Why do Identical Twins Differ in Personality: Shared Environment Reconsidered

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While heritability studies show that most of the variance in adult personality can be attributed to genetic or so-called nonshared environmental influence, this does not mean that shared events lack importance for the development of later personality differences. We studied the relationship between Big Five personality differences in monozygotic (MZ) twins at age 29, and life stressors at age 6 to 15, using prospective data from 26 MZ pairs studied from birth onwards. A positive significant correlation was found between stressors in childhood and early adolescence, and intrapair personality differences in Agreeableness, Openness, Conscientiousness, and five-factor profiles. We note that the effects of shared events are labeled "nonshared" environment when the effect is to make siblings more different. Case examples illustrate the relationship between stress and personality differences, and provide hypotheses for further studies in larger samples.

The findings of numerous heritability studies of adult personality traits show that most of the important influences seem to be attributable to either genetic or nonshared environmental factors, while there are no important effects of shared environment (Plomin, DeFries, et al., 2001). It is important to realise that this does not mean that shared experiences (or indeed the environment in general) are without importance for the development of later personality differences (Rutter et al., 1999). Since there is a lack of studies in the behavior genetics literature, in which environment has been actually measured, our point of departure was to study the effect of demonstrable, gross, shared life stressors in adolescence on the adult personality of monozygotic (MZ) twins. We hoped that the results might show how some current understandings of the term "shared environment" are problematic.

Heritability of Main Personality Traits

Among the approaches to the study and description of individual differences in personality, Costa and McCrae (1992) have received wide acceptance for their Big Five model, which summarises what is conceived of as the main structure of personality in five dimensions: Neuroticism, Extraversion, Openness to experience (below referred to only as "Openness"), Agreeableness, and Conscientiousness. According to Costa and McCrae (2000), the main personality traits, "like temperaments, are endogenous dispositions that follow intrinsic paths of development essentially independently of environmental influence".

The Big Five personality dimensions are among the variables most thoroughly researched with respect to influences of genetic and environmental factors. Several broad-scaled twin studies have shown 40 to 50 percent of the variance in the five dimensions to be explainable by genetic variance (Segal & McDonald, 1998).

Some recent studies conclude that the five dimensions seem to be about equally heritable (Loehlin et al., 1998). This is in contrast to the commonly held view that Extraversion and Neuroticism would be the two most biological dimensions, closely related to temperament (Jang et al., 1998). When summarising several studies, Bouchard (1996) found a lower broad heritability for Agreeableness than for the other Big Five traits.

Shared and Nonshared Environmental Influences

The environmental influences on personality are divided into two main types in the behavior genetic literature: "shared" versus "nonshared" environment. In typical behavior genetic studies, actual measures of environmental factors are not obtained, but influences are inferred from the outcome pattern of observed similarities between subjects. Plomin, DeFries, et al. (2001; pp. 378–379; p. 300) define *shared environment* as "environmental factors responsible for resemblance between family members" or "family resemblance not explained by genetics", and *nonshared environment* as "environmental influences that contribute to differences between family members" or "variance not explained by genetics or by shared family environment".

The two environmental components may be estimated by various methods. Plomin (1986; p. 70) summarises the possibilities for estimating the influence of shared environment:

> … in three ways: 1) from the correlation for genetically unrelated children reared together in the same adoptive families, 2) from the difference in correlations for relatives reared together and relatives adopted apart, and 3) from twin studies, as the remainder of phenotypic variance when genetic variance, variance due to nonshared environment, and error are removed.

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In contrast, nonshared environment,

> … is usually estimated as the remainder of phenotypic variance, once variance due to heredity, shared environment, and error of measurement is removed. Differences within pairs of identical twins reared together provide a direct estimate of nonshared environment as experienced by identical twins. (Plomin, 1986; p. 70).

These types of definitions, which are closely linked to the statistical models employed in behavior genetics, are unequivocal. It is important to note that the distinction between shared and nonshared environment is made solely in terms of outcome, i.e., if an environment has the effect of making siblings more similar, it is defined as a shared environment, and if an environment has the effect of making siblings more different, it is defined as a nonshared environment. Goldsmith (1993) names an environment that affects a person in either direction an "effective environment." The observed environment, however, termed the "objective environment," by Goldsmith (1993), is shared or not shared by siblings in the family, regardless of its effect. It may therefore be confusing to talk about shared or nonshared environmental influences on behavior, as if these constructs denoted similar or different actual events or experiences. Unfortunately, there are many instances of confusion of this kind. For example, one standard textbook on personality gives the following definitions (Pervin, 1996, p. 150):

> *Shared environments* consist of those environments shared by siblings as a result of growing up in the same family. For example, family values and child-rearing practices may be common across siblings. *Nonshared environments* consist of those environments that are not shared by siblings growing up in the same family. For example, siblings may be treated differently by parents because of sex differences, birth order differences, or life events unique to a particular child (e.g. illness in the child or financial difficulties during the youth of one of the children).

Not only textbook authors, but even reports from behavior genetic studies oscillate between the outcome-based shared/nonshared distinction, and the causal-event-based variety. A recent description of the nature of "shared environment" is given by Reiss et al. (2000) in their book from the well known NEAD (Nonshared Environment and Adolescent Development) twin and sibling study, in explaining the results of minimal influence of "shared environment" (p. 68): "This analysis tells us that the major environmental influences on adolescents' proneness to anxiety must be different for sibs in the same family. This rules out a number of influences, such as the family social class or the level of parents' anxiety, all of which are *shared* by siblings in the same family." According to the definition of "shared environment" this interpretation is incorrect when it comes to siblings living in their original family, since two siblings perfectly well can have different responses to a parent's anxiety. Such gene-environment interaction would be accounted as a nonshared environmental effect in many commonly used behavior genetic models, in which nonshared environment incorporates interaction effects.

The confusion attached to the concepts of shared and nonshared environments in behavior genetic research has been thoroughly discussed in some recent articles (Rutter et al., 1999; Turkheimer & Waldron, 2000). One conclusion seems to be that nonshared environmental effects are not as influential as first claimed. However, it is important to acknowledge that while partitioning variance among a few main sources (as much of the recent research has been devoted to) is efficient in suggesting the relative importance of main influences, in actuality, a much wider range of interacting sources of influence on outcomes can be identified. Specifying different influences and their interactions has been a focus of interest for decades; for a thorough discussion see for example Eaves et al. (1977).

Environmental Influences on Big Five Personality Dimensions

The results of many heritability studies of the Big Five personality dimensions show that most of the environmental influence is attributable to nonshared environment. In repeated large-scale twin and sibling studies, no major contribution of shared environment to the Big Five personality dimensions Extraversion and Neuroticism has been found (Eaves et al., 1998). In a Swedish study of twins reared apart, some effect of shared environment was found for Agreeableness. MZ twins reared apart, as compared to reared together, were significantly more different for this personality factor (Bergeman et al., 1993). Some evidence for shared environment on Agreeableness was also found by Loehlin (1992).

The important conclusion to be drawn from the accumulated findings of behavior genetic studies of adult personality traits, is that familial environments influence siblings in different directions. "It is generally not shared family environment that causes family members to resemble each other" (Plomin, DeFries, et al., 2001; p. 298).

Personality Differences in Monozygotic Twins

Since behavior genetic studies agree in that about half of the variance explaining individual differences in personality is caused by environmental factors, efforts have been made the last years to identify such factors in MZ twin studies. After decades of statistical modeling, steps are now taken to find out more about what "nonshared environment" looks like in actuality.

A number of studies have looked for objectively nonshared environmental factors and their effect (e.g., Hetherington et al., 1994), and a few results are reported. Differences in MZ twins adjustment in adolescence were in one study found to be related to experiences of differences in parental negativity (Pike et al., 1996). Vernon et al. (1997) in a similar way demonstrated that differences between MZ twins in some dimensions of personality were correlated with differences in some family and background environmental measures.

So far, objectively shared environmental conditions or events have mainly been studied in twins as possible causes of shared environmental outcomes, that is, investigators have studied specific environmental circumstances seeking for an effect of making siblings similar (see e.g., Rose et al., 1990). If the task is to look for all effective environmental factors, then objectively shared environmental factors that

make siblings more different must also be studied. In a review of the recent studies of nonshared environment, Plomin, Asbury, et al. (2001) conclude that nonshared environmental effects can be found in siblings' differential responses to ostensibly shared environment. Among empirical results that point in this direction, is the report of different reactions of siblings to their parents' divorce in a study by Hetherington and Clingempeel (1992). In our study, we wanted to explore whether objectively shared environmental factors also make identical twins different, that is — in behavior genetic language — whether they have a nonshared environmental effect.

Aims of the Study

The present study investigates nonshared environmental effects — measured as differences in adult MZ twins' personality — of objectively shared life events in childhood and adolescence. To what degree will high objective stress shared by family members have a different influence on the personality development of genetically identical siblings? The present study had a longitudinal design where stressors were reported at age 15 for the age interval 6 to 15 years. Within-pair twin differences in self-reported Big Five personality dimensions were registered at age 29. Since our sample is small, though rich in qualitative data, we chose to present qualitative data for some selected twin pairs in addition to quantitative analyses.

Materials and Method

Twin Sample

The parents of all 53 same-sexed twin pairs born over a period of 18 months in 1969 and 1970 in a middle-sized Norwegian city, were asked to participate in a longitudinal developmental research project. Blood tests (eleven systems) were performed on blood from the umbilical cord of all twins (Torgersen & Kringlen, 1978). Thirty-five of the twin pairs were eventually identified as monozygotic (MZ) and seventeen as dizygotic (DZ) on the basis of blood and serum typing, and parents completing questionnaires on twin similarity. One twin pair was not possible to diagnose. They died in their second year. The likelihood of twin pairs receiving a wrong zygosity diagnosis is negligible. The present study used data from all the MZ twin pairs attending follow-ups at the ages of 15 years (n = 58 twins — 29 complete pairs — making up 83% of the original MZ sample) and 29 years (n = 57 twins or 80%, including 28 complete pairs). 26 pairs attended both of these follow-ups. The death of one twin accounted for the discontinuation in the study of three MZ pairs.

Procedure

The total group of twins, were first seen a few days after birth, and then visited in their homes at the ages of 2 and 9 months, and at 6 and 15 years (Torgersen, 1989). The mothers were interviewed at every visit, and at age 15 also the twins. A new follow-up assessment, including an interview and the completion of self-report measures, took place when the twins were 29 years old.

Measure of Stressors at Age 6 to 15

Objectively shared family stress for each twin pair at the age interval 6 to 15 years was comprehensively assessed at age 15. This assessment comprised separate interviews with the twins' mother, the twins, and the completion of self-report inventories by mother and twins. Based on the total available material, thirteen stressor factors were coded: only one caregiver; divorce or separation of parents; family conflict; new stepmother or stepfather; new siblings; illness of siblings (other than twin); illness of parents; loss of close person; nervous problems in parent; nervous problems in sibling (other than twin); multiple moves; change of school; and other stressor. Each item was coded 0 for Absence, 1 for Slightly present, or 2 for Clearly present. The coding was undertaken after data were collected from the participants at age 15, many years prior to the collection of personality self-reports at age 29 (Torgersen, 1987). The average of the 13 item scores was used as a summary measure of stressors. High stressor scores thus represent several major changes in life situation or continuous strain. Measures of the experience of these stressors were not sampled. The mean life stressor score was 0.37 for all MZ pairs, with a minimum of 0.00 and a maximum of 0.85. Internal consistency (Cronbach's alpha) for the scale was 0.76 calculated on 58 MZ individuals.

Personality Measures at Age 29

Self-report measures of the Big Five dimensions were collected using the NEO-PI-R (Costa & McCrae, 1992). The questionnaire is translated into Norwegian (Costa & McCrae, 1996) and standardised in a large sample which included non-twins (N = 902) and the DZ and MZ twins in the present longitudinal cohort. The factor structure in the Norwegian sample was very similar to that found in other countries, and according to a personal communication from Nordvik (2000), reliability estimates (Cronbach's alpha) were 0.92, 0.89, 0.90, 0.86, and 0.89, for the dimensions Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness, respectively — similar to what has been found for the original instrument. The mean raw scores for the MZ twins for these five dimensions can be seen in Table 1.

Difference scores within twin pairs for the single personality dimensions were calculated as the absolute difference in raw scores between twins A and B. A difference score for the composite profile of the five Big Five personality dimensions was calculated as the Euclidean distance in raw scores in

Table 1

Descriptive Data for NEO-PI-R Dimension Raw Scores in the Group of MZ Individuals (N = 57)

NEO-PI-R dimension	Mean	*SD*
Neuroticism	80.51	16.38
Extraversion	114.44	16.14
Openness	102.77	16.41
Agreeableness	124.98	14.94
Conscientiousness	115.02	17.69

Note: 57 MZ individuals made up of 28 twin pairs and one single twin.

Table 2

Descriptive Data for Personality Difference Scores Within MZ Twin Pairs (N = 28 Pairs)

Big 5 factor	Mean within-pair absolute raw score difference	Intraclass correlation
Neuroticism	14.79	0.21
Extraversion	12.46	0.54
Openness	10.79	0.64
Agreeableness	14.04	0.35
Conscientiousness	13.46	0.57
5-factor profile[a]	34.45	—

Note: n = 28 MZ twin pairs.

[a]Multivariate Euclidean distance in 5-dimensional space.

five-dimensional space, between twins A and B. Descriptive statistics for personality difference scores within MZ twin pairs are shown in Table 2.

Qualitative Data for Case Examples

For the case examples we used descriptive data concerning the family situation, parent-twin relations, twin-twin relations, twins' social life, education, and partnership relations. The data had been collected in the interviews with the participants' mothers at all the home visits; as well as in interviews with the twins themselves at the ages of 15 and 29.

Results

Quantitative Analyses

When each twin was treated as an individual, the only significant correlation between the stressor score at age 6 to 15, and personality at age 29, was a positive correlation with Openness (Table 3). As individuals, twins who had experienced more stressors in childhood and early adolescence were more likely to have higher scores on Openness.

Correlations between the measure of shared stress, and personality difference scores are shown in Table 4. As can be seen, there was a significant correlation between stressors at age 6 to 15, and personality differences within MZ twin pairs, for the dimensions Openness, Agreeableness, and Conscientiousness, as well as for the multivariate difference

Table 3

Prediction of Individual Adult Personality From Life Stressors in Childhood and Early Adolescence

NEO-PI-R dimension	Correlation with life stressors
Neuroticism	.03
Extraversion	.03
Openness	.31*
Agreeableness	.04
Conscientiousness	.03

Note: n = 53.

*p < .05 (two-tailed)

Table 4

Correlations Between Life Stressors at Age 6 to 15, and Within-Pair Differences in Self-Reported Big Five Personality Factors at Age 29

Intrapair difference score, NEO-PI-R dimension	Correlation with life stressors
Neuroticism	.16
Extraversion	–.04
Openness	.37*
Agreeableness	.53**
Conscientiousness	.37*
5-factor profile	.49**

Note: n = 26 MZ twin pairs.

*p < .05 **p < .01 (one-tailed)

on all five dimensions. Twin pairs who had shared more stressors at ages 6 to 15, tended to be more different in personality at age 29. To further illustrate the relationship between stressors and personality differences, Figure 1 shows a scatterplot of the relationship between the stressor score and intrapair multivariate differences on the five personality dimensions, and Figure 2 shows a scatterplot of the relationship between the stressor score and MZ intrapair differences in Agreeableness. (Twin pairs described qualitatively below, are marked in the figures.)

Case Examples

To illustrate the relation between type of stress and within-pair differences in personality, four cases are presented. The two twin pairs with the combined highest stress score and the largest total difference in personality (pairs A and B), and the two twin pairs with the combined lowest stress and the smallest difference in personality (pairs C and D) were picked out (Figures 1 and 2, and Table 5). Accidentally, each of the two groups had one pair of each sex. The question was whether it was possible to find any signs in the developmental history that might generate some hypotheses for the processes leading up to intrapair differences in adult personality.

All four pairs came from middle-class families, with a reasonably good income and parents with secondary or

Table 5

Stressors and Personality for Four Selected Twin Pairs

Twin pair	Stressor score	Twin	Big Five factor T-scores N	E	O	A	C
A	0.85	Trine	52	127	133	154	157
		Anne	80***	117	98***	119***	149
B	0.62	Ola	107	92	83	162	144
		Per	92*	110*	106**	131***	117**
C	0.00	Hans	71	118	88	128	124
		Ulf	69	102*	85	123	126
D	0.15	Ellen	87	109	90	115	101
		Gro	81	109	79	120	97

Note: * p < .05 ** p < .01 *** p < .001 (two-tailed) for difference between two independent single test scores based on sample means and standard deviations, and normative study reliability estimates of scales.

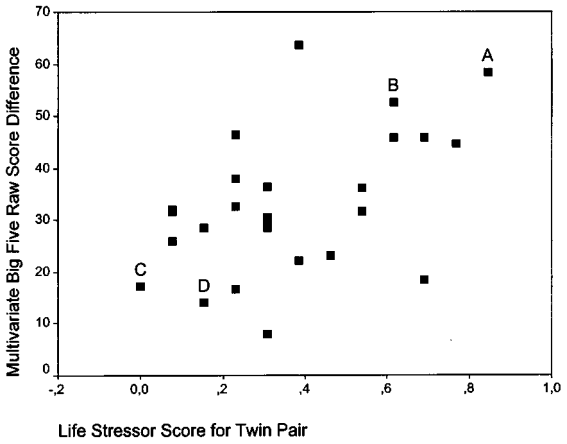

Figure 1

Big 5 Profile withinpair difference scores by life stressor score.

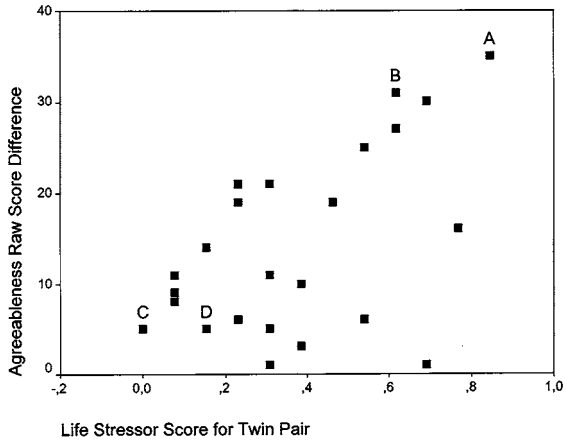

Figure 2

Agreeableness withinpair difference scores by life stressor score.

higher education. All four pairs were dressed more or less alike in childhood, and were in the same class at school. None of the eight twins had a birth weight below 2000g, and none had severe perinatal complications.

Pair A. In the discordant MZ female pair with high stress, some differences could be seen already from infancy on. The parents saw Trine as resembling her mother's family, while Anne seemed to resemble the relatives on her father's side. When the girls were six years old, this pattern was even more obvious. Trine was now also rather more attached to her mother, while Anne was closer to her father. Trine was more open and social and others saw her as the more dominant of the two. Anne was the one who was quick to please her parents. At the age of 15, Trine was better at sports and music, more dependent on her group of friends, and more fashion-minded. Anne spent more time doing her school homework, and had few, but stable friends. Both girls went through a phase of twin differentiation in puberty. When they reached puberty, their father started having problems with alcohol, the parents divorced, the family moved, and began having financial difficulties. Prior to this, there had been conflicts between the parents and the mother was depressed. At 29 years, in retrospect, Trine's life after puberty had been varied and rich in different experiences. She was now a single career woman. Anne continued her stable life style. She started dating later, but had from the beginning a steady relationship to one boyfriend. She married young and had children. At age 29, Trine was significantly less Neurotic, more Open, and more Agreeable than Anne (Table 5).

Pair B. The discordant MZ male pair with high stress, Ola and Per, lived in a more turbulent family with several siblings from birth on. From infancy onwards the boys were very active. Both were thought to resemble their paternal grandfather, but neither one was reported to be more attached to one of the parents, in infancy, or later. At age six, both resembled their father, in looks and in personality. Ola was rather more pleasing towards the parents, while Per wanted more often to be hugged and to sit on his parents' lap. The twins were very dependent on each other and spent all their time together. They were both highly active, and shy in front of strangers, but Per was consistently more outgoing and dominant. At puberty, these twins were very close, they had the same sporting interests, the same friends, and they never had a wish to be different from each other. In pre-puberty, the twins' mother fell seriously ill, and was somewhat depressed afterwards. As adults both twins became craftsmen, but in different trades. Their mother died a few years before the last follow-up. Ola's development had been more stable than his brother's. At the time of the interview, he was married and well settled, while Per had an outgoing social life, had several short-lasting relationships, and he also had some problems with alcohol. At age 29, Ola was significantly more Neurotic, less Extraverted, less Open, more Agreeable, and more Conscientious than Per (Table 5).

Pair C. The concordant pair with low stress, Hans and Ulf, grew up in a closely-knit family where both parents worked. In infancy they were both thought to look like their father and to be like him in personality — Ulf a little more so than Hans. At six years, Hans was more attached to his mother, and Ulf to his father. They were both slow-to-warm-up children, but Hans was seen as more outgoing and dominant. He was the leading one of the two, but when they got into trouble, Ulf took over and helped his brother out. They were very similar and always together. Throughout his childhood years, Hans remained more sociable and outward directed than his twin brother whom he also dominated. He was also emotionally more open and more attached to his mother than his brother. Ulf was more independent, more successful and concentrated at school, and he helped his brother with his homework. At the time of puberty, Hans was the one who most actively wanted to differentiate himself from his twin, and they went through a distinct phase of differentiation. As adults, they had about the same education. They were both married and had children, and both planned to settle down close to their parents' home. At age 29, the twins were very similar on all personality dimensions, except that Hans was more extrovert than Ulf (Table 5).

Pair D. The female concordant pair, Ellen and Gro, grew up in a conventional and orderly family with a housewife as a mother. In early infancy Ellen was more like her father in that she was quiet and patient. Gro cried more and could not wait. At six, Ellen was thought to look like her father. Both of them, especially Gro, were more attached to their mother. At six, Gro was the more dominating one toward her twin. She seemed to be the more outgoing and independent one of the two, but she was dependent on her sister's presence when it came to anything serious. While Gro liked having her sister nearby, Ellen was tired of being a twin.

At age 15, their mother reported that at school, Ellen was more independent and concentrated. Gro was more social, more openly emotional, and showed more initiative and action. They were always very close. They did not have a distinct period in adolescence when they wanted to be different, except that Ellen partly wanted them to dress differently. They both moved away from home at an early age, had early steady boyfriends, and at the time of the adult interview they had been married for several years, to two men who had been close friends. Both twins had children. They had the same kind of education and similar work experience. They lived not far from each other and spent much of their spare time together.

Pair D did not differ significantly on any personality dimension at age 29 (Table 5).

Comments on Case Examples

Parent relationship. Based on a reading of some of the earlier literature, one might hypothesise that different parental identifications would lead to a later difference in personality (Schave & Cirello, 1983). This pattern did not emerge in our in-depth study of four twin pairs. Different attachment patterns to the parents could be seen both in one pair with much stress and great personality difference (A), and in one pair with little stress and small personality difference (C). The reason for a high stress score in pair A, however, was directly related to the father and a conflict between the parents. When life stress is directly related to parents to whom the twins are differently attached, this may enhance the possibility of a differentiating effect.

Twin relationship. Considering the relations between dominance and later psychopathology referred to in the literature (Tienari, 1963), one might hypothesise that dominance in childhood would influence later personality, but this did not seem to be the case. More or less clear dominance patterns were seen both in pairs with much stress and great personality difference, and in pairs with little stress and small personality difference. The clearest pattern was seen in pair C, who became very similar in adult personality.

Whether the twin pairs had gone through a twin-differentiating period in adolescence also varied within the groups. There was least evidence to suggest that such a process had been effective both in pairs B (high stress and great personality difference) and D (low stress and similar in personality). One hypothesis emerging from the observations regarding twin pair B, could be that Per, who was clearly the most dependent within the undifferentiated pair, experienced the stress related to family members more negatively than his brother, and that these experiences consequently made it difficult for him to find new attachments.

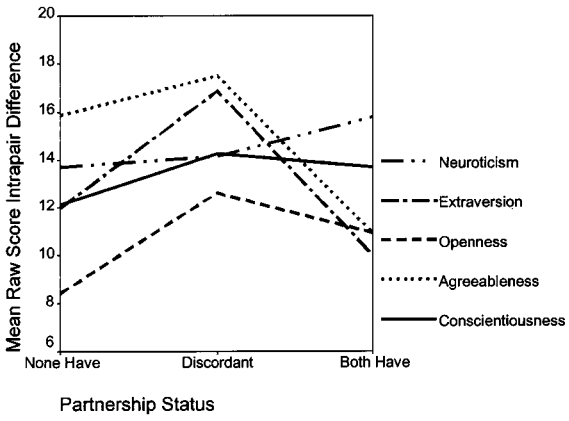

Figure 3

Personality withinpair differences in MZ twin pairs where none, only one, or both of the twins have a stable partner.

Partnership. The most striking difference between the similar pairs versus the different pairs, was the difference in adult partnership. In both different pairs one twin had a stable partner, the other not. To see whether this hypothesis would hold true for the whole group, we conducted a post hoc comparison of intrapair personality differences by partnership status, in the total group of 28 MZ twin pairs who also answered the NEO PI-R questionnaire. 34 of these twins had at the time of the interview lived with a stable partner for one year or more, and 22 individuals were single. Eight twin pairs were discordant for stable partner; in 13 pairs both had partners, while in 7 pairs none of the twins lived with a stable partner. No statistically significant differences in personality were found between these three groups. However, as can be seen from Figure 3, the emerging pattern was that pairs discordant for a stable partner, tended to be more different in personality than pairs concordant for partner. This held true for all personality factors except for Neuroticism. The hypothesis that discordant partner status is associated with larger personality differences, should be examined further in a larger sample. Careful longitudinal analysis might even elucidate the direction of causation between discordance in personality and discordance in partnering (Posner et al., 1996).

Discussion

The present longitudinal study showed that personality differences between adult MZ twins were related to familial stress factors shared by the twins in childhood and early adolescence. MZ twins with a history of high-stress family environment in these years became more different in adult personality than twins from low-stress families. The personality differences related to shared life stressors which we found, were significant for the total difference in the Big Five personality dimensions, as well as for the single personality dimensions Openness, Agreeableness, and Conscientiousness.

The results showed that with higher early stress the twins were more open to experience. Although this is in accordance with impressions from the interviews, we have no explanation of these results. One hypothesis is that it might be related to specific coping strategies used in MZ twin pairs.

We used data from a prospective, longitudinal study. The measure of life stressors was taken from questionnaire self-reports and interviews with the subjects and their mothers at age 15, and coded into numeric variables long before the follow-up self-report personality measures were collected. Adult personality measures were collected using a standardised self-report measure, and there seems to be little to suggest that shared method variance or experimenter bias could account for the associations found. Our sample was small, and the measure of life stressors relied to some extent on coders' inference. Our results should be interpreted with caution until replicated in other studies. Bearing these shortcomings in mind, the findings of the present study remain noteworthy in several respects.

The present study shows how the same family environment is associated with two siblings with the same genetic endowment becoming different. The fact that more life stressors seemed to make MZ twins more different in personality, is thus an example of shared events having what is labeled as a "nonshared" environmental effect in the conventional behavior genetic terminology. This result should be a reminder of the fact that "shared environment" in behavior genetic studies, means a similar reaction to environmental influences, but it does not imply that shared family environment is of no importance, as Plomin, DeFries, et al. (2001; p. 74) also point out. In fact, while the results obtained from research in behavior genetics during the last decades are of great interest by showing how family environmental factors have an individualising effect on siblings (rather than influencing siblings in the same direction), the concepts of "shared" and "nonshared" environment may mislead readers to conclude that common environment is of no importance.

Any single convincing hypothesis for the intervening processes between high stress in late childhood and differences in adult personality was not expected. However, that the predictions from childhood within-pair differences in parent relationship, or dominance pattern, were not supported, was of interest. One possible explanation might be that such different relational experiences in combination with high stress could have an influence on later attachment experiences.

The most striking difference between the two example twin pairs with high personality differences and high stress on the one hand, and the pairs similar in personality and with low stress on the other, was perhaps that the low-stress, similar, twins were all married with children when they were interviewed at age 29. They had also lived a stable life, and had settled down in their new homes close to their parents' homes. Their education was quite similar. In contrast, in both pairs with high stress and great personality difference in adulthood, one of the twins was without a stable partner, while the other was married. In these two different pairs, one pair had a different attachment to the parents, and the other pair had an unresolved twin relationship. The combination with high stress experiences may be one reason for their different partner relations as well as for their difference in personality. The results are in the same direction as shown for depression in female twins. In a study by Heath et al. (1998), results suggested that having a stable partner acts as a protective factor in reducing the impact of inherited liability to symptoms of depression in the general population (Heath et al., 1998).

Our case examples suggest that parental divorce or loss, as well as one twin having a stable partner in adulthood and not the other, might play a role in creating personality differences. Divorce, marital conflict, and difficulties in finding and keeping a partner are related to personality in various complex ways. Parents who have unstable relations, are more likely to have children with relational problems than parents with stable relations, and if stability in relations does play a role for personality development, factors like these might have had an influence on the twin differences.

The fact that there exists a relation between two variables (such as between life stressors at one particular time and later personality differences) does not of course imply that the one must have caused the other. While our results seem to suggest that life stressors do influence personality differences, the relationship may in reality be more complicated, involving complex interactions between common familial experience and individual environmental differences. What is certainly true is that we have not in any satisfactory way assessed the intervening processes that might explain more precisely how family stress could influence twins to diverge in personality. While our qualitative descriptions of a number of extreme cases yield a number of reasonable hypotheses for further study, the limitations of our sample will unfortunately preclude any formal testing of more complicated models. This task constitutes a challenge for future research.

Pending further solid evidence which would elucidate the causal relationships involved, it may be appropriate to make some remarks concerning the possible influence of life stress on personality differences. First, life stress as it was conceptualised in our study, is not a specific event, but a broad class of environmental circumstances, which may be thought to have a cumulative effect on the individual (Rutter et al., 1999). It is difficult to think that this type of life stress should "cause", by any specific mechanism, specific personality differences. Instead, it is more natural to consider that increased stress would generally have a greater impact on the type and the intensity of the individual's interactions with his or her environment (i.e., that increased stress intensifies, modifies, or alters phenotype-environment interaction). If stress acts as a catalyst to phenotype-environment interaction, then preexisting minor phenotypic differences between twins could be the departure point for growing differences in personality, as self-organising mechanisms of complex systems are brought to action at an increased rate (Turkheimer & Waldron, 2000). Preexisting differences between twins may become particularly accentuated when differences play an important role in the competition for resources or for environmental

niches in a family environment marked by crisis or conflict. There seems to be an increasing awareness that the importance of genotype X environment interaction effects has received insufficient attention. An example of this is reported in a recent study of the etiology of substance use disorders (Heath et al., in press). The same might be true also for interaction effects between common family environment and individual environmental factors.

It is uncontroversial to state that genes and environment contribute to individual differences in personality. The contribution of the present investigation is to suggest, contrary to what has been assumed in the behavior genetic literature in later years, that environmental events shared by siblings may indeed influence personality differences. The fact that the influence of the types of shared events studied here seems to cause MZ twins to become more different, may signify that even genetically identical persons differ in how they experience and act upon one and the same event. As research now progresses from partitioning outcome variance into portions mistakenly thought to indicate different sources of environmental influence, one very important task seems to be to attempt a fuller understanding of the processes of phenotype/environment interactions taking place as the individual differences in personality are developing.

Acknowledgement

The Research Council of Norway supported the present research (122837/320). We thank H. Nordvik, Laila Eriksen, and PAR Psychological Assessment Resources for their kind permission to use the Norwegian translation of the NEO-PI-R inventory in this study, and Dag Erik Eilertsen for extensive help with preparing data for the present study.

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