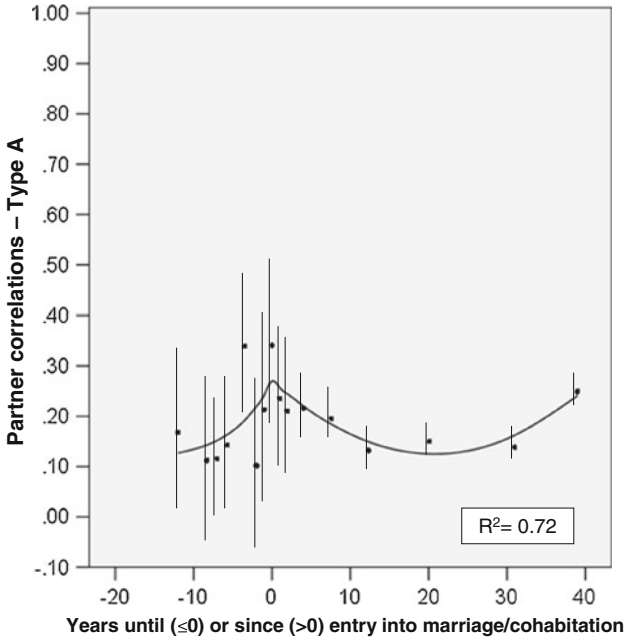

Fig. 4 Non-linear regression analysis of spouse similarity in type A behavior. Data points are polychoric partner correlations adjusted for male age. *Bars* indicate 95 % CI. The *fit line* indicates correlations predicted from function *F3* in Fig. 1

$$F3 : y = \underset{(0.0140-0.0451)}{0.0296} * D_{neg} + \underset{(0.000116-0.000434)}{0.000275} * (D_{pos} \div \underset{(13.73-22.54)}{19.50})^2 + \underset{(0.261-0.325)}{0.293}$$

Predicted spouse similarity regarding optimism based on F3 with a linear function for D_{neg} is shown in Fig. 5. Although the original function based on z-transforms of correlations provides a perfectly straight function for negative D values, the figure based on data points back-transformed to correlations shows a slightly curved line for this interval. Initial similarity 12 years before entry was predicted to be 0.04, after which there is a significant increase ($t = 4.147$, $p < 0.001$) in similarity to 0.38 at the year of entry. Divergence was predicted across D during the first 20 years (to 0.29), with subsequent convergence to 0.38 after 39 years.

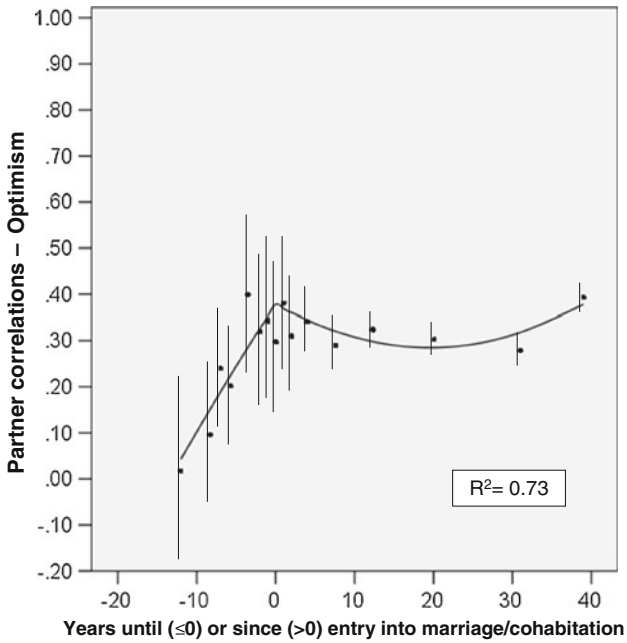

Fig. 5 Non-linear regression analysis of spouse similarity in optimism. Data points are polychoric partner correlations adjusted for male age. *Bars* indicate 95 % CI. The *fit line* indicates correlations predicted from function *F3* in Fig. 1

Discussion

Our goal was to examine to what extent individuals mate with partners that resemble themselves and to what extent partners converge over time. Based on the same sample, we have already published an article demonstrating non-random mating and convergence regarding lifestyle factors (Ask et al. 2011); the present article focuses on mental health and personality traits. With responses from married couples, cohabitating couples, and participants entering into marriage/cohabitation during the 16 years after data collection, we had a unique opportunity to extend the literature in this field. Except for optimism, observed and predicted initial correlations indicated a significant but moderate level of non-random mating for the studied areas; the highest initial correlation was for life satisfaction. Our results suggest that the duration of a relationship changes the magnitude of spousal correlation. Convergence is mostly observed during the time before couples enter marriage/cohabitation, as well as after approximately 25 years of marriage. A moderate divergence during the first 20 years of marriage/cohabitation was suggested.

Level of spousal resemblance

Consistent with earlier studies, our sample demonstrated significant spousal concordance for four different survey variables: mental health, life satisfaction, optimism, and type A personality. The highest level of observed spousal similarity within the total groups of future and existing couples occurred for life satisfaction in future couples and optimism in existing couples. The lowest observed similarity in both future and existing couples occurred for type A personality. The low correlation observed for type A behavior is in agreement with earlier research that has shown lower spousal resemblance for personality traits compared with measures of mental health (Price and Vandenberg 1980; Tambs and Moum 1992). However, the correlation for optimism is actually higher than for global mental health.

Non-random mating versus convergence

Because data from future couples on optimism, type A personality, mental health, and life satisfaction were collected at a time when the probability of partners knowing and influencing each other was quite low, the initial correlations clearly indicate a low to moderate level of non-random mating. For all variables except optimism, the observed initial correlation was approximately one-half of the maximum correlation estimated among couples already married/cohabitating at the time of data collection. Contrary to what might be expected, the level of non-random mating was lower for the two variables measuring personality traits than for the other variables. The level was especially low in the case of optimism, with an initial non-significant correlation close to zero. It seems plausible that people mate because of similarities in personality rather than similarities in mental health or life satisfaction, and convergence is not believed to take place for traits assumed to be stable throughout life. However, our results suggest that convergence explains most of the similarity in optimism. We could argue that our measure of optimism is more an expression of life satisfaction than an actual personality trait. For the other personality trait, type A personality, correlations were generally lower across all D values compared with the other measures, and were explained by a low level of non-random mating with subsequent convergence and divergence.

Although the levels of initial and subsequent spousal concordance differed between the variables, the pattern of convergence/divergence was quite similar for all four models of partner similarity. All survey variables demonstrated significant (linear) convergence between partners during the years before entering into marriage/cohabitation. This finding is in agreement with a study showing convergence of emotions in 39 couples in early dating relationships (Anderson et al. 2003). The highest level of pre-relationship convergence was for optimism, with an increase of 0.34. The trends for pre-marital convergence suggest an exponential development for all variables

except optimism, in which most of the convergence takes place during a period of a few years before entry into the relationship. The steepest convergence was estimated for life satisfaction in the full model, in which there was a sharp increase in similarity, from 0.22 3.5 years before entering into marriage to 0.47 during the year of entry. In reality, this trend may reflect that the start of the relationship or entry into marriage itself, over and above convergence caused by other factors, generates a spousal similarity because the spouses' reactions to the event are correlated. Relationship satisfaction has been demonstrated to correlate at 0.55 between spouses (Røsand et al. 2012), and it would not be surprising if this correlation contributes to the similarity between spousal life satisfaction in new couples. However, the power of the data does not permit safe conclusions regarding the shape of the convergence function before marriage or start of cohabitation.

The simplified models, which specify a linear increase during the time before entry, showed a significant increase in similarity for all study areas. A priori, we thought that a linear model would be an oversimplification of the relationship. An exponential increase in similarity caused by the increasing probability of couples knowing and influencing each other seems more realistic. Nevertheless, our results clearly show a substantial increase in spousal correlations before relationship entry.

All four models demonstrated a u-shaped tendency of divergence/convergence after entering into marriage/cohabitation. Slight divergence occurred during the first 15 years of the relationship, followed by convergence for couples with D longer than 25 years. The "u" was most distinct for type A personality, with a difference of 0.14 from the top to bottom level of similarity. The non-linear pattern suggested by our results might explain the conflicting results reported in the literature regarding convergence. The demonstration of a u-shaped pattern of divergence and convergence is contradictory to one earlier study on personality, in which quadratic and cubic functions were uniformly non-significant (Humbad et al. 2010). However, most of their sample had been married for between 11 and 25 years, with few recent couples.

Our results indicate that processes that occur soon after spouses get to know each other explain a large proportion of spousal similarity in mental health and personality traits. Our study does not investigate which factors promote greater similarity during the years before entrance into marriage or in the late stages of a relationship, or what factors promote divergence during the first 20 years of marriage. Because the model changes from convergence to divergence and back to convergence, this observation generally indicates that psychological variables reflect the dynamic processes, shared experiences, and environments impinging upon couples.

Study limitations

Cohabitation data were based on registry information available from 1992, and only for couples with children. This limitation restricts our sample in that all cohabitating couples without children were excluded. The reliability of year of entry into marriage/cohabitation is not perfect. Some couples undoubtedly have been living together some years before they married or were registered as cohabitating after having children. The limitations caused by incomplete information about cohabitation may have biased our estimates somewhat, although unmarried cohabitation was much less common in the 1990s than it is today, and married couples by far outnumber cohabitating couples in our sample. Furthermore, the demonstration of no significant interaction between relationship duration and cohabitation versus marriage supports the validity of our results. Marriages entered into before 1976 were estimated based on the woman's age, which may also have slightly affected our results. However, female age has been demonstrated to serve as a good indicator of duration (Ask et al. 2011).

There may have been some selective attrition in our sample. Some evidence indicates that between-spouse differences in personality traits and social background predict divorce (Bentler and Newcomb 1978). Thus, observed similarities between spouses that increase during marriage may arise from the attrition of less-similar couples because of divorce. Because the divorce rate was low in Nord-Trøndelag before the time of data collection, and our results show that both divergence and convergence occur across the duration of a relationship, divorce has hardly more than trivially biased our results.

Another limitation is the scarcity and crudeness of personality measures in the present study. Studies of type A personality and optimism usually involve much more comprehensive measures than the ones included here. It would have been interesting to include measures on established dimensions of personality, such as the Big Five personality dimensions. The literature demonstrates well-established relationships between the Big Five dimensions of neuroticism (N) and extraversion (E) and both type A personality (Cramer 1991; Eysenck and Fulker 1983; Bruck and Allen 2003; Lichtenstein et al. 1989; Kimberley 1997; Furnham 1984) and optimism (Marshall et al. 1992; Kam and Meyer 2011; Sharpe et al. 2011). In addition, neuroticism is strongly related with both measures of mental distress such as ours, with correlations approaching 0.6 (Jardine et al. 1984), and with life satisfaction, typically correlating at approximately −0.5 (Schimmack et al. 2004). Our results show the same general trend for all measures: moderate correlations from the start, which increase until marriage and then decrease somewhat, before increasing a little again late in life. This quite distinct pattern applying for a number of different

variables, all of which are correlated with more established measures of personality, suggests that the same trend might well apply for personality in general.

A limitation of our data and analysis is the inability to separate the effects of primary assortment from those of social homogamy. Phenotypic assortative mating would have implications for quantitative genetic modeling distinct from those of social homogamy, because the latter would result in increased genetic resemblance between spouses and their offspring only if the frequency of genes coding for certain phenotypes varied between social strata.

What might be considered a somewhat arbitrary choice of mathematical models for convergence represents a limitation. The functions we have chosen represent a few of a number of possible options. For instance, a quadratic function might have replaced the exponential function for the specification of a non-linear trend before entry into marriage/cohabitation. The functions likely all represent simplifications of the real and more complex causality underlying changes in spousal similarity. On the other hand, there is a danger of over-specifying the model with too many parameters, with a risk of unreliable results. Although we cannot be absolutely sure that our results optimally demonstrate the trends in the data, there is no large risk of a severe misrepresentation of the trends.

One limitation in our data is associated with the age of the sample, all participants being 20 years of age or older at the examination time. Thus, on average, the group of future couples was older than couples in the general population when entering into marriage/cohabitation. For example, partners that married 10 years after data collection would have to be at least 30 years of age at the year of entry to be included in the sample. However, testing the effects of age at the start of the relationship on spousal resemblance did not yield evidence of such effects, so we can assume that possible bias due to high marital age is small or absent.

Last, but not least, we assumed that all systematic variation in spousal similarity with relationship duration is due to convergence or divergence. There is a possibility that the observed variation reflects secular trends. However, it is hard to imagine any good reason why the degree of non-random mating should have changed much during the last 50 years, and especially during the period of 1985–2000, on which the results prior to relationship entry are based. The level of similarity during the years after entry was relatively stable, generally not suggesting much variability in spousal similarities between cohorts.

Conclusions and implications

Our results demonstrate that spouses have a moderate level of concordance in measures of mental health and personality. The origins of this similarity appear to be both non-random mating due to initial correlations, and processes that occur after mating. Convergence can be particularly observed during the years before entry into marriage/cohabitation. Knowledge about premarital convergence has implications for conclusions drawn in previous studies and is an important consideration in future studies.

Our finding of initial correlations between spouses is essential to the interpretation of quantitative genetics studies of mental health and life satisfaction. Classical models that assume random mating when phenotypic assortative mating is present make incorrect assumptions about the genetic similarity of dizygotic twins and first-degree relatives. Our results, at least in principle, imply that rules of correct specifications of quantitative genetic models are complicated, because our evidence of convergence shows that we cannot always use observed spousal correlations as estimates of non-random mating.

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