

Original Article

Meeting One's Twin: Perceived Social Closeness and Familiarity

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Abstract: Perceptions of social closeness and familiarity were assessed among 44 monozygotic (MZA) and 33 dizygotic (DZA) reunited twin pairs, and several individual twins and triplets. Significantly greater MZA than DZA closeness and familiarity were found. Closeness and familiarity ratings for co-twins exceeded those for nonbiological siblings with whom twins were raised. Correlations between perceptions of physical resemblance and social closeness and familiarity were positive and statistically significant. However, most correlations between social relatedness and contact time were non-significant. Associations between social relatedness and similarities in selected behavioral traits were also examined. The findings support various theoretical perspectives anticipating greater affiliation among close relatives than distant relatives.

Keywords: twins, siblings, cooperation

Introduction

“The brothers shook hands stiffly, when they saw each other for the first time. They then hugged and burst into laughter. ‘I looked into his eyes and saw a reflection of myself . . . I wanted to scream or cry, but all I could do was laugh.’ ” (Jim Springer, *New York Times Magazine*, December 9, 1979)

The psychological literature includes numerous reports demonstrating greater cooperation and affiliation between monozygotic (MZ) twins than dizygotic (DZ) twins (Segal, 2000). These studies represent diverse viewpoints, methods and populations so convergence among the findings is compelling. Extant research can be organized into four theoretical perspectives: psychoanalytic/psychodynamic, behavioral-genetic, social-genetic and evolutionary psychological. These separate perspectives generate similar and/or related hypotheses.

Psychoanalytic and Psychodynamic Theories

Psychoanalytic and psychodynamic approaches highlight the unique effects of shared development with a physically identical sibling. Perceptions of resemblance by twins and similar treatment by others are held responsible for blurring co-twins' individuality and sense of self (Siemon and Adelman 1986). Psychoanalysts have also recognized a "twinning reaction" consisting of "mutual identification and part fusion of object and self-representation, leading to a diffusion of ego boundaries between the two individuals" (Joseph 1961:159-161). This perspective would predict a positive association between physical resemblance and social closeness.

These themes are well illustrated in Engel's (1975) moving account of the loss of his MZ twin brother. In a moving address marking the tenth anniversary of his MZ co-twin's death, psychiatrist George Engel (1975) recalled childhood nicknames (both were "oth" -- short for other) and confusion between events affecting himself and his twin.

Efforts in this area have been almost exclusively case reports and commentaries. A recurrent difficulty with these approaches is nearly exclusive focus on look-alike (presumably MZ) pairs, with lack of reference to the crucial distinction between twin types. The presumption that look-alike twins are necessarily MZ is also misconceived, given the physical variability among DZ twinships (Segal, 2000).

Behavioral-Genetic Theory

Behavioral-genetic research assesses relative genetic and environmental contributions to trait variation. Co-twin similarities in behavior would be expected to contribute to twin pair assessment and satisfaction with the twin relationship. MZ twins have shown greater *agreement* in twinship satisfaction than DZ twins, although mean ratings in some experiential features (e.g., fighting frequency) have not always differed (Loehlin and Nichols 1976). Subsequent findings support both greater "positivity" and reduced "negativity" between MZ twins, relative to other siblings (Reiss, Neiderhiser, Hetherington and Plomin, 2000). A

more recent study found similar levels of intimacy between MZ and DZ twins, but greater likelihood of MZ twins naming each other as best friends (Foy, Vernon and Jang 2001).

Behavioral genetics emphasizes *reactive gene-environment correlation*, the concept that individuals respond to, rather than create, co-twins' separate and joint behaviors. Behavioral genetics does not, however, sample the full range of explanatory domains, leaving some questions (e.g., how social circumstances modify genetic effects on social relationships) unanswered.

Social-Genetic Theory

Social genetics, a subdiscipline of behavioral genetics, addresses the proximal effects of genes on social behavior and organization (Hahn 1990, Scott 1997). It acknowledges that genotypic effects differentially influence individual and joint behaviors, underlining the contribution of interactants' genetic backgrounds to social acts and consequences (Hahn 1990). Genetically homogeneous partners (MZ twins) would be expected to show greater cooperation in problem-solving tasks, relative to genetically heterogeneous partners (DZ twins).

Exemplary of this approach is Von Bracken's (1934) early experiment, comparing the behaviors of MZ and DZ twin children working apart and in close proximity. MZ twins performed more alike when working together than apart. Among pairs showing the greatest differences when apart, the more skillful twin allowed the co-twin to catch up when together. In contrast, DZ twins were more individually motivated. Partners perceiving ability differences were unmotivated in the presence of their co-twin, given that a cutting edge for competition was lacking. However, partners perceiving matched abilities competed intensely. More recently, Segal (1997; 2002) observed greater MZ than DZ twin success and cooperation during joint puzzle completion even though all twins were individually competent. Finally, a new study of older twins demonstrated higher levels of intimacy, attachment security and support within MZ than DZ twin pairs (Neyer, 2002). In that study, MZ twins' attachment security and relationship satisfaction were unrelated to contact frequency, while the reverse was true for DZ twins.

Social genetics builds natural bridges between behavioral genetics and evolutionary psychology. So far, few studies have proceeded with this view in mind.

Evolutionary Psychology

Evolutionary psychology aims to identify psychological and physical attributes promoting survival and reproduction during the course of human history. In seminal papers, Hamilton (1964a,b) described a theoretical basis for the evolution

of altruism: Natural selection favors alleles predisposing individuals to behave in ways promoting the transmission of those alleles into later generations. Alleles influencing individuals to favor others likely to carry replicas of those alleles is an indirect means by which genes achieve future representation (i.e., inclusive fitness). The frequency with which one is predisposed to direct benefits to others should, thus, vary as a function of relative genetic relatedness. MZ twins would, thus, be expected to show greater within-pair altruism than DZ twins.

Working from this perspective, Segal and Hershberger (1999) observed more frequent cooperative trials between MZ than DZ twin adolescents and adults during a Prisoner's Dilemma game. Loh and Elliott (1998) reported greater MZ than DZ twin cooperation on a task with uncertain reward equality. Interestingly, the reverse proved true when reward equality was certain, suggesting that inconsistent dominance relations between some MZ co-twins allows competition in settings promising matched outcomes to partners.

Evolutionary psychology offers a theoretical framework capable of unifying multidisciplinary findings (Mealey 2001; McAndrew 2002). Integrating twin and other behavioral-genetic methods into this approach can facilitate tests of novel hypotheses and ameliorate concerns over inattention to behavioral variation within species.

Twins Raised Apart

Twin studies of social relatedness have been limited to twins raised together. Despite numerous publications on reared apart twins, spanning 75 years (Popenoe 1922; Mueller 1925; Newman, Freeman and Holzinger 1937; Shields 1962; Juel-Nielsen 1966; Bouchard, Lykken, McGue, Segal and Tellegen 1990; Bouchard, McGue, Hur, and Horn 1998; Kendler, Thornton, and Pedersen 2000; Kervinen, Kaprio, Koskenvuo, Juntunen, and Kesaniemi 1998), twin relationships in reunited pairs have *never* been assessed systematically. These rare pairs offer a unique model for exploring genetic and environmental underpinnings of social relatedness, at both proximate and ultimate explanatory levels.

Early reared apart twin studies and reports (Popenoe 1922: 1 MZA pair; Newman, Freeman and Holzinger 1937: 19 MZA pairs; Shields 1962: 44 MZA pairs; Juel-Nielsen; 1966: 12 MZA pairs) appended biographical details to the quantitative findings. This material is illuminating, but limited. First, DZA twin pairs were not recruited, thus precluding comparative evaluation by zygosity. Second, the quality of available information varies across cases and studies. Despite these caveats, this work has yielded some theoretically provocative trends. It appears that 40 of the 76 pairs showed close social relations as evidenced by frequent contact following reunion, satisfaction with the relationship, investigator's comments and other indicators. In contrast, 14 pairs did not display warm relations. The remaining 22 pairs were difficult to judge

because of "mixed" characterizations and/or because contact was controlled by young twins' adoptive families. In summary, nearly three-fourths of the pairs for whom information was unequivocal (40/54) developed close social relationships soon after meeting.

The rapport displayed by these previously studied MZA twins challenges the view that shared time is requisite to developing close social attachments and similar interests. Perspectives acknowledging the contribution of twins' relative genetic relatedness to their social relations would seem necessary. Mechanisms underlying social closeness and affiliation are examined below.

Social Relatedness Mechanisms

Similarity as a basis for attraction and liking is supported by numerous psychological observations. Similarities include physical, behavioral and situational features. Keller, Thiessen and Young (1996) showed that both dating and married couples assort positively for physical traits (e.g., age and bodily attractiveness) and behavioral traits (e.g., humor and imaginativeness). Married couples, however, showed greater assortment for behavioral traits, suggesting that psychological similarity contributes more importantly to relationship duration. The assortative mating literature does, in fact, include many studies showing various degrees of positive spousal assortment across measured traits (Plomin, DeFries, McClearn, and McGuffin 2001). Consistent with these findings are studies linking personality and attitudinal similarities (and perceptions of these similarities) with friendship attraction across age groups (Rosenblatt and Greenberg 1988; Eiser, Morgan, Gammage, Broos, and Kirby 1991; Rubin, Lynch, Coplan, Rose-Krasnor and Booth 1994). Rowe, Woulbroun and Gulley (1994) emphasized that friends' behavioral similarities are present prior to relationship formation.

In their classic work, Tiger and Fox (1971) asserted that members of groups are held together by symbolic processes; thus, one responds to person categories by virtue of common unifying features. Examples include the communality and support of kibbutz children (Bettelheim 1969) and bereaved relatives (Lieberman 1993).

Cultural conceptions of twins affect beliefs about their roles and relationships (Gufler, 1996; Renne and Bastian 2001). Western cultures typically associate twinship with expectations of behavioral and physical similarities, not differences (Stewart 2000). Stereotypes of twins convey the idea of extraordinary emotional closeness and intimacy between co-twins, especially those who are same-sex. These beliefs are a likely reflection of the phenotypic similarities shown by most genetically identical twins. Many people are, however, insensitive to the varieties of twinning, so apply this view equally to MZ and DZ pairs. In fact, it has been argued that "the social label 'twin,' for both types of twins, is more valid or

consequential than the label monozygotic twin or dizygotic twin" (Stewart 2000:729). Of course, not all twins and their families conform to these views either in belief or behavior.

Some evolutionary researchers have considered mechanisms shaping the infrastructure of our social relations. At the proximal level, attraction may be facilitated by *phenotypic matching*, a mechanism proposed to foster recognition of close kin. Specifically, information is learned about one's own phenotypic characteristics and those of relatives. The outcome of this learning process is an "image," "template" (Sherman and Holmes 1985) or "learned standard of appearance" (Trivers 1985) against which to assess the phenotype of an unfamiliar individual. (Accurate identification of individuals would be requisite to directing altruism toward genetically related recipients, as prescribed by Hamilton. It also lends meaning to the social-psychological view that "similarities attract.") The nature of proximal mechanisms facilitating attraction between family members does, however, warrant elaboration. A recent study demonstrated that emotional closeness partially mediates the effect of genetic relatedness on willingness to behave altruistically (Korchmoros and Kenny 2001).

It is possible that MZ and DZ twins' behavioral and/or physical similarities (and dissimilarities) and their perceptions of these features underlie emotional and cognitive processes affecting social bonding between them. This view concurs with the proposal (based on MZ twins' close attachment) that "Recognition of this sense [of 'we'] triggers a series of emotions whose net effect is tribal unity and the increased chance for altruism" (Freedman, 1979:129). Such reasoning lends fresh dimensions to psychodynamic explanations which see causal connections between twins' physical identity, treatment by others and close attachment.

The Present Study

The present study compared subjective social closeness in MZA and DZA twin pairs. It also compared twins' feelings of familiarity, defined as "how well you think you know this person." The social relationship literature draws a distinction between subjective closeness (perceptions of relationship quality) and behavioral closeness (degree and variety of interaction) (Aron, Aron and Smollan 1992). The former conceptualization was the focus of the present work.

Hypotheses were generated by evolutionary theorizing, although expected findings would support the range of theoretical perspectives presented above. The first hypothesis was that MZA twins would experience greater social closeness and familiarity than DZA twins. Second, it was expected that degree of contact prior to assessment would not be associated with social relatedness. Third, it was anticipated that twins' perceptions of their physical similarity would correlate positively with the nature of their social relations. Fourth, it was expected that reunited twins would feel socially closer and more familiar to one another than to

the unrelated siblings with whom they were raised. Associations between social relations and personality traits, interests, values and education were also of interest.

Method

Sample and Procedures

Twins were participants in the Minnesota Study of Twins Reared Apart (MISTRA). The MISTRA is a longitudinal study of twins separated at birth, reared in separate homes and reunited as adults. This project was launched in 1979 in the Psychology Department at the University of Minnesota (Bouchard, et al. 1990). The majority of twins came from the United States and Great Britain, while some came from Australia, Canada, China, New Zealand, Sweden, the Netherlands and Germany. Twins were identified by referrals from colleagues, the media, reunion registries and other sources. Participants were invited to the University of Minnesota where they completed approximately fifty hours of psychological and medical testing. A detailed description of the assessment schedule is available in Segal (2000).

The final sample consisted of 44 MZA twin pairs, 33 DZA twin pairs and 7 individual twins and triplets. Two sets of triplets were entered as three pairs each. Twins ranged in age from 16 – 70 years, with a mean age of 45.28 years ($sd = 13.68$). Age at separation ranged from 0 to 54.08 months with a mean age of 8.03 months ($sd = 12.64$). DZA twins were separated significantly later than MZA twins [$t(54.71) = -2.14, p < .05$]. Time from separation to first contact ranged from 2 years to 69 years with a mean time of 37.09 years ($sd = 14.51$). DZA twins exceeded MZA twins on this measure, a difference that approached statistical significance [$t(75) = -1.76, p < .08$]. It is likely that DZA twins' differing appearance extended their time until reunion because they were unlikely to be mistaken for one another. (The natural DZ twinning rate is approximately twice as high as the MZ twinning rate in western societies; see Bulmer [1970]. However, most DZA twins' meetings were facilitated by personal searches and/or professional assistance. In contrast, a number of MZA twin pairs were reunited because they were mistaken for one another by others.) Additional descriptive characteristics of the twins are summarized in Tables 1a and 1b.

This study presents mostly pair analyses, although some individual analyses are included. (Some inflation of p-values in individual analyses may occur due to lack of independence from paired observations.) Sample sizes vary across analyses depending upon availability of data. Adjustment was also made in individual analyses for triplets included in multiple pairings.

Table 1a. Participant Characteristics – 1

Zyg	N (Ind)	Age (Years)	SD	Min – Max	%F
MZA	89	44.33	13.48	16 - 68	64
DZA ^a	65	46.59	13.92	22 - 70	66
ALL	154	45.28	13.68	16 - 70	65

^aNote. Includes 14 twins from opposite-sex pairs.

Table 1b. Participant Characteristics – 2

Zyg ^a	N (Pairs)	Months Before Separation ^b	Separation to 1st Contact (Yrs)	Reunion to Assessment (Yrs) ^c
MZA	44-48	5.37 (9.51)	36.11 (15.14)	6.49 (11.32)
DZA	32-36	11.57 (15.85)	40.33 (12.03)	3.51 (7.87)
ALL	79-84	8.03 (12.64)	38.02 (13.89)	5.17 (9.99)

Note. ^aIncludes mostly intact, but some non-intact pairs.

^bDZA > MZA, $t(54.71) = -2.14, p < .05$; $F = 2.60, p < .01$

^cMZA > DZA, $F = 2.07, p < .05$

Measures

Zygosity was assessed by serological analyses using blood samples gathered while the twins were in Minnesota. Based on these results, plus comparison of anthropometric measures (fingerprint ridgcount, ponderal index and cephalic index), the probability of misclassifying a DZ pair as MZ is less than .001 (Lykken 1978). Serological findings were unavailable for several weeks so, with the exception of opposite-sex twins (whose sex difference classified them as DZ), participants did not know their twin type with certainty during the study.

A Twin Relationship Survey (TRS) was introduced into the standard assessment schedule in 1983. TRSs were completed independently by each twin with the assistance of a trained examiner. Several twins completed the survey by mail, a procedure that was possible given that each section contained clear instructions. Questions concerned the circumstances of separation, the nature of

the adoption experience, events surrounding the search for the twin, impressions of physical resemblance, perceptions of social relatedness and reactions to other twinship features. In some cases only one pair member took part in this phase of the study due to scheduling considerations. Given that the TRS was unavailable in the study's early years (1979-1982) approximately 25% of the twins completed it during their ten-year follow-up visit.

The present study examines twins' perceptions of initial (retrospective) and current social closeness and familiarity vis-à-vis contact time, perceived physical resemblance and similarity in measured behavioral traits.

Social Relatedness

Twins recalled their initial impression of social closeness using a six-point scale (1 = closer than best friends to 6 = less close than most people I meet for the first time). Comparable ratings were requested for current closeness, and for initial and current familiarity. (Initial ratings were retrospective and referred to the first meeting in adulthood. Current ratings reflected twins' present feelings at the time of participation in the study.) Twins also provided current social closeness and familiarity ratings for the unrelated siblings with whom they were raised, furnishing an informative comparison group. If ratings were available for more than one adoptive brother (and/or sister) the brother (and/or sister) whose score(s) reflected the highest levels of closeness and familiarity were chosen. This was done to set up a more stringent test of differences between ratings for co-twins and unrelated siblings.

The two current measures showed significant relationships with *frequency of thinking about the twin* (current closeness, .52, $p < .01$; current familiarity, .38, $p < .01$, $n = 155-156$) and *having plans to meet in the future* (current closeness, .45, $p < .01$; current familiarity, .38, $p < .01$, $n = 151-152$). These items, therefore, appear to be tapping the positive nature of the relationship.

Contact Time

Twins' contact time measures included days before separation, separation to first contact (years), reunion to assessment (months), total contact time (weeks), total time apart (cumulative time together, in months, from birth to assessment) and percent of lifetime apart (total time apart/age in months). These data were obtained separately from both twins during the life history interview on the first assessment day. This information was important to obtain given some critics' claims that reared apart twins' similarities are explained by length of contact, status of rearing family (biological or adoptive) and other life events. (See Bouchard, 1993 for a discussion and refutation of these allegations.)

Physical Resemblance

Twins judged their physical resemblance using a six-point scale (1 = as alike as two copies of the same person to 6 = not at all similar; no more alike than any two people of the same age and sex). This question referred to the *current* time frame. This item was highly reliable (Cronbach's alpha = .92) with reference to a second physical similarity measure (perceived physical resemblance if weight and/or hair style were the same), rated on the same six-point scale. Its validity is demonstrated by its significant correlation with zygosity ($r = .67$, $p < .01$, $n = 157$).

Personality

The Multidimensional Personality Questionnaire (MPQ) was routinely administered to all participants. MPQ scales represent eleven personality dimensions (e.g., well-being, stress reaction) and three higher order factors (positive emotionality, negative emotionality and constraint) (Tellegen 1982, 1985). One month test-retest reliabilities range from .82 - .92, and internal consistency reliabilities (Cronbach's alpha) range from .76- .89. Validity scales identify questionable records (Tellegen, Lykken, Bouchard, Wilcox, Segal and Rich 1988). Heritabilities of .30 to .50 for MPQ Big Five markers have been reported (Bouchard 1997a).

Interests

The Strong Vocational Interest Blank-Campbell Interest Inventory (SVIB-SCII; Hansen and Campbell 1985) was administered to all participants. It is organized into sections assessing preferences (like – indifferent - dislike) for occupations, school subjects and activities, as well as preferences for one of two activities. A final section assesses personality characteristics. Responses yield scores for scales representing General Occupational Themes (6 scales), Basic Interests (23 scales) and Occupations (207 scales). Two week test-retest reliabilities exceed .90. The predictive and concurrent validities of the scales have been well documented and are available in the 1985 manual (Hansen and Campbell 1985). Twins reared apart data have yielded mean heritabilities of .35 and .37 for the General Occupational Themes (e.g., Artistic, Social) and Basic Interest scales (e.g., Nature, Mechanical), respectively (Moloney, Bouchard and Segal 1991). (Only occupational themes and interests were investigated in the present study.) Somewhat higher heritabilities were found in a subsequent study combining twins reared apart and together, using alternative measures (Lykken, Bouchard, McGue and Tellegen (1993).

Values

The Allport-Vernon-Lindzey (AVL) Study of Values (Allport, Vernon and Linzey 1960) measures six values (Religious, Social, Economic, Political, Aesthetic and Theoretical). Scoring is ipsative such that scores on one dimension are influenced by scores on another dimension. Split-half reliabilities range from .84 - .85, and one month test-retest reliabilities range from .77 - .92. The validity of the AVL is demonstrated by numerous studies which have examined scores of groups with known characteristics (Allport, Vernon and Lindzey 1970).

Educational Background

Life history information generated scores for years of higher education and the Hollingshead Educational code. The Hollingshead Educational code indicates level of education completed, ranging from 1 (less than seventh grade) to 7 (graduate degree) (Hollingshead 1975). Individuals still in school were excluded from these analyses.

Results

Associations Between Social Relatedness Measures and Other Variables

1. Social Closeness and Familiarity

The four social relatedness measures (initial and current closeness; initial and current familiarity) correlated negligibly with age ($r = -.00$ to $.01$, $n = 156 - 161$) and sex ($r = -.15$ to $.00$, $n = 156 - 161$). In addition, all four measures showed negligible or slight correlations with the six contact time measures ($-.16$ to $.21$, $n = 133 - 161$). Two correlations deserve comment. First, the relationship between days before separation and current familiarity, while significant ($r = .16$, $p < .05$, $n = 161$), was in a counterintuitive direction. (This correlation suggested that longer time together predicted reduced familiarity.) However, elimination of several outlying cases yielded a smaller, non-significant correlation ($r = .10$, ns, $n = 154$). Second, the correlation between time from reunion to assessment and current closeness ($r = .21$, $p < .05$, $n = 150$) suggested that twins studied soon after meeting were socially closer than those studied later. However, many factors affected scheduling (e.g., twins' work responsibilities; twins' distance from Minneapolis), thus tempering this finding.

Mean ratings of initial closeness, current closeness and initial familiarity did not differ between DZA same-sex and opposite-sex twins. The difference in current familiarity approached, but did not achieve, statistical significance. These two twin groups were, therefore, combined in subsequent analyses.

2. Social Relatedness and Physical Resemblance

Twins' current perception of physical similarity correlated significantly with current closeness ($r = .28$, $p < .01$, $n = 157$) and with current familiarity ($r = .33$, $p < .01$, $n = 157$) for the combined sample. Age and sex were unrelated to perceptions of physical resemblance.

Recall that physical similarity correlated significantly with zygosity ($r = .67$, $p < .01$, $n = 157$), such that MZA twins judged themselves to look more alike than did DZA twins. This was expected, given the causal relationship between genetic factors and physical development. Assigning this variable as a covariate in subsequent analyses would have violated the assumption of independence between the covariate and independent measure and removed meaningful variance. It was, nevertheless, interesting to examine physical similarity-social relatedness correlations *within* zygosity groups. (Separate correlations did not differ for DZA same-sex and opposite-sex twins. DZA opposite-sex twins' mean physical similarity rating was somewhat below that of the DZA same-sex twins, as expected.) Correlations between physical similarity and current closeness were statistically significant for both MZA ($r = .33$, $p < .01$, $n = 89$) and DZA twins ($r = .29$, $p < .05$, $n = 68$), and did not differ between twin groups. The correlation between physical similarity and current familiarity was statistically significant for MZA twins ($r = .46$, $p < .01$, $n = 89$), but not for DZA twins ($r = .16$, ns, $n = 68$), a difference that was statistically significant ($z = 2.044$, $p < .05$).

MZA vs. DZA Twin Pairs

Twin Group Differences in Mean Ratings

A repeated measures analysis of variance compared MZA-DZA twin differences in initial and current closeness and familiarity. The design included one between-subjects measure (Zygosity: MZA, DZA) and two within-subjects measures (Feeling: closeness, familiarity and Time: initial, current). The assumption of homogeneity of variance-covariance matrices was satisfied. Given that twin data are not independent, the analysis used mean social relatedness ratings for each pair (see Kenny and Judd, 1986); data from individual twins (twins whose co-twins did not complete the TRS) were retained. The between-subjects effect of zygosity was statistically significant [$F(1, 80) = 6.26$, $p < .01$, $\eta^2 = .07$] and, as expected, MZA twins expressed greater overall closeness and familiarity than DZA twins. Significant within-subject effects were observed for both Feeling [$F(1, 80) = 7.55$, $p < .01$, $\eta^2 = .09$] and Time [$F(1, 80) = 5.32$, $p < .05$, $\eta^2 = .06$]. Specifically, twins experienced greater closeness than familiarity toward their co-twin, and current ratings generally exceeded initial ratings. A significant

feeling by time effect [$F(1, 80) = 26.34$ $p < .001$, $\eta^2 = .25$] indicated increased familiarity across time, but little change in closeness. None of the interactions involving zygosity were significant. Mean ratings for MZA and DZA twins are displayed in Table 2.

Table 2. Twin Pair Means and Standard Deviations for Social Relatedness Measures

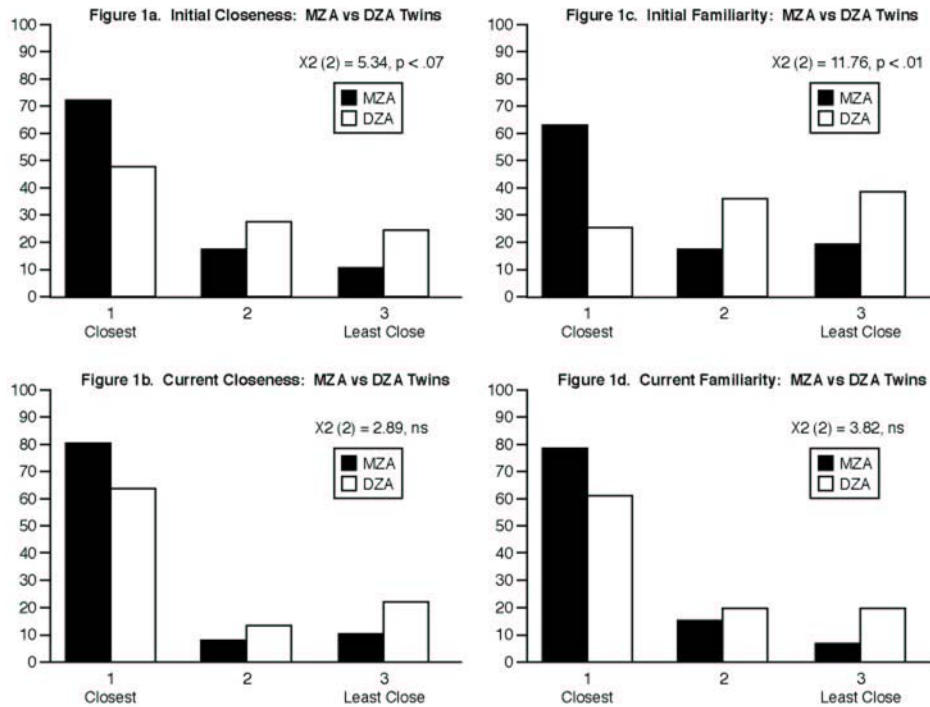
	Initial Closeness	Initial Familiarity	Current Closeness	Current Familiarity
MZA ^a	1.51	1.84	1.63	1.51
(SD)	(0.77)	(1.00)	(1.34)	(1.05)
Range	1 - 5	1 - 6	1 - 6	1 - 6
DZA ^b	2.04	2.57	1.90	1.89
(SD)	(0.98)	(1.15)	(1.12)	(0.98)
Range	1 - 6	1 - 6	1 - 6	1 - 6

Note: Lower numbers reflect greater closeness and familiarity. The n's include twin pair means and several individual twin ratings; the range includes ratings prior to calculation of twin pair means. $a_n = 46$ $b_n = 36$

Twin Group Differences in Distributional Characteristics

It was anticipated that the most meaningful differentiation between MZA and DZA twins would occur at the highest levels of social relatedness ("closer than best friends;" "more familiar than best friends"). Of course, DZA twins are genetically equivalent to full siblings so some would be expected to feel quite close and familiar after meeting. However, if reared apart twins' social relationships mirror those of reared together twins, then higher proportions of MZA than DZA twins should endorse the highest choice levels. Few pairs of either zygosity were expected to endorse the lowest levels of social relatedness (e.g., "less close than most people I meet for the first time"; "less familiar than most people I meet for the first time"). Frequency tables revealed reduced numbers of subjects in the lowest choice categories, so the data were recast into four 2 x 3 contingency tables: zygosity by three response categories (*choice 1*: closer/more familiar than best friends; *choice 2*: as close/as familiar as best friends; *choices 3 – 6*: less close/less familiar than best friends). These data are displayed graphically in Figures 1a – 1d.

Fig. 1a-1d.



There are several interesting features to these findings. First, as expected, all chi square analyses showed that the largest MZA-DZA differences occurred in the proportion of twins endorsing the highest levels of closeness and familiarity. Only two (initial closeness: [$\chi^2(2) = 5.34, p < .07$] and initial familiarity [$\chi^2(2) = 11.76, p < .01$]) approached/achieved statistical significance, respectively; this probably reflected the reduced cell sizes from using pair data. Significance tests for residuals in the case of initial familiarity (choice 1) were statistically significant [MZA: $z = 1.668, p < .05, 1$ -tailed; DZA: $z = 1.884, p < .05, 1$ -tailed]. Second, the proportion of DZA twins' endorsing the highest level of *current* closeness was somewhat *less* than the proportion of MZA twins' endorsing the highest level of *initial* closeness (although the zygosity x feeling x time interaction in the repeated measures analysis was not statistically significant).

Twin-Sibling Differences in Mean Ratings

Comparative examination of twins' closeness and familiarity ratings for their co-twins and for the adoptive siblings with whom they were raised offered

another approach to issues posed in this study. The mean age difference between twins and their adoptive brothers was 6.41 years ($sd = 5.04$) and ranged from 1 to 22 years. The mean age difference between twins and their adoptive sisters was 6.64 years ($sd=5.28$) and ranged from 1 to 20 years. Age differences were uncorrelated with closeness and similarity ratings for twins' adoptive siblings.

Current social relatedness ratings were used to achieve twin-sibling comparability. Mean sibling scores were used if twins provided ratings for both an adoptive brother and an adoptive sister. In addition, in order to circumvent bias introduced from linked observations, twin pair means were used when data were provided by both pair members; this reduced the sample size from 61 to 41. Only participants with complete data records were included.

The analysis was a repeated measures design with two within-subject factors: Relative (twin and sibling) and Feeling (closeness and familiarity). All tests of within-subject effects were statistically significant or approached significance: [Relative: $F(1,40) = 26.79, p < .001, \eta^2 = .40$; Feeling: $F(1,40) = 3.19, p < .08, \eta^2 = .07$; and Relative by Feeling: $F(1,40) = 3.78, p < .06, \eta^2 = .09$]. Feelings were stronger for co-twins than for adoptive siblings, and feelings of familiarity exceeded feelings of closeness. Twins rated co-twin closeness and co-twin familiarity equally, but they rated adoptive sibling familiarity higher than adoptive sibling closeness. Mean ratings are presented in Table 3.

Table 3. Co-Twin and Adoptive Sibling Means and Standard Deviations for Social Relatedness Measures

	Current Closeness	Current Familiarity
Co-Twins ^a	1.60	1.60
(SD)	(1.03)	(1.00)
Range	1 - 6	1 - 6
Adoptive Siblings ^b	2.92	2.67
(SD)	(1.30)	(1.24)
Range	1 - 6	1 - 6

Note: Lower numbers reflect greater closeness and familiarity.

The n's include co-twin and adoptive sibling means and several individual twin ratings; the range includes ratings prior to calculation of pair means. ^an = 41

^bn = 41

Twin-Sibling Differences in Distributional Characteristics

The relative proportions of twins endorsing the highest, intermediate and lowest levels of current closeness and familiarity for their co-twins and adoptive

siblings were revealing. These differences were first evaluated by the Stuart-Maxwell chi square statistic which is appropriate when marginal frequencies are not independent (Fleiss 1981; also see Stuart, 1955). This analysis showed a significant difference in the distribution of co-twin-adoptive sibling ratings for both closeness [$\chi^2(2) = 26.29, p < .001$] and familiarity [$\chi^2(2) = 16.70, p < .001$]. This analysis does not, however, consider the ordering inherent in these ratings. The data were, therefore, further examined by the method of Fleiss and Everitt (1971, cited in Fleiss 1981) to determine if the two sets of responses were distributed differently at the ends of the scale. Significant chi square values showed greater concentrations of "high level" co-twin ratings and "low level" adoptive sibling ratings for both closeness [$\chi^2(1) = 21.06, p < .001$] and familiarity [$\chi^2(1) = 21.06, p < .001$]. (The chi square values were identical!). These data are displayed in Figures 2a and 2b.

2a

		Twin			
		1	2	3	
Adoptive Sibling	1	8	0	0	8
	2	7	2	2	11
	3	12	8	2	22
		27	10	4	41

$\chi^2(2) = 26.29, p < .001$ Note: Ratings reflecting equal twin-adoptive sibling closeness or greater twin closeness are shown in bold.

2b

		Twin			
		1	2	3	
Adoptive Sibling	1	10	0	0	10
	2	4	3	0	7
	3	14	5	5	24
		28	8	5	41

$\chi^2(2) = 16.70, p < .001$ Note: Ratings reflecting equal twin-adoptive sibling familiarity or greater twin familiarity are shown in bold.

Personality, Interests, Values and Education

Prior to analysis, scale scores for personality traits, interests and values were age- and sex-corrected according to the methods of McGue and Bouchard (1984). Age corresponded to the time at which these psychological traits were assessed; thus, questionnaires for some twins were administered up to ten years earlier than the TRS. (In other words, those twins completing the TRS during the follow-up visit had completed personality and interest forms during the initial visit.) The age-sex adjustment procedure utilized information from 443 individuals including reared apart twins and their significant others (e.g., spouses, partners, adoptive siblings and children) who accompanied them to Minnesota. Mean score substitution was used to accommodate missing data.

Data are reported for 41 – 43 MZA twin pairs and for 31 – 33 DZA twin pairs. The absolute co-twin difference in each scale was correlated with both the (1) absolute co-twin difference and (2) twin pair mean on each social relatedness measure. These correlations provide different information. For example, the first correlation shows whether a small difference in a personality trait (e.g., social potency) is associated with a small difference in social relatedness (e.g., current closeness). However, co-twins with a small personality difference might show a small closeness difference at either end of that scale. The second correlation supplements the first by revealing whether a small difference in personality is associated with greater mean pair closeness. In the context of the present study, pairs of correlations were considered meaningful if both types were statistically significant. Given the large number of correlations calculated, the significance level was set to .001 to contain type I error.

Personality

Mean correlations between the social relatedness measures and eleven personality traits were quite modest, ranging from -.01 to .23 for MZA twins and from -.03 to .19 for DZA twins. The only statistically significant findings were the DZA twin correlations between co-twin difference in aggression and twin pair mean in initial closeness ($r = .57$), and co-twin difference in absorption and co-twin difference in current familiarity ($r = .71$). Thus, small co-twin differences in aggression were associated with early impressions of increased social closeness, and co-twin differences in absorption were associated with co-twin differences in current familiarity. However, the corresponding correlations were not statistically significant.

Occupations and Interests

Mean correlations across the six occupational themes were small, ranging from

-.03 to .22 for MZA twins and from .09 to .22 for DZA twins. For MZA twins, the co-twin difference in Artistic occupations correlated significantly with mean pair current familiarity ($r = .52$), but the corresponding correlation was non-significant. None of the DZA twin correlations were statistically significant.

Mean correlations across the twenty-three basic interests ranged from -.00 to .18 for MZA twins and from .12 to .18 for DZA twins. For MZA twins, the co-twin difference in science interest correlated significantly with mean pair initial familiarity ($r = .58$). For DZA twins, correlations were statistically significant between the co-twin difference in Domestic Arts and co-twin difference in current closeness ($r = .53$), and between the co-twin difference in Nature and the co-twin difference in initial closeness ($r = .64$). However, corresponding correlations were not significant.

Values

Mean correlations across the six values ranged from -.04 to .15 for MZA twins and -.02 to .12 for DZA twins. None of the correlations reached statistical significance.

Educational Background

For MZA twins, both correlations involving the Hollingshead Educational Code and initial familiarity were statistically significant. A smaller co-twin difference in education was associated with a smaller co-twin difference in initial familiarity ($r = .49$), and with increased mean pair initial familiarity ($r = .58$). None of the DZA twin correlations reached statistical significance.

Discussion

This study was the first to systematically explore associations between genetic and social relatedness in twins reared apart. Adoptive siblings of the reared apart twins furnished a unique comparison group.

Twin Group and Sibling Differences

As expected, greater closeness and familiarity between MZA co-twins than DZA co-twins was demonstrated. Also, as expected, MZA and DZA twins' ratings were most sharply differentiated at the highest levels of social relatedness. Initial experiences of closeness and familiarity reached/achieved statistical significance, while current experiences did not. These findings place the well-known "twin bond phenomenon" in a scientific context. Specifically, the greater social attraction initially experienced by MZA twins suggests that correlates of

genetic identity confer special understandings between these twins, despite meeting for the first time as adults. This interpretation receives some support from the fact that DZA twins' *current* closeness ratings were somewhat *below* MZA twins' *initial* closeness ratings. A purely cultural explanation (i.e., society expects twins to be close so they act accordingly) appears unwarranted, given the twin group differences that emerged.

The finding that closeness ratings exceeded familiarity ratings for twins overall is not surprising. The twins were living apart all their lives so the newly found co-twin, while triggering feelings of closeness, may have still seemed somewhat novel or unfamiliar. Feelings of familiarity did, understandably, increase over time for both MZA and DZA twins as they grew better acquainted.

Twins' closeness and familiarity ratings for their adoptive siblings furnished an important backdrop against which to assess their ratings for their co-twins. The higher ratings for twins than siblings demonstrate that (1) shared time is not mandatory for developing close social relations and (2) genetic relatedness affects social relationships. The concentrations of co-twin ratings at the high ends of the social relatedness scales, and adoptive sibling ratings at the low ends, underline the differential social significance of these relatives to reared apart twins. Higher familiarity than closeness ratings for adoptive siblings are not surprising because the twins and their adoptive siblings were raised together since infancy and childhood.

Twins' perceptions of their physical resemblance correlated significantly with their feelings of current closeness and familiarity. This finding does not imply a causal association, partly because of the confounding of MZA twins' physical and behavioral similarities. Disentangling these effects would require organizing MZA twins according to various combinations of physical and personality similarity. Note that physical resemblance correlated significantly with closeness for both zygosity groups, but with familiarity for MZA twins only. Perhaps some MZA twins accentuate slight physical differences, leading to feelings of reduced familiarity, relative to more "look-alike" twins. Current familiarity between some DZA co-twins may rely more importantly on degree of resemblance in other phenotypic traits. Unfortunately, twins' perceptions of their physical similarity to their co-twin at the time of meeting (and to their adoptive siblings) were unavailable.

The present findings are, thus, consistent with Hamilton's inclusive fitness theory which views altruistic acts toward close genetic relatives as a way of facilitating transmission of genes into future generations. An evolutionary psychological interpretation does not deny contributions from other theoretical perspectives. Instead, it both invigorates and gains from these views. For example, evolutionary psychology refines psychodynamic understanding of how treatment by others may affect social relations. Other peoples' responses to twins' behaviors may reflect or reinforce (but not create) their affiliative feelings.

Conversely, psychodynamic theories offer rich descriptive material to which evolutionary researchers may turn for proximal mechanisms underlying social relatedness.

Few meaningful associations emerged between twins' social relatedness measures and similarities in personality, interests, values and education. The only exception was the pair of significant MZA twin correlations between the Hollingshead educational code and initial familiarity. Of course, twins do not respond to their co-twins' educational background per se, but most likely to the ideas, activities and motivations underlying their educational experiences. A closer look at factors driving these MZA correlations, and the absence of these relationships among DZA twins, would be worth pursuing.

Despite the absence of clear findings, it may be premature to conclude that twins' similarities in personality, interests and values are irrelevant to social relatedness. It is possible that the MPQ scales are insensitive to facets of personality and temperament that meaningfully shape relations between reunited relatives. It is also possible that alternative instruments, as well as twins' *own perceptions* of their similarities in general intelligence, special abilities, personality traits, values and interests would provide a more comprehensive assortment of measures for assessing the bases of social relatedness. Leek and Smith (1991) found that relatives' perceived personality similarity correlated with various help and conflict measures. Twins' evolving relations may have also rested partly on interpersonal factors not measured in the present study. Attributes such as "trust," "openness" and "spontaneity" are valued in twin relationships (Foy, Vernon and Jang 2001) so may modify closeness and familiarity.

The present study is not without limitations. Twins' closeness and familiarity were assessed using four single-item measures. Future studies will, hopefully, corroborate these findings via multi-item scales and diverse methods. However, one- and two-item measures (e.g., Inclusion of Other in the Self Scale [IOS] and Social Closeness Scale [SCL]) have proven valid in studies on the nature and structure of social closeness (see Aron, Aron, and Smollan 1992; Aron and Fraley 1999). Both these measures assess relatedness on a 1 to 7 scale, similar to items used in the present study, although the IOS uses a pictorial format.

More detailed assessment of the nature of twins' contact time prior to assessment (e.g., type of activities; presence of others) could augment the present findings. For example, time from reunion to assessment was significantly longer for MZA than DZA twins, raising the possibility that MZA twins used that opportunity to interact. However, *shorter* time from reunion to assessment was associated with *increased* current closeness. It is, therefore, plausible that socially closer twins were more eager participants than those who felt less close. This relationship remained significant for MZA twins ($r = .35$, $n = 83$), but not for DZA twins ($r = -.02$, $n = 67$). However, as indicated above, scheduling was

affected by many factors so this association should be viewed cautiously. It is also possible that closeness may be experienced even without frequent and varied contact. Aron and Fraley (1999) found that degree of self-other overlap was associated with subjective feelings of closeness, but not with behavioral interaction.

It might be objected that even though zygosity assignments were unavailable during participation, twins' impressions of their twin type (based on physical resemblance and/or other indicators) may have biased their subjective relationship experience. This possibility cannot be fully discounted, but seems unlikely. First, cultural conceptions of twinship do not draw sharp distinctions between twin types (Stewart 2000). Second, twins' treatment by others is generally unrelated to co-twin similarity in behavior (LaBuda, Svikis, and Pickens 1997; Klump, Holly, Iacono, McGue, and Willson 2000.) Third, parental treatment of twins is associated with true zygosity, not perceived zygosity (Goodman and Stevenson 1991). Finally, in the present study, correlations between twinship preference while searching for the twin (1 = hoped to look exactly the same to 4 = did not care how similar or different we looked) and the four social relatedness measures were negligible ($r = -.01$ to $.19$, $n = 75$).

Conclusions

The present study suggests several points. First, twin research methodology is useful for assessing evolutionary-based hypotheses concerning genetic and social relatedness. Second, the greater affiliation between MZA than DZA twins should redirect attention to proximal social processes underlying these differences. The additional finding that closeness and familiarity ratings for newly found co-twins exceeded those for adoptive siblings is compelling and worth additional study.

Future work on the bases of social relations should move in exciting directions if integrated with molecular genetic analysis. It will be interesting to determine if, and to what extent, associations between perceptions of physical resemblance and social relatedness may be mediated by degree of genetic overlap. Some early twin studies suggest that this is so. Pakstis, Scarr-Salapatek, Elston and Siervogel (1972) reported correlations between DZ twins' absolute number of blood group differences and physical dissimilarity and activity level. Dumont-Driscoll and Rose (1983) found that DZ twins sharing more blood groups showed greater confusion over their twin type and received higher similarity ratings from mothers than DZ twins sharing fewer blood groups. Such research, as well as studies suggesting links between specific genes and personality traits (Benjamin, Lin, Patterson, et al. 1996), support the feasibility of such efforts.

Identifying the processes underlying MZ-DZ twin relationships may enhance understanding of many complex human social behaviors. We might, for example, better comprehend why some family members are more closely affiliated than

others, why people grieve more for some relatives than for others, why it is important for many adoptees to search for biological kin and why it is necessary for many children conceived through sperm donation to locate their fathers.

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