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Change in Cohabitation and Intrapair Similarity of Monozygotic (MZ) Cotwins for Alcohol Use, Extraversion, and Neuroticism

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We have reported cross-sectional evidence that behavioral similarities of adult monozygotic (MZ) cotwins are associated with their age at initial separation and the frequency of their subsequent social interaction (Kaprio et al., *1987; Rose* et al., *1988; Rose and Kaprio, 1988). Twins who separated early and twins in infrequent interaction were less alike. Data for those reports came from a 1981 survey of the Finnish Twin Cohort. The Finnish cohort had been surveyed in 1975 with a similar questionnaire, and we now report a longitudinal analysis of the 1975–1981 surveys. All cohabiting MZ cotwins, ages 18–25 at the 1975 baseline, were followed up in 1981, and pairwise similarities at baseline and follow-up were compared for three groups: MZ pairs that remained cohabiting, separated pairs in which the cotwins retained regular contact with one another, and separated cotwins whose social interactions at follow-up were infrequent. For alcohol consumption and EPI Neuroticism scores, relative similarities of the MZ cotwins at follow-up paralleled the relative frequencies of their social contact; baseline differences in resemblance for Extraversion scores preceded follow-up differences in social interaction. These findings clarify the directional nature of associations found in our cross-sectional data and provide new, more compelling evidence of effects of shared experience on sibling resemblance for some dimensions of adult behavior.*

KEY WORDS: monozygotic (mz) twins; shared experience; alcohol use, personality.

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INTRODUCTION

Influential analyses of twin (Loehlin and Nichols, 1976) and adoption (Scarr and Grajek, 1982) data have fostered the hypothesis that experiences shared by siblings while growing up together have a negligible influence on their adult behavioral similarities. That hypothesis was advanced with a hint of incredulity a dozen years ago, (Loehlin and Nichols, 1976, pp. 91–92), but now it is accepted as a general finding, no longer surprising, and no longer limited to personality traits, but applicable to all dimensions of adult behavior (Plomin and Daniels, 1987). Individual differences across a diverse array of behavioral traits are attributed to moderate heritabilties, with negligible effects from common environment: experiences unique to individuals constitute the only systematic source of environmental influence on behavioral development and account for much, if not most, of the observed variability. That is conventional wisdom.

However, recent cross-sectional data from the population-based Finnish Twin Cohort provide some evidence of a significant, albeit modest, effect of common experience. Frequency of social interaction of adult twin brothers was significantly predictive of similarities in their self-reported patterns of social drinking (Kaprio *et al.*, 1987); hierarchical multiple regression analyses of the frequency, quantity, and density of drinking among >2800 pairs of twin brothers, ages 24–49, revealed a significant effect of frequency of social contact after the effect of twin type had first been removed. Analyses of neuroticism (N) scores revealed similar effects (Rose *et al.*, 1988) in twins of both genders and both zygosities, and restricting the analyses to monozygotic twin pairs, to eliminate genetic confounds, we (Rose and Kaprio, 1988) documented a linear association of pairwise similarity with age- at -separation and frequency of subsequent social contact. Data from Sweden's population-based twin registry (Medlund *et al.*, 1977) provide independent evidence that resemblance for N scores among adult MZ twin pairs correlates with their frequency of social contact. And an analysis of 200 Australian adult twin pairs, recently reported by Heller *et al.* (1988), confirms our finding that the frequency of cotwins' social contact is associated with their concordance for alcohol use and other life-style variables;

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the Australian investigators scaled twins' social contact into five categories from "almost every day" to less often than "a few times a year"; in both MZ and DZ cotwins, this pairwise measure of "current shared environment" consistently correlated with pairwise concordance for patterns of alcohol consumption, smoking, and exercise.

These cross-sectional analyses, however, fail to address the direction of effect in the association of social contact with adult similarity. Are the differences in adult similarity cause or consequence of the associated differences in social interaction? We (Rose *et al.*, 1988) suggested that change in similarity follows change in social interaction—that twins who separate at an early age, or who interact infrequently after separation, will be less alike than pairs who have shared more of their lives together. But we could not dismiss the alternative argument that differences in similarity precede differences in social interaction—that twins who are less alike in adolescence separate at an earlier age and less frequently interact as adults. As a consequence, we presented our correlational data with due caution (Rose and Kaprio, 1988, p. 324), anticipating that the data would be unconvincing to many (e.g., Loehlin *et al.*, 1987; Plomin and Daniels, 1987; Lykken, 1987). To help resolve the issues, we now present longitudinal data from the Finnish Twin Cohort.

All twin pairs in the Finnish Cohort were surveyed in 1975 and, again, in 1981. The cross-sectional data which formed the basis for our earlier reports were obtained in the 1981 survey. A very similar questionnaire was administered in 1975, and the items dealing with alcohol consumption, cohabitation status, frequency of social contact with cotwin, and the abbreviated version (Floderus, 1974) of the Eysenck Personality Inventory were identical in the two surveys. From the computer data files of these two surveys, we analyzed a 6-year follow-up of all young MZ twin pairs who were cohabiting during baseline testing in 1975. We restricted the analysis to MZ cotwins in order to eliminate genetic variation within pairs; interpretation of results from a parallel analysis among dizygotic cotwins would be ambiguous, because DZ pairs differ in genetic similarity and *that* difference could create both decreased social contact and decreased behavioral resemblance.

METHOD

Sample

We identified all monozygotic twin pairs in the Finnish Cohort who, at baseline testing in 1975, were living together, were 18–25 years of age, and who jointly participated in the follow-up survey during 1981 ($N > 550$ pairs). As described elsewhere (Kaprio *et al.*, 1979), the completeness of Finnish population registries from which the twin cohort was formed and the compliance

of Finnish MZ twins to mail surveys ensure that the sample on which we report include >90% of all eligible, living MZ twins in this age range in the entire country.

Measures

The 1975 and 1981 surveys included abbreviated forms of the Neuroticism (N) and Extraversion (E) Scales of the Eysenck Personality Inventory developed by Floderus (1974) and subsequently used in both Swedish (Floderus-Myrhed *et al.*, 1980) and Finnish (Rose *et al.*, 1988) twin studies. Social drinking measures common to the two population-based twin studies (described by Kaprio *et al.*, 1987) were also included in both the 1975 and the 1981 surveys, and in 1981 twins were asked for their age at separation and the frequency of their social contact, by telephone or in person, subsequent to separation.

Analyses

Based on the twins' reports to the 1981 follow-up survey, we classified the MZ pairs into three groups: those still living together, those who had separated but remained in frequent (daily or weekly) contact with each other, and those whose contact at follow-up was infrequent or rare (once a month or less often). The classification permits a direct test of the competing interpretations of the association found in our cross-sectional analyses. As suggested in Table I, if pairwise similarity is a consequence of social contact, differences in similarity will be found only at follow-up and not at baseline; conversely, if differences in similarity cause variation in social contact, differences in similarity will be evident at baseline.

Table I. Patterns of MZ Twin Correlations Expected Under Alternative Interpretations of the Association of Twins' Social Contact with Their Intrapair Similarity: Correlations for MZ Finnish Twin Pairs Who Were Cohabiting During Baseline Testing in 1975 and Subsequently Categorized by Frequency of Their Social Contact During Follow-Up, 6 Years Later

	Social contact pattern in 1981		
	Remained cohabiting	Frequently in contact	In contact but rarely
If frequency of social contact is a causal factor in the twins' adult similarities			
Baseline correlation	High	High	High
Follow-up correlation	High	Mod.	Low
If differences in social contact arise from differences in twins' similarities			
Baseline correlation	High	Mod.	Low
Follow-up correlation	High	Mod.	Low

We first restricted the analysis to cohabiting MZ pairs aged 18–21 at baseline, but to obtain adequate sample size for that limited age range, we collapsed on gender. Then, to obtain samples of adequate size to test whether effects of social contact differ by gender (Heath *et al.*, 1989a), we extended the age range at baseline to 25 years. Twins who fail to separate by that age may, however, be atypical, given that only 13% of Finnish MZ twin brothers and <17% of Finnish MZ twin sisters ≥24 years old were cohabiting at baseline. Because of missing data (and our decision to delete pairs with incomplete replies to the abbreviated personality scales), sample *N*'s differ by variable; the data are most complete for alcohol use: 539 MZ pairs, 261 male and 278 female pairs, were ages 18–25 at baseline; restricting on age and collapsing on gender, there were 409 cohabiting MZ pairs, ages 18–21, for whom we have data on alcohol consumption.

RESULTS

Figures 1–3 illustrate our test of the competing hypotheses framed in Table I. Intrapair correlations at baseline and at follow-up for data from the combined sample of 18- to 21-year-old MZ twins are illustrated. There were no significant differences in pairwise resemblance at baseline for twins grouped by their social contact status at follow-up. But at follow-up, the intraclass correlation for alcohol use among twin pairs in rare contact was lower than that for twins in frequent contact, and resemblance for both of these separated groups of twins was significantly lower than that for pairs continuing to live together. No significant change in cotwin similarity was observed for pairs whose social status did not change over the 6-year follow-up. For neuroticism (N) scores, a similar pattern was found: comparable correlations at baseline and a linear decrease in similarity with decreasing contact at follow-up. For N scores, however, differences at follow-up failed to achieve significance. For extraversion scores, group differences in correlations were evident at baseline, and these differences persisted, but were no larger, at follow-up; young MZ cotwins discordant for extraversion may be more likely to socially drift apart during a subsequent 6-year period of young adulthood. Developmental differences in social interaction among twin pairs may also relate to their pairwise differences in baseline means, as suggested in Table II; MZ twins who remain in close contact consume less alcohol and report less anxiety at ages 18–21 than do MZ cotwins who subsequently drift apart.

Intraclass correlations at baseline and follow-up, and means at baseline, for 18–25 year olds separated by gender are shown in Table III for MZ twin sisters and in Table IV for MZ twin brothers. The results are consistent with those found for the younger subgroup collapsed on gender; for neuroticism and alcohol use, decreased social contact is associated with decreased resemblance,

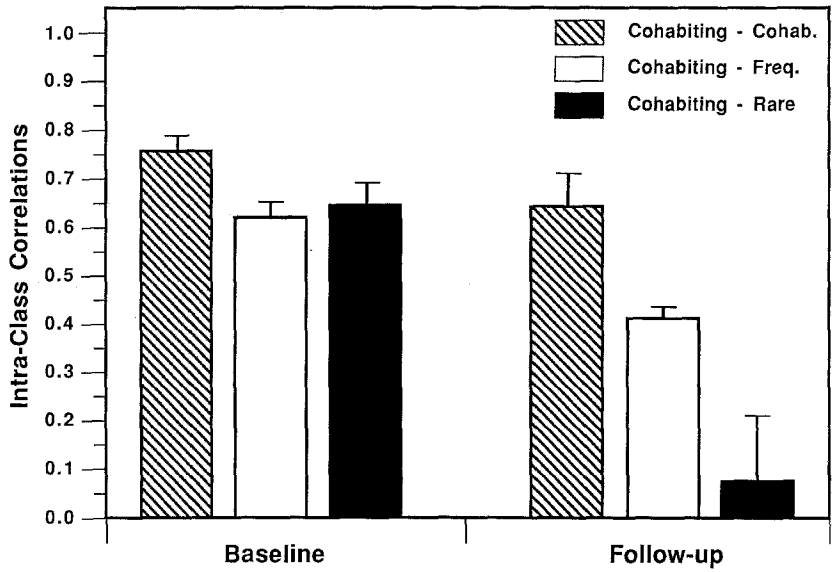

Fig. 1. Intraclass correlations (±SE) for alcohol consumption among MZ twin pairs, aged 18–21 and living together during the baseline survey in 1975, categorized by frequency of their social contact at follow-up in 1981. Cotwins yet cohabiting (Cohabiting—Cohab.) are contrasted with separated pairs whose social contact at follow-up is daily or weekly (Cohabiting—Freq.) and separated pairs reporting contact no more often than 1× monthly (Cohabiting—Rare). Data for twin brothers and sisters were combined.

while for extraversion, lower resemblance precedes diminished social contact. The effects are more evident in sisters than in brothers: MZ twin sisters categorized by variation in their social contact significantly differ in resemblance for all three measured variables. In contrast, significant differences for men were found only for alcohol use and only among the two groups at the extremes of social contact. Baseline differences in group means were observed for all three variables studied. Among both male and female twin pairs, those who, at follow-up, are more socially separated, were, at baseline, more neurotic and more extraverted, and they consumed greater amounts of alcohol. The number of MZ pairs whose social relationship, over 6 years, shifts from cohabitation to rare contact is, not surprisingly, modest, and standard errors for the pairwise correlations for that subgroup are large.

DISCUSSION

These prospective data indicate that, for some behaviors, changes in social contact between monozygotic cotwins precede (and causally contribute to) changes

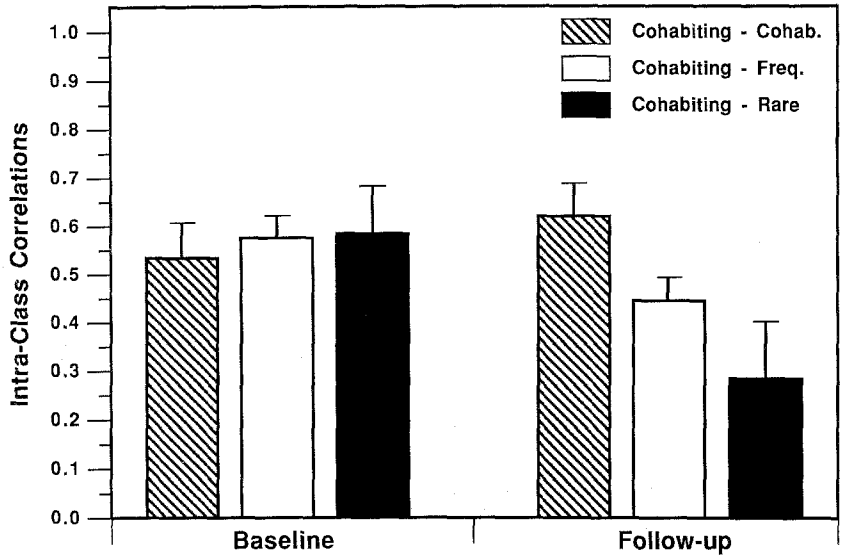

Fig. 2. Intraclass correlations (±SE) for Neuroticism scores among MZ twin pairs, aged 18–21 and living together during the baseline survey in 1975, categorized by frequency of their social contact at follow-up in 1981. Cotwins yet cohabiting (Cohabiting—Cohab.) are contrasted with separated pairs whose social contact at follow-up is daily or weekly (Cohabiting—Freq.) and separated pairs reporting contact no more often than 1× monthly (Cohabiting—Rare). Data for twin brothers and sisters were combined.

in their intrapair similarity. For cohabiting MZ twins aged 18–25, we found no differences in baseline resemblance for neuroticism and alcohol use between pairs who had little social contact 6 years later and pairs who remained living together. But at follow-up, pairwise resemblance of those now living apart had significantly decreased, in the absence of change for pairs continuing to live together. This observation supplements our earlier analyses of cross-sectional data relating the frequency of twins' social contact to their intrapair similarity for alcohol use (Kaprio *et al.*, 1987) and personality (Rose *et al.*, 1988, Rose and Kaprio, 1988). Our cross-sectional data left the causal direction unresolved: Does decreasing social contact lead to decreasing twin similarity, or do twins who happen to be less similar (due to chance environmental effects) associate less, as a consequence (Loehlin *et al.*, 1988, p. 111)? The longitudinal data presented above suggest that both mechanisms operate, depending on the behavioral variable studied. Our results suggest that decreased social contact precedes, and causally contributes to, decreased intrapair similarity for neuroticism and alcohol use, while for extraversion, unshared environmental experiences attentuate twins' intrapair similarities prior to their separation, and the decreased

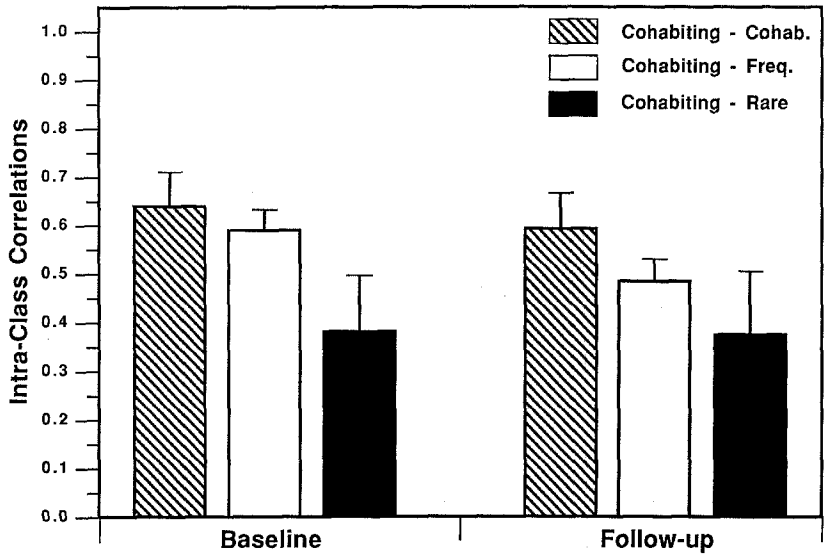

Fig. 3. Intraclass correlations (±SE) for Extraversion scores among MZ twin pairs, aged 18–21 and living together during the baseline survey in 1975, categorized by frequency of their social contact at follow-up in 1981. Cotwins yet cohabiting (Cohabiting—Cohab.) are contrasted with separated pairs whose social contact at follow-up is daily or weekly (Cohabiting—Freq.) and separated pairs reporting contact no more often than 1× monthly (Cohabiting—Rare). Data for twin brothers and sisters were combined.

Table II. Sample *N*'s and Baseline Means (±SD) for Alcohol Consumption (Grams/Month), Neuroticism (10 Items), and Extraversion (9 Items) for MZ Twins, Ages 18–21 and Living Together at 1975 Baseline, Categorized by Frequency of Their Social Contact Upon Follow-Up in 1981 (Data Are for Twin Brothers and Sisters Combined)

	Social contact at follow-up in 1981		
	Cohabiting	Frequent contact	Rare contact
Alcohol consumption			
Sample *N*	90	268	67
Baseline mean	131.2 ± 279.4	205.8 ± 328.1	244.5 ± 286.1
Neuroticism Scale scores			
Sample *N*	79	249	45
Baseline mean	3.94 ± 2.59	4.41 ± 2.49	4.68 ± 2.50
Extraversion Scale scores			
Sample *N*	83	255	49
Baseline mean	4.30 ± 2.23	4.77 ± 2.27	4.58 ± 2.41

social contact observed at follow-up may be a consequence, rather than a cause, of the twins' reduced similarity. Our analyses also suggest that decreased adult

Table III. Intraclass Correlations in 1975 and 1981, Sample *N*'s, and 1975 Baseline Means for Alcohol Consumption, Neuroticism, and Extraversion; Data for MZ Twin Sisters, Who, at 1975 Baseline, Were 18–25 and Living Together, Categorized by Frequency of Their Social Contact in 1981

	Social contact at follow-up in 1981		
	Cohabiting	Frequent contact	Rare contact
Alcohol consumption			
Sample *N*	61	189	28
r in 1975	.851 ± .035	.538 ± .052	.741 ± .085
r in 1981	.778 ± .051	.448 ± .058	.147 ± 1.84
Baseline mean	121.6 ± 26.9	145.9 ± 9.5	194.8 ± 27.2
Neuroticism Scale scores			
Sample *N*	58	175	27
r in 1975	.626 ± .080	.576 ± .049	.651 ± .110
r in 1981	.708 ± .065	.414 ± .062	.372 ± .166
Baseline mean	4.543 ± .238	5.043 ± .129	5.296 ± .336
Extraversion Scale scores			
Sample *N*	60	178	27
r in 1975	.697 ± .066	.586 ± .049	.426 ± .158
r in 1981	.728 ± .061	.402 ± .062	.262 ± .179
Baseline mean	4.133 ± .226	4.365 ± .132	4.454 ± .286

Table IV. Intraclass Correlations in 1975 and 1981, Sample *N*'s and 1975 Baseline Means for Alcohol Consumption, Neurotocism, and Extraversion; Data for MZ Twin Brothers, Who, at 1975 Baseline, Were 18–25 and Living Together, Categorized by Frequency of Their Social Contact in 1981

	Social contact at follow-up in 1981		
	Cohabiting	Frequent contact	Rare contact
Alcohol consumption			
Sample *N*	67	155	39
r in 1975	.762 ± .051	.597 ± .052	.826 ± .051
t in 1981	.519 ± .089	.413 ± .066	.161 ± .158
Baseline mean	217.4 ± 27.2	321.4 ± 24.9	376.2 ± 62.8
Neuroticism Scale scores			
Sample *N*	53	141	33
r in 1975	.358 ± .120	.496 ± .063	.524 ± .126
r in 1981	.517 ± .100	.428 ± .068	.242 ± .164
Baseline mean	3.028 ± .225	3.634 ± .143	3.940 ± .302
Extraversion Scale scores			
Sample *N*	55	136	35
r in 1975	.708 ± .067	.519 ± .062	.400 ± .142
r in 1981	.414 ± .112	.480 ± .066	.268 ± .156
Baseline mean	4.180 ± .209	5.048 ± .138	4.436 ± .286

social interaction among monozygotic cotwins can be predicted from individual means and pairwise correlations on dimensions of personality (neuroticism/introversion) and behavior (social drinking).

We conclude with three comments. The first is that the magnitude of effect that twins' social contact exerts on adult cotwin resemblance is modest. One appreciation of that fact comes from hierarchical multiple regression (HMR) analyses of double-entry twin data, in which each twin's behavior is predicted from that of the cotwin in interaction with the pairs' zygosity and social contact; our HMR analyses of Finnish twin data ([cf. Kaprio *et al.* (1987) for alcohol consumption and Rose and Kaprio (1988) for E and N scores]) reveal that social contact accounts for but a small amount of predicted variance. Yet it does so even in conservative ordering of predictive terms in HMRs, and such findings lead to our second summary comment: conventional comparisons of MZ/dizygotic (DZ) twins are confounded by MZ/DZ differences in social contact, and, for some behaviors, social contact does correlate with cotwin resemblance. Greater social contact among MZs, as we find for Finnish twins, has been reported among adult samples of MZ/DZ twins in the United States (Fabsitz *et al.*, 1978), Sweden (Medlund *et al.*, 1977), and Australia (Kendler *et al.*, 1986), and data from the United Kingdom (Clifford *et al.*, 1984), Australia (Heller *et al.*, 1988), and Japan (Hayakawa, 1987) replicate our evidence that cotwins' social contact correlates with their observed resemblance for (some) metric traits. These correlations are not large, and they are not always found. Twins' resemblances for self-reported anxiety and depression (Kendler *et al.*, 1986) and social attitudes (Martin *et al.*, 1986) were but trivially associated with their patterns of social contact. Among adult twin sisters who volunteered for the Austalian National Twin Register, a correlation between intrapair differences in alcohol consumption and frequency of social contact was found only in older MZ sisters (Heath *et al.*, 1989a), and it was of modest magnitude. Conversely, for some blood chemistries, cohabitation dramatically modulates sibling resemblance: sibling resemblance for blood lead levels was 5 × greater for cohabiting sibs than among older sibs no longer sharing a household environment (Hopper and Matthews, 1983), and similar effects of cohabitation on sibling resemblance for high-density lipoprotein cholesterol have been reported (Morrison *et al.*, 1982; Hasstedt *et al.*, 1985). These empirical findings prompt our final comment: the emerging data on cohabitation and familial resemblance should stimulate efforts to identify and assess dimensions of shared environmental experience relevant to behavioral development and to specify the traits and developmental ages for which such shared experience matters. An elegant conceptual approach for that effort has been developed by Hopper and his colleagues (Hopper and Matthews, 1982, 1983; Hopper and Culross, 1983), and analytic tools for modeling cohabitation effects are being developed at a rapid rate (Lange, 1986; Hopper *et al.*, 1987;

Heath *et al.*, 1989b). The present paper suggests that longitudinal data from population-based twin cohorts will provide rich material for these analyses.

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