

Three-Factor Model of Schizotypal Personality: Invariance Across Culture, Gender, Religious Affiliation, Family Adversity, and Psychopathology

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Abstract

Whilst the syndrome approach to schizotypy has recently demonstrated differential correlates of a three-factor model of schizotypal personality, variations in the nature of these factors question a basic assumption of this approach. This study tested competing models of the factor structure of schizotypal personality using the Schizotypal Personality Questionnaire (SPQ) in a sample of 1,201 Mauritians. Factor invariance across gender, ethnicity, family adversity, and religion and across a psychopathologically select group was also assessed. Results suggest that a three-factor model, Cognitive-Perceptual Deficits, Interpersonal Deficits, and Disorganization, underlies individual differences across widely varying groups. Other competing three-factor schizotypal personality models did not fit the data better. It is argued that the three-factor Disorganized model is a well-replicated model of *DSM* schizotypal personality in community samples but possibly not in some clinical samples.

Keywords: Schizotypal personality, SPQ, factor analysis, cross-cultural comparison.

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A critical question in the research on schizotypal personality concerns the number of discrete dimensions that make up this construct. Several competing models have been proposed over the last decade. Because schizotypal personality disorder (SPD) is thought by some to have a similar etiology as schizophrenia (Spitzer et al. 1979; Siever and Gunderson 1983; Siever et al. 1993), some of these models originate from theories of the structure of schizophrenic symptomatology. An implication of SPD's purported close ties to schizophrenia is that the underlying structures of schizotypal personality and schizophrenia ought to closely match if schizotypy lies on the same multidimensional continuum. However, if schizophrenic

symptomatology does not evolve closely from the schizotypal state, then such a parallel relationship may be less likely to exist (Venables and Bailes 1994).

A prevailing view until recently was that schizotypy could be conceptualized along two dimensions reflecting positive and negative characteristics: cognitive-perceptual deficits and deficits in interpersonal functioning (Siever and Gunderson 1983; Widgier et al. 1986). Indeed, several studies that examined the factor structure of the then-available schizotypal and psychosis-prone personality measures suggested the presence of a two-dimensional model corresponding broadly to positive and negative features (Allen et al. 1987; Muntaner et al. 1988; Raine and Allbutt 1989), which seemed to parallel that of schizophrenia symptomatology (Andreasen and Olson 1982).

Over the last decade, however, studies in clinical and normal populations have not presented a unified picture of the underlying structure of schizotypal personality. At least seven recent studies of schizotypal personality have suggested the potential presence of at least three, not two, factors (Bentall et al. 1989; Kendler and Hewitt 1992; Raine et al. 1994; Venables and Bailes 1994; Gruzelier et al. 1995; Bergman et al. 1996a; Gruzelier 1996). Several of these studies have identified schizotypal factors that closely resemble three-factor structures of schizophrenic symptoms (Bilder et al. 1985; Liddle and Barnes 1990; Arndt et al. 1991; Gruzelier 1991): cognitive-perceptual dysfunction/unreality (ideas of reference, magical thinking, unusual perceptual experiences, odd speech, and paranoid ideation); interpersonal deficits/withdrawn (social anxiety, no close friends, constricted affect, and paranoid ideation); and disorganization/active (odd behavior and odd speech) (Raine et al. 1994; Gruzelier et al. 1995; Gruzelier 1996). However, not all studies precisely replicate this three-factor solution. Battaglia et al. (1997) also found three factors labeled cognitive-perceptual,

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interpersonal, and odd (disorganized) that were very similar to previous three-factor structures, with the key difference being that constricted affect loaded on the disorganization (not interpersonal deficits) factor. More discrepant findings were obtained by Bergman et al. 1996a, who found evidence for a three-factor model in which paranoia, not disorganization, constituted the third factor.

Why do different research groups obtain different factor structures for SPD? One reason is that, unlike the SPQ (Raine 1991), many earlier instruments assessing schizotypal personality did not include items tapping all nine symptoms as outlined by *DSM-III-R* criteria (American Psychiatric Association 1987) and largely maintained by *DSM-IV* (American Psychiatric Association 1994). Variations in factor structure are thus likely to be a function of the number and type of schizotypal traits entered into the analysis. This explanation cannot, however, account for the fact that three previous studies all utilized confirmatory factor analytic procedures and made use of either the SPQ or the *DSM-III-R* diagnostic criteria for SPD and nevertheless obtained divergent results (Raine et al. 1994; Bergman et al. 1996a; Battaglia et al. 1997).

Five other important factors can be identified as conceivably accounting for differences among these three studies. First, study populations differed in terms of cultural background (Italians in Battaglia et al. 1997 vs. Americans in Raine et al. 1994 and Bergman et al. 1996a). Second, the proportion of females in the studies varied from 32 percent in Bergman et al. (1996a) to 60 percent in Battaglia et al. (1997). Third, while Bergman et al. (1996a) and Battaglia (1997) employed clinical populations with significant psychopathology, Raine et al. (1994) utilized noninstitutionalized, nonclinical community and university samples. Fourth, while the samples used by Raine et al. (1994) are socially advantaged, Bergman et al. (1996) utilized a sample of socially disadvantaged clinical outpatients and inpatients (Bronx Veterans Affairs Medical Center and Mount Sinai Hospital in New York); Battaglia et al. (1997) employed clinical outpatients (seen at San Raffaele Hospital in Milan, Italy) and nonpatient controls (surgical patients from day-hospital facilities, medical students, and relatives of outpatients with mood or anxiety disorders) who are more likely to be of intermediate social status. Fifth, variations in religious affiliation (predominantly Catholics in the Italian sample of Battaglia et al. 1997, vs. more heterogeneous affiliations in the American samples of the other two studies) may also have contributed to the divergence in findings.

These five processes represent critical gaps in the literature on the factor structure of schizotypal personality. To our knowledge, there has been little or no research on the generalizability of the factor structure of a *DSM* con-

ceptualization of schizotypy across gender, psychopathology, religion, socioeconomic grouping, and culture. The issue is a conceptually important one because group differences in factor structure (for example, across gender, socioeconomic, ethnic, or religious affiliations) may point to etiological differences in SPD, and thus potentially in schizophrenia. In addition, it is critically important to establish precisely which specific factors underlie the nine *DSM* traits of schizotypy in order that factorial validity research can proceed.

The purpose of the present study was to attempt to partially fill these gaps in the literature and to test competing models of the factor structure of schizotypal personality using the SPQ in a nationally representative and ethnically diverse Mauritian sample (Venables 1978; Venables et al. 1978). The goals of the current study were thus twofold: (1) to assess competing schizotypy models (one factor, two factor, trifactor paranoid [Rosenberger and Miller 1989], trifactor odd [Battaglia et al. 1997], and trifactor disorganized [Raine et al. 1994]); and (2) to compare the factor structure across gender, socioeconomic status, ethnic and religious affiliation, and psychopathology status.

Method

Subjects. This current sample has participated in the longitudinal Mauritius Child Health Project since 1972. Almost all children from two towns on the island, Vacoas and Quatre Bornes, who were 3 years old between August 1972 and July 1973 were originally recruited. The two towns were chosen because their population was representative of the ethnic diversity of the whole island. The sample comprised 1,800 children and of these, complete data were available on 1,795. In the present phase 1,212 subjects (694 male, 518 female) from the original sample of 1,795 participated. Of these, 69.8 percent were of Indian decent, 24.6 percent "General Population" (the official Mauritian Government designation for members of the population of substantially African origin), 1.4 percent Chinese, and 0.1 percent French; the remaining 4.1 percent were classified as "other." Religious affiliation was 54.5 percent Hindu, 25.4 percent Catholic, and 18.8 percent Muslim; the remaining 1.3 percent were classified as "other." (Both the Hindu and Muslim faiths are made up primarily of those of Indian decent, while those classified as "General Population" are primarily adherents of the Catholic faith.) The average age of participants in this latest wave of data collection was 23.36 years (standard deviation = 1.17).

Of the 588 nonparticipants, 4.2 percent refused, 19.4 percent were abroad, 4.6 percent were dead, and the

remaining 71.8 percent were untraceable. It is likely that many of the "untraceables" had moved abroad. There were no significant differences between participants and nonparticipants in overall socioeconomic status (a principal component of measures of parent education, occupation, family size, and dwelling characteristics) at initial testing in 1972 ($t[974.65] = 1.04, p = 0.30$).

Measures. The measures reported below were administered to subjects as part of a larger protocol of psychometric tests and clinical interviews by interviewers personally trained by one of the authors (A.R.). All measures were translated into Creole and then translated back into English to assess the accuracy of the translation process.

SPQ. The SPQ (Raine 1991), read aloud to each participant by the interviewer, was completed by 1,201 of the 1,212 subjects. Full reliability and validity information on the SPQ instrument, a 74-item questionnaire, is provided in Raine (1991). Briefly, the SPQ has been found to have high internal consistency (Cronbach's $\alpha = 0.91$), convergent validity, and test-retest reliability (Pearson's $r = 0.82$) and also has some criterion validity (0.60 point biserial correlation between the SPQ and *DSM-III-R* SPD, 0.68 Spearman correlation between the SPQ and dimensional scores of SPD derived from diagnostic interviews).

Nine subscales of the SPQ instrument are typically constructed from the 74 yes or no items: ideas of reference (9 items), magical thinking (7 items), unusual perceptual experiences (9 items), paranoid ideation (8 items), social anxiety (8 items), no close friends (9 items), constricted affect (8 items), odd behavior (7 items), and odd speech (9 items). These subscales have shown moderate to high internal consistencies in college- and community-based samples (Cronbach's $\alpha = 0.66$ – 0.81 , Raine 1991; Cronbach's α [Taiwanese adults] = 0.58 – 0.7 , Chen et al. 1997). The nine subscales were utilized in the confirmatory analyses described below.

Family adversity. A family adversity score, analogous to the Family Adversity Index first developed by Rutter (1978) and later expanded by Moffitt (1990), was calculated by adding one point for the presence of each of the following: low parent education (less than 10 years), semiskilled or unskilled parent occupation, teenage mother (18 years or younger when child was born), single parent status, separation from parents (orphaned or raised by substitute mother), large family size (sibling order of five or greater), and poor mother's health (as rated by an interviewer). A total of 1,128 subjects in the current phase had valid adversity scores at age 3. Out of a possible score of seven, the range of adversity was from zero to five with a median value of two; 74.1 percent obtained a score of two or less. Low- and high-adversity groups were formed by median split, with 25.8 percent classified as high adversity.

Psychopathology. To form a psychopathologically selected sample, those with a high number of psychopathological symptoms relative to the total sample were classified as high psychopathology: subjects scoring in the top 10 percent of the Michigan Alcoholism Screening Test (MAST; Selzer 1971), the Beck Depression Inventory (BDI; Beck 1967), or the Antisocial Personality Disorder (APD) section of the Structured Clinical Interview for *DSM-III-R* Personality Disorders (Spitzer et al. 1987). Antisocial personality scores were created by summing all the possible three-point items. The corresponding 10 percent cutoff scores were 7 or greater for the MAST, 25 or greater for the BDI, and 6 or greater for the APD. The cutoffs for the MAST and for the BDI are higher than clinical cutoffs typically reported across various samples (e.g., Gorelick et al. 1990; Chan 1991; Kogan et al. 1994; Nielsen et al. 1994). Altogether, 238 subjects were classified as high psychopathology and the remaining 963 as low psychopathology.

Design and Procedures. Confirmatory factor analysis (CFA) was conducted using LISREL 8 (Joreskog and Sorbom 1993). Unlike exploratory factor analysis, in CFA an a priori model is constructed that attempts to account for the observed covariance matrix. Fits of various models to the data can be evaluated using goodness-of-fit indices. In the present study, LISREL analyses were performed on variance and covariance matrices.

In addition to a null model, five models based on prior research were evaluated: one-factor, two-factor, and three different three-factor models. The factor analytic structures predicted by the models tested are presented in table 1. To provide a baseline comparison for all models considered, the null model was fit. Under this model, each of the nine schizotypal traits is assumed to represent completely independent and uncorrelated dimensions of schizotypy.

Six commonly used goodness-of-fit indices were reported to assess fit of the models. The first, chi-square (χ^2), indicates a good fit when nonsignificant; however, it is very sensitive to sample size. Therefore, additional indices with less sensitivity to sample size were also used:

1. The Normed Fit Index (NFI) compares the fit of a particular model to a baseline null model; values greater than 0.90 indicate a good fit (Bentler and Bonett 1980).
2. The Tucker-Lewis Index (TLI; Tucker and Lewis 1973) is a nonnormed fit index that reflects model fit very well at all sample sizes (Bentler 1990). As for the NFI, values above 0.90 indicate a good fit.
3. The Comparative Fit Index (CFI) is a similar fit index to the NFI in that it provides a measure of proportional increase in fit over a null model (Goffin 1993;

Table 1. Factor structures predicted by the five models

Trait	Model											
	One-factor	Two-factor		Paranoid three-factor			Odd three-factor			Disorganized three-factor		
	1	1	2	1	2	3	1	2	3	1	2	3
Ideas of reference	1	1	0	0	0	1	1	0	0	1	0	0
Magical thinking	1	1	0	1	0	0	1	0	0	1	0	0
Unusual perceptual experiences	1	1	0	1	0	0	1	0	0	1	0	0
Paranoid ideation	1	1	0	0	0	1	1	0	0	1	1	0
Social anxiety	1	0	1	0	0	1	0	1	0	0	1	0
No close friends	1	0	1	0	1	0	0	1	0	0	1	0
Constricted affect	1	0	1	0	1	0	0	0	1	0	1	0
Odd behavior	1	1	0	0	1	0	0	0	1	0	0	1
Odd speech	1	1	0	0	1	0	0	0	1	0	0	1

Yadama and Pandey 1995). This index has been shown to be relatively stable across sample sizes (Yadama and Pandey 1995).

4. The Akaike Information Criterion (AIC; Akaike 1987) provides a nonnormed measure of the goodness of fit that accounts for the number of parameters estimated. There are various forms of the AIC; the version used here is $\chi^2 - (2 \times \text{degrees of freedom})$. Smaller values indicate a better fit.
5. The Root Mean Squared Error Index (RMSEA; McDonald 1989) is based on a weighted sum of discrepancies between the model and observed data. A good fit is indicated by values less than 0.10 and a very good fit is indicated by values below 0.05.

The NFI, CFI, and RMSEA indices were taken from the output generated by LISREL 8 (Joreskog and Sorbom 1993).

Direct comparison can be made between models that are in hierarchical relationship (i.e., nested) using the difference chi-square ($\Delta\chi^2$) test (Loehlin 1992): the chi-square is equal to the difference between the chi-square values from the models being compared, with degrees of freedom equal to the difference between the respective degrees of freedom. All models except the null model estimated factor loadings, uniquenesses (i.e., error or unexplained variation), and factor intercorrelations. Tests of factorial invariance across groups comparing nested models were done (Horn et al. 1983; Horn and McArdle 1992). A model constraining all parameters to be the same across groups was first compared to a model allowing all the parameter estimates (i.e., factor loadings, uniquenesses, and factor intercorrelations) to vary between groups. If the difference chi-square was significant, then two additional models were tested to examine possible reasons in more detail: (1) a model equating factor loadings across groups (factor correlations and uniquenesses are free to vary), and (2) a model constraining both factor

loadings and uniquenesses, making them equal across groups (factor intercorrelations are free to vary).

Multivariate normality. Tests of multivariate normality in the full sample were conducted in PRELIS 2.0 (Joreskog and Sorbom 1993) and were significant, suggesting violation of normality ($\chi^2[\text{skew}] = 21.009, p < 0.01$; $\chi^2[\text{kurtosis}] = 6.912, p < 0.01$; $\chi^2[\text{skew and kurtosis}] = 489.175, p < 0.01$). To examine the issue of normality further, we conducted model-fitting analyses on the full sample ($n = 1,201$), including both the covariance matrix and an asymptotic weight matrix calculated in PRELIS 2.0, an appropriate inclusion in cases of nonnormality (Joreskog and Sorbom 1989). Results based on including asymptotic weight matrices showed identical findings in terms of the best fitting model as described below, though with less favorable model-fit indices (e.g., NFI, CFI, TLI).

Results

CFA goodness-of-fit indices are presented by group affiliation in tables 2 to 6. In all cases, the five hypothesized models fit better than the null model. Furthermore, in all cases the Disorganization trifactor model fit best with satisfactory CFI, NFI, TLI, AIC, and RMSEA indices. The chi-squared values were significant in every case and are likely due to the large sample sizes. While the AIC is also influenced by sample size and alone may be unreasonable to use for model selection (McDonald and Marsh 1990), for nonnested models with identical degrees of freedom we retain its use in determining the best fitting model.

Gender. Model-fitting results by gender are reported in table 2. A comparison of models within gender suggested that the Disorganization trifactor model fit best across all fit indices. However, factor loadings and correlations for males and females could not be equated ($\Delta\chi^2[22] = 36.65, p = 0.02$). A model equating factor loadings only

Table 2. Model-fitting results by gender

Model	χ^2	df	p	AIC	CFI	NFI	TLI	RMSEA
Males (n = 688)								
1. Null	2,770.35	36	0.00	2,698.35	—	—	—	0.33
2. 1-factor	449.86	27	0.00	395.86	0.85	0.84	0.79	0.15
3. 2-factor	306.79	26	0.00	254.79	0.90	0.89	0.86	0.13
4. 3-factor: Paranoid	301.05	24	0.00	253.05	0.90	0.89	0.85	0.13
5. 3-factor: Odd	255.48	24	0.00	207.48	0.92	0.91	0.87	0.12
6. 3-factor: Disorganized	161.44	23	0.00	115.44	0.95	0.94	0.92	0.09
Females (n = 513)								
1. Null	2,004.10	36	0.00	1,932.10	—	—	—	0.33
2. 1-factor	286.41	27	0.00	232.41	0.87	0.86	0.82	0.14
3. 2-factor	228.43	26	0.00	176.43	0.90	0.89	0.86	0.12
4. 3-factor: Paranoid	194.82	24	0.00	146.82	0.91	0.90	0.87	0.12
5. 3-factor: Odd	146.53	24	0.00	98.53	0.94	0.93	0.91	0.10
6. 3-factor: Disorganized	122.17	23	0.00	76.17	0.95	0.94	0.92	0.09
Male-female comparison								
6a. Disorganized unequal	283.62	46	0.00	191.62	0.95	0.94	0.92	0.10
6b. Equate factor loadings	301.32	56	0.00	189.32	0.95	0.94	0.93	0.09
6c. Equate loadings + unique	316.38	65	0.00	186.38	0.95	0.93	0.94	0.08
6d. Equate loadings + unique + factor correlations	320.27	68	0.00	184.27	0.95	0.93	0.94	0.08

Note.—AIC = Akaike Information Criterion; CFI = Comparative Fit Index; NFI = Normed Fit Index; RMSEA = Root Mean Squared Error Index; TLI = Tucker-Lewis Index.

was then fit to test if the lack of fit was primarily because of differences in the magnitude of the loadings; the difference chi-square was not significant when compared to the model allowing all estimates to vary between groups ($\Delta\chi^2[10] = 17.70, p = 0.06$). Next, a model constraining both factor loadings and uniquenesses to be equal across groups was fit and compared to the model constraining only factor loadings to be equal; the difference chi-square was not significant ($\Delta\chi^2[9] = 15.06, p = 0.09$). A model that constrained the factor intercorrelations to be equal, as well as factor loadings and uniquenesses, did not have a significantly worse fit than the model equating just factor loadings and uniquenesses ($\Delta\chi^2[3] = 3.89, p = 0.27$). The source of discrepancy between males and females may be differences in the magnitude of factor loadings, uniquenesses, or both, although the nested model comparisons testing for this missed significance. Inspection of standardized factor loadings and correlations (table 7) reveals no striking differences between males and females. Figure 1 presents model estimates for both males and females.

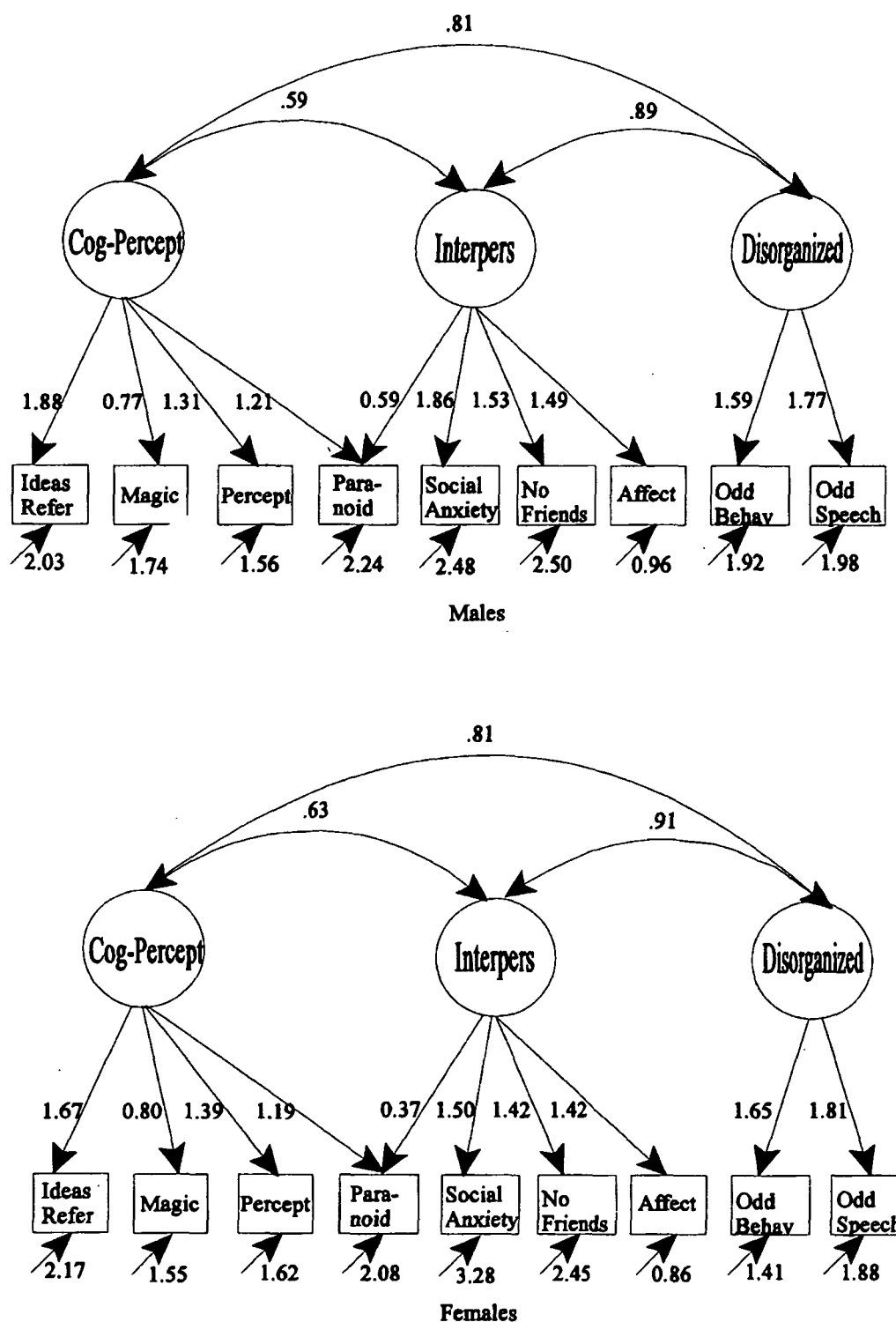
Ethnicity. Model-fitting results by ethnic affiliation are reported in table 3. A comparison of models within affiliation suggested that the Disorganization trifactor model fit

best across all fit indices. Factor loadings, uniquenesses, and correlations could be equated ($\Delta\chi^2[22] = 31.33, p = 0.09$). Inspection of factor loadings and correlations (table 7) reveals no large substantive differences between groups.

Religion. Model-fitting results by religious affiliation are reported in table 4. A comparison of models within religion suggested that the Disorganization trifactor model fit best across all fit indices. Factor loadings and correlations could be equated ($\Delta\chi^2[44] = 58.23, p = 0.07$). Of note is the especially large factor correlations in the Muslim subsample; indeed, the factor correlation matrix was not positive definite. A message of a non-positive-definite matrix may be likely a result of the near-perfect correlations estimated between the Disorganization factor and the Cognitive-Perceptual and Interpersonal factors. Other possible reasons may be sampling variation or poor start values (Joreskog and Sorbom 1993). Several start values were tried, but no other solution was found. Overall, inspection of factor loadings and correlations (table 8) reveals no large substantive differences between religious groups.

Family Adversity. Model-fitting results by adversity group are reported in table 5. A comparison of models

Figure 1. LISREL 8 model estimates for males and females



Note.—Cog-Percept = cognitive-perceptual; Interpers = interpersonal; Ideas Refer = ideas of reference; Magic = magical thinking; Percept = unusual perceptual experiences; Affect = constricted affect; Odd Behav = odd behavior.

Table 3. Model-fitting results by ethnicity

Model	χ^2	df	p	AIC	CFI	NFI	TLI	RMSEA
General population (n = 297)								
1. Null	1,138.99	36	0.00	1,066.99	—	—	—	0.44
2. 1-factor	188.82	27	0.00	134.82	0.85	0.83	0.80	0.15
3. 2-factor	124.11	26	0.00	72.11	0.91	0.89	0.88	0.11
4. 3-factor: Paranoid	116.85	24	0.00	68.85	0.92	0.90	0.87	0.13
5. 3-factor: Odd	135.49	24	0.00	87.49	0.90	0.88	0.85	0.13
6. 3-factor: Disorganized	94.01	23	0.00	48.01	0.94	0.92	0.90	0.10
Indian (n = 843)								
1. Null	3,344.89	36	0.00	3,272.89	—	—	—	0.45
2. 1-factor	525.22	27	0.00	471.22	0.85	0.84	0.80	0.16
3. 2-factor	381.18	26	0.00	329.18	0.89	0.89	0.85	0.13
4. 3-factor: Paranoid	380.31	24	0.00	332.31	0.89	0.89	0.84	0.14
5. 3-factor: Odd	243.66	24	0.00	195.66	0.93	0.93	0.90	0.11
6. 3-factor: Disorganized	169.59	23	0.00	123.59	0.96	0.95	0.93	0.09
General population-Indian comparison								
6a. Disorganized unequal	263.60	46	0.00	171.60	0.95	0.94	0.92	0.09
6b. Equal	294.93	68	0.00	158.93	0.95	0.93	0.95	0.08

Note.—AIC = Akaike Information Criterion; CFI = Comparative Fit Index; NFI = Normed Fit Index; RMSEA = Root Mean Squared Error Index; TLI = Tucker-Lewis Index.

Table 4. Model-fitting results by religious affiliation

Model	χ^2	df	p	AIC	CFI	NFI	TLI	RMSEA
Catholic (n = 308)								
1. Null	1,189.49	36	0.00	1,117.49	—	—	—	0.32
2. 1-factor	197.19	27	0.00	143.19	0.85	0.83	0.80	0.14
3. 2-factor	129.43	26	0.00	77.43	0.91	0.89	0.88	0.11
4. 3-factor: Paranoid	125.98	24	0.00	77.98	0.91	0.89	0.87	0.12
5. 3-factor: Odd	127.95	24	0.00	79.95	0.91	0.89	0.86	0.12
6. 3-factor: Disorganized	87.45	23	0.00	41.45	0.94	0.93	0.91	0.10
Hindu (n = 660)								
1. Null	2,633.45	36	0.00	2,561.45	—	—	—	0.33
2. 1-factor	418.11	27	0.00	364.11	0.85	0.84	0.80	0.15
3. 2-factor	317.24	26	0.00	265.24	0.89	0.88	0.84	0.13
4. 3-factor: Paranoid	302.75	24	0.00	254.75	0.89	0.89	0.84	0.13
5. 3-factor: Odd	187.16	24	0.00	139.16	0.94	0.93	0.91	0.10
6. 3-factor: Disorganized	140.39	23	0.00	94.39	0.95	0.95	0.93	0.09
Muslim (n = 228)								
1. Null	909.35	36	0.00	837.35	—	—	—	0.33
2. 1-factor	142.95	27	0.00	88.95	0.87	0.84	0.82	0.14
3. 2-factor	88.55	26	0.00	36.55	0.93	0.90	0.90	0.10
4. 3-factor: Paranoid	110.68	24	0.00	62.68	0.90	0.88	0.85	0.13
5. 3-factor: Odd	92.43	24	0.00	44.43	0.92	0.90	0.88	0.11
6. 3-factor: Disorganized	53.74	23	0.00	7.74	0.96	0.94	0.94	0.08
Ethnic comparison								
6a. Unequal	281.58	69	0.00	143.58	0.95	0.94	0.93	0.09
6b. Equal	339.81	113	0.00	113.81	0.95	0.93	0.95	0.07

Note.—AIC = Akaike Information Criterion; CFI = Comparative Fit Index; NFI = Normed Fit Index; RMSEA = Root Mean Squared Error Index; TLI = Tucker-Lewis Index.

within group suggested that the Disorganization trifactor model fit best across all fit indices. Furthermore, factor loadings and correlations could be equated across adversity groups ($\Delta\chi^2[22] = 23.30, p = 0.38$). Factor loadings and correlations are presented in table 9.

Psychopathology. Model-fitting results by high versus low scores on symptoms of depression, alcohol problems, and antisocial personality disorder are reported in table 6. A comparison of models within groups suggested that the Disorganization trifactor model fit best across all fit indices. However, model estimates could not be equated across groups ($\Delta\chi^2[22] = 80.76, p = 0.00$). A model equating factor loadings only was then fit to test if the discrepancy was due to differences in factor loadings; the difference chi-square was not significant when compared to the model allowing all estimates to vary between groups ($\Delta\chi^2[10] = 15.79, p = 0.10$). Next, a model constraining both factor loadings and uniquenesses to be equal across groups was fit and compared to the model constraining only factor loadings to be equal; the difference chi-square was significant ($\Delta\chi^2[9] = 61.01, p = 0.00$). Additionally constraining the correlations to be equal did not fit significantly worse than the model equating factor loadings and uniquenesses but not correlations ($\Delta\chi^2[3] = 3.96, p = 0.26$). Thus, the major source of discrepancy was due to differences in the magnitude of uniquenesses (i.e., error or

unexplained variance). Inspection of standardized factor loadings and correlations (table 9) reveals no substantial differences between those low or high on symptoms of depression, alcohol-related problems, or antisocial personality disorder. Model estimates for both groups are presented in figure 2.

Factor Intercorrelations. Overall, inspection of factor correlations across all groups indicates highly correlated factors, especially between the Cognitive-Perceptual and Disorganization factors and between the Interpersonal and Disorganization factors. Previous studies have suggested smaller or imposed zero correlation between these factors (Raine et al. 1994; Gruzelier et al. 1995; Bergman et al. 1996a; Gruzelier 1996). However, like Raine et al. (1994), we found the correlations between the Cognitive-Perceptual and Interpersonal factors to be lower than those between Disorganization and the other two factors respectively. As in previous studies, all factors were defined by high loadings (Raine et al. 1994; Gruzelier et al. 1995; Gruzelier 1996), except the loading of paranoid ideation on the Interpersonal factor.

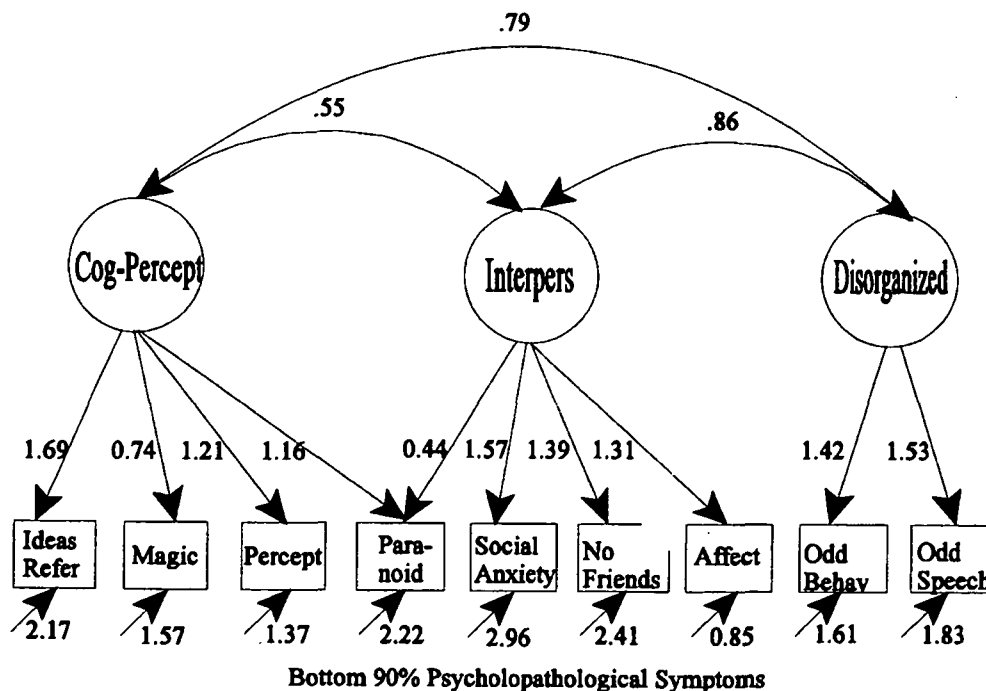
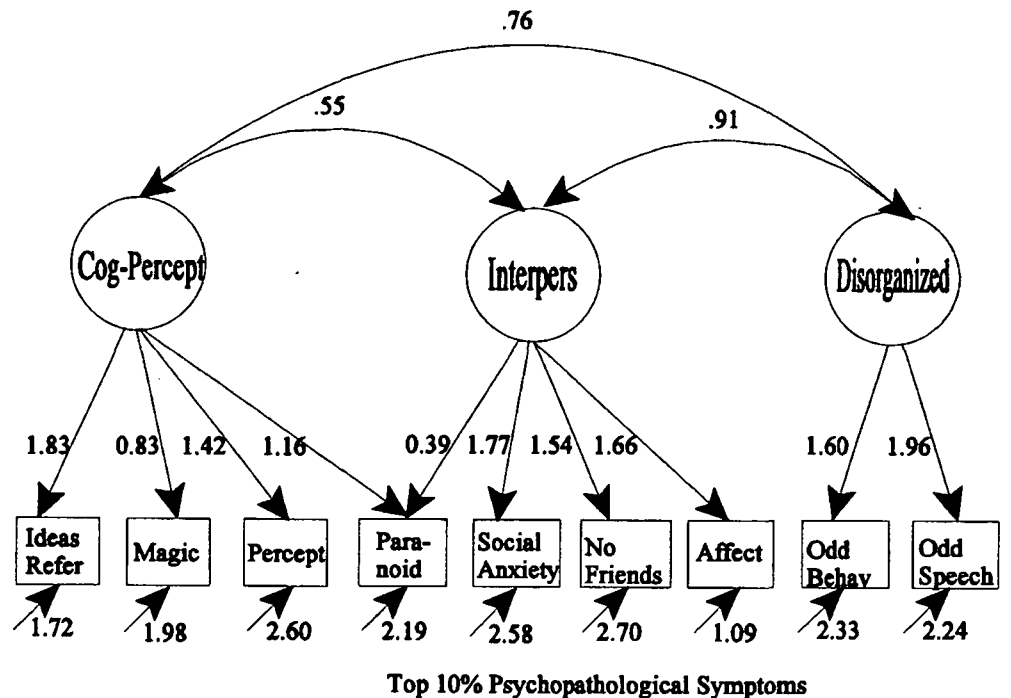
Discussion

Results of the present study suggest that a three-factor model, comprising Cognitive-Perceptual deficits,

Table 5. Model-fitting results by adversity group

Model	χ^2	df	p	AIC	CFI	NFI	TLI	RMSEA
Low adversity (n = 836)								
1. Null	3,126.42	36	0.00	3,054.42	—	—	—	0.44
2. 1-factor	485.63	27	0.00	431.63	0.85	0.84	0.80	0.16
3. 2-factor	339.70	26	0.00	287.70	0.90	0.89	0.86	0.13
4. 3-factor: Paranoid	333.25	24	0.00	285.25	0.90	0.89	0.85	0.14
5. 3-factor: Odd	249.10	24	0.00	201.10	0.93	0.92	0.89	0.11
6. 3-factor: Disorganized	169.59	23	0.00	123.59	0.95	0.95	0.93	0.09
High adversity (n = 292)								
1. Null	1,264.33	36	0.00	1,192.33	—	—	—	0.47
2. 1-factor	210.77	27	0.00	156.77	0.85	0.83	0.80	0.17
3. 2-factor	151.99	26	0.00	99.99	0.88	0.90	0.86	0.14
4. 3-factor: Paranoid	155.07	24	0.00	107.07	0.89	0.88	0.84	0.15
5. 3-factor: Odd	109.53	24	0.00	61.53	0.93	0.91	0.90	0.11
6. 3-factor: Disorganized	83.28	23	0.00	37.28	0.95	0.93	0.92	0.10
Low adversity–high adversity comparison								
6a. Unequal	252.86	46	0.00	160.86	0.94	0.95	0.93	0.09
6b. Equal	276.16	68	0.00	140.16	0.95	0.94	0.95	0.08

Note.—AIC = Akaike Information Criterion; CFI = Comparative Fit Index; NFI = Normed Fit Index; RMSEA = Root Mean Squared Error Index; TLI = Tucker-Lewis Index.

Figure 2. LISREL 8 model estimates for subjects with low and high psychopathology¹

Note.—Cog-Percept = cognitive-perceptual; Interpers = interpersonal; Ideas Refer = ideas of reference; Magic = magical thinking; Percept = unusual perceptual experiences; Affect = constricted affect; Odd Behav = odd behavior.

¹ Subjects scoring in the top 10% on measures of alcoholism, depression, or antisocial personality disorder were classified as high psychopathology; subjects scoring in the bottom 90% were classified as low psychopathology.

Table 6. Model-fitting results by psychopathology

Model	χ^2	df	p	AIC	CFI	NFI	TLI	RMSEA
Low psychopathology¹ (n = 963)								
1. Null	3,193.03	36	0.00	3121.03	—	—	—	0.30
2. 1-factor	542.04	27	0.00	488.04	0.84	0.83	0.78	0.14
3. 2-factor	358.46	26	0.00	306.46	0.89	0.89	0.84	0.12
4. 3-factor: Paranoid	358.06	24	0.00	310.06	0.89	0.89	0.84	0.12
5. 3-factor: Odd	261.31	24	0.00	213.31	0.92	0.92	0.89	0.10
6. 3-factor: Disorganized	171.57	23	0.00	125.57	0.95	0.95	0.93	0.08
High psychopathology² (n = 238)								
1. Null	919.56	36	0.00	847.56	—	—	—	0.32
2. 1-factor	187.33	27	0.00	133.33	0.82	0.80	0.76	0.16
3. 2-factor	144.64	26	0.00	92.64	0.87	0.84	0.81	0.14
4. 3-factor: Paranoid	148.15	24	0.00	100.15	0.86	0.84	0.79	0.15
5. 3-factor: Odd	113.27	24	0.00	65.27	0.90	0.88	0.85	0.13
6. 3-factor: Disorganized	89.57	23	0.00	43.57	0.92	0.90	0.88	0.11
Low psychopathology–high psychopathology comparison								
6a. Disorganized unequal	261.14	46	0.00	169.14	0.95	0.94	0.92	0.06
6b. Equate factor loadings	276.93	56	0.00	164.93	0.95	0.93	0.93	0.06
6c. Equate loadings + unique	337.94	65	0.00	207.94	0.93	0.92	0.93	0.06
6d. Equate loadings + unique + factor correlations	341.90	68	0.00	205.90	0.93	0.92	0.93	0.06

Note.—AIC = Akaike Information Criterion; CFI = Comparative Fit Index; NFI = Normed Fit Index; RMSEA = Root Mean Squared Error Index; TLI = Tucker-Lewis Index.

¹ Subjects scoring in the bottom 90% on measures of alcoholism, depression, or antisocial personality disorder were classed as low psychopathology.

² Subjects scoring in the top 10% on measures of alcoholism, depression, or antisocial personality disorder were classed as high psychopathology.

Table 7. Standardized factor loadings and correlations by gender and ethnicity

Trait	Male			Female			General Population			Indian		
	C/P	Int	Dis	C/P	Int	Dis	C/P	Int	Dis	C/P	Int	Dis
Ideas of reference	0.80	—	—	0.75	—	—	0.72	—	—	0.79	—	—
Magical thinking	0.51	—	—	0.54	—	—	0.50	—	—	0.54	—	—
Unusual perceptual experiences	0.72	—	—	0.74	—	—	0.72	—	—	0.73	—	—
Paranoid ideation	0.55	0.27	—	0.58	0.18	—	0.53	0.20	—	0.57	0.22	—
Social anxiety	—	0.76	—	—	0.64	—	—	0.70	—	—	0.72	—
No close friends	—	0.69	—	—	0.67	—	—	0.72	—	—	0.68	—
Constricted affect	—	0.84	—	—	0.84	—	—	0.83	—	—	0.84	—
Odd behavior	—	—	0.75	—	—	0.81	—	—	0.82	—	—	0.75
Odd speech	—	—	0.78	—	—	0.80	—	—	0.79	—	—	0.78
Factor correlations												
	C/P			C/P			C/P			C/P		
	Int	0.59		Int	0.63		Int	0.64		Int	0.59	
	Dis	0.81	0.89	Dis	0.81	0.91	Dis	0.84	0.82	Dis	0.80	0.92

Note.—C/P = cognitive/perceptual deficits; Dis = disorganization; Int = interpersonal deficits.

Table 8. Standardized factor loadings and correlations by religious affiliation

Trait	Catholic			Hindu			Muslim		
	C/P	Int	Dis	C/P	Int	Dis	C/P	Int	Dis
Ideas of reference	0.72	—	—	0.79	—	—	0.78	—	—
Magical thinking	0.50	—	—	0.54	—	—	0.50	—	—
Unusual perceptual experiences	0.74	—	—	0.73	—	—	0.71	—	—
Paranoid ideation	0.56	0.19	—	0.59	0.19	—	0.53	0.30	—
Social anxiety	—	0.70	—	—	0.73	—	—	0.68	—
No close friends	—	0.73	—	—	0.66	—	—	0.72	—
Constricted affect	—	0.84	—	—	0.83	—	—	0.86	—
Odd behavior	—	—	0.81	—	—	0.76	—	—	0.71
Odd speech	—	—	0.79	—	—	0.81	—	—	0.73
Factor correlations									
	C/P	Int		C/P	Int		C/P	Int	
	Int	0.62		Int	0.60		Int	0.61	
	Dis	0.82	0.83	Dis	0.78	0.92	Dis	0.94	0.92

Note.—C/P = cognitive/perceptual deficits; Dis = disorganization; Int = interpersonal deficits.

Table 9. Standardized factor loadings and correlations by adversity and psychopathy symptoms

Trait	Low Adversity			High Adversity			Low Psychopathy ¹			High Psychopathy ²		
	C/P	Int	Dis	C/P	Int	Dis	C/P	Int	Dis	C/P	Int	Dis
Ideas of reference	0.76	—	—	0.82	—	—	0.75	—	—	0.81	—	—
Magical thinking	0.50	—	—	0.57	—	—	0.51	—	—	0.51	—	—
Unusual perceptual experiences	0.67	—	—	0.86	—	—	0.72	—	—	0.66	—	—
Paranoid ideation	0.58	0.21	—	0.57	0.22	—	0.56	0.21	—	0.57	0.19	—
Social anxiety	—	0.70	—	—	0.76	—	—	0.67	—	—	0.74	—
No close friends	—	0.69	—	—	0.69	—	—	0.67	—	—	0.68	—
Constricted affect	—	0.83	—	—	0.86	—	—	0.82	—	—	0.85	—
Odd behavior	—	—	0.74	—	—	0.83	—	—	0.74	—	—	0.72
Odd speech	—	—	0.77	—	—	0.87	—	—	0.75	—	—	0.79
Factor correlations												
	C/P	Int		C/P	Int		C/P	Int		C/P	Int	
	Int	0.59		Int	0.60		Int	0.55		Int	0.55	
	Dis	0.79	0.88	Dis	0.82	0.90	Dis	0.79	0.86	Dis	0.76	0.91

Note.—C/P = cognitive/perceptual deficits; Dis = disorganization; Int = interpersonal deficits.

¹ Subjects scoring in the bottom 90% on measures of alcoholism, depression, or antisocial personality disorder were classed as low psychopathology.

² Subjects scoring in the top 10% on measures of alcoholism, depression, or antisocial personality disorder were classed as high psychopathology.

Interpersonal deficits, and Disorganization, underlies individual differences in a nationally representative and ethnically diverse Mauritian sample. Other competing schizotypal models (one-factor, two-factor, trifactor-paranoid [Rosenberger and Miller 1989], and trifactor-odd [Battaglia et al. 1997]) did not fit the data better than the trifactor-disorganized model in any of the samples. The fact that eight independent and diverse samples from five studies based in four separate countries (United States, Great Britain, Mauritius, and Taiwan) all produce exactly

the same factor structure (two samples, Raine et al. 1994; one sample, Gruzelier et al. 1995; two samples, Gruzelier 1996; two samples, Chen et al. 1997; three samples in this study) constitutes strong, replicable, cross-cultural support for the three-factor model of schizotypal personality as measured by the SPQ. These findings from Mauritius also add to the recent and growing body of evidence from diverse countries outside of the United States (Great Britain, Israel, Canada, Taiwan, and Australia) indicating cross-cultural construct validity for the SPQ (Lipp and

Vaitl 1992; Gruzelier and Kaiser 1996; Chen et al. 1997; Poreh et al. 1997; Roth and Baribeau 1997).

We had hypothesized that the discrepancies in factor models between three previous studies that enter the same nine *DSM* schizotypal traits into the analysis (Raine et al. 1994; Bergman et al. 1996a; Battaglia et al. 1997) may be accounted for by variations in the nature of the subject samples. We tested this hypothesis by comparing factor structures from subgroups that differed on the basis of gender, ethnicity, religion, and socioeconomic groupings. However, no substantive differences between either the factor structure or the factor intercorrelations resulted from these analyses. Furthermore, no substantive differences in factor structure or intercorrelations were observed in a subsample selected on the basis of high scores (top 10%) on measures of alcohol-related problems, symptoms of depression, or symptoms of antisocial personality disorder, indicating that differences are not easily accounted for by the fact that some studies employed clinical populations. The low loading for paranoid ideation on the Interpersonal factor across all analyses was the only minor difference compared to previous findings. Other studies have shown, as in the present case, that paranoid ideation loads relatively higher on the Cognitive-Perceptual factor than on the Interpersonal factor (e.g., Gruzelier et al. 1995; Battaglia et al. 1997; adult sample in Chen et al. 1997). Replication of the Disorganization trifactor model structure by gender, ethnicity, religion, and socioeconomic groupings in samples with other ethnic compositions would add to the strong findings reported in the present study.

A remaining possibility that we could not test is that discrepancies between studies may be due to the different instruments used to assess SPD. While we have used the SPQ, Battaglia et al. (1997) and Bergman et al. (1996a) used semistructured diagnostic instruments. This cannot explain why the latter two studies, both of which used clinical diagnostic instruments, obtained quite different results from each other. Indeed, factor loadings from Battaglia et al. (1997), which employed a semistructured interview, were more similar to those in the current study, which employed the self-report SPQ, than to loadings obtained in Bergman et al. (1996a).

The question remains, therefore, as to what factor can account for the discrepancy in factor analyses. One recent finding that sheds some light on this issue is an unpublished study by Bergman and colleagues in which the trifactor-Disorganized model was supported in analysis of first-degree relatives of patients with schizophrenia (Bergman et al. 1996b). Therefore, the main discrepancy in factor structure across *DSM* schizotypal personality studies is found in Bergman et al. (1996a), which used an inpatient and outpatient veteran sample, the majority of whom had coexisting axis I disorders in addition to other

axis II disorders. In contrast, studies with either identical findings (Raine et al. 1994; Gruzelier et al. 1995; Bergman et al. 1996b; Gruzelier and Doig 1996) or very similar findings (Battaglia et al. 1997) to the Disorganization trifactor model used either community samples or outpatients. Hence, factors associated with institutionalization and degree of psychopathology may account for differences across studies.

The conceptual, theoretical, and empirical importance of establishing a reliable factor model for a *DSM* conceptualization of schizotypal personality cannot be underestimated. Despite extensive efforts, investigators are still struggling with the central conceptual question of "what is schizotypy?" (Lencz and Raine 1995; Raine et al. 1995), partly because there are multiple conceptualizations and measures of this construct. Answering this question will depend partly on establishing a clear, replicable factor structure to the schizotypal personality construct (Venables 1995). Chapman et al. (1995) have argued that a syndromal approach to schizotypy is likely to be superior to the measurement of a pure single factor. The success of this approach is critically dependent on understanding how many and what type of syndromes make up schizotypal personality. While the answer to the question of "what factors underlie individual differences in *DSM*-defined schizotypal personality in noninstitutionalized populations?" seems to be increasingly "Cognitive-Perceptual deficits, Interpersonal deficits, and Disorganization," a different answer may be required for institutionalized populations.

The importance of understanding what schizotypy is can also be seen at an empirical level. To the extent that the view of Meehl (1989) that there is a single vulnerability dimension to schizotypal personality is incorrect, attempts to relate a unitary concept of schizotypal personality to neuroanatomical, neurochemical, neuropsychological, psychophysiological, and cognitive correlates will be relatively unsuccessful. Instead, it becomes critically important to relate subfactors of schizotypy to these putative etiological mechanisms. This argument is becoming increasingly substantiated empirically. Gruzelier and Kaiser (1996) have found Cognitive-Perceptual features of schizotypy to be selectively related to extremes in age of puberty, which is in turn related to synaptic density. Conversely, Interpersonal deficits have been related to right hemisphere overactivation as indicated by better face recognition (Gruzelier et al. 1995; Gruzelier and Doig 1996), mild olfactory agnosia (Park and Schoppe 1997), poor spatial working memory (Park and McTigue 1997), poorer attention (Chen et al. 1997), and poor eye tracking (Kendler et al. 1991). While both the Cognitive-Perceptual and Interpersonal deficits factors are related to retarded

habituation of the skin conductance orienting response (reflecting a deficit in preattentive template matching and working memory, Raine et al. 1997) and mild olfactory agnosia (a marker for orbitofrontal dysfunction, Park and Schoppe 1997), the Disorganization factor is not. Siever (1994) has developed a model of schizotypy (with supporting empirical evidence) that argues that the positive schizotypy (Cognitive-Perceptual deficits) is produced by increased dopamine activity in predominantly subcortical brain regions, while conversely negative schizotypy (Interpersonal deficits) is caused by a neurodevelopmental cortical impairment predicated on a disorder of neuronal cell migration. Traits making up Disorganization, but not other factors, have been associated with left hemisphere overactivation as indicated by better word recognition (Gruzelier et al. 1995), left and mixed handedness (Kim et al. 1992; Gruzelier and Doig 1996), and increased self-report arousal (Gruzelier and Doig 1996). These findings consequently provide increasing support for a syndrome approach to understanding schizotypal personality (Kendler and Hewitt 1992; Chapman et al. 1995; Gruzelier 1995; Lencz and Raine 1995; Venables 1995) and for the critical importance of establishing the precise factor structure underlying schizotypal personality.

A second implication of the findings is that the well-replicated three-factor structure to *DSM*-defined schizotypal personality using the SPQ parallels the three-factor structure reported in patients with schizophrenia (Bilder et al. 1985; Liddle and Barnes 1990; Arndt et al. 1991; Gruzelier 1991). This parallel may not be coincidental. Rather, it can be hypothesized that the three-factor structure found in schizophrenia may arise from an exaggeration of the same factor structure of schizotypal personality found in the normal population. If this is true, then research into individual differences in schizotypal personality in nonclinical populations may importantly inform our understanding of the etiology of schizophrenic symptomatology (Siever 1985; Nuechterlein 1990; Kendler et al. 1991). For example, when mechanisms that underlie individual differences in speech and behavior in the normal population become mildly dysfunctional, they may give rise to odd speech and odd behavior at the clinical level in schizotypal individuals in the community, while a still greater degree of dysfunction may give rise to symptoms of thought disorder and bizarre behavior observed in hospitalized schizophrenia patients. While such research may importantly inform our understanding of the etiology of schizophrenia, it is again dependent on clearly establishing the factor structure to schizotypal personality.

A potentially important issue that cannot be addressed by the current study concerns recent findings in

the schizophrenia literature that premorbid social adjustment may reflect a fourth factor. Recent factor analyses of schizophrenic symptoms (Lenzenweger and Dworkin 1996) suggest the presence of three to four factors, three of which appear similar to the Disorganization trifactor model of schizotypal personality (reality distortion, negative symptoms, and disorganization). The fourth factor, premorbid social adjustment deficits, has not been included in criteria for SPD to date (American Psychiatric Association 1994). This issue prompts caution in making definitive claims about the factor structure of schizotypal personality. More specifically, the strength of the SPQ, that it is based on *DSM* criteria for schizotypal personality, is also a limitation because the "true" composition of schizotypal personality may ultimately be shown to differ from that expressed in *DSM* criteria. Nevertheless, the current findings for the SPQ at least provide a starting point for understanding the factor structure to one (the *DSM*) conceptualization of schizotypy.

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