Factorial Composition of Self-Rated Schizotypal Traits Among Young Males Undergoing Military Training

by Nicholas C. Stefanis, Nikolaos Smyrnis, Dimitrios Avramopoulos, Ioannis Evdokimidis, Ioannis Ntzoufras, and Costas N. Stefanis

Abstract

The aim of this study within the Athens Study of Psychosis Proneness and Incidence of Schizophrenia (ASPIS) was the examination of the latent structure of schizotypal dimensions among a large population of young male conscripts in the Greek Air Force during their first week of military training. Confirmatory factor analysis (CFA) was conducted on 1,355 reliable responders to the self-rated Schizotypal Personality Questionnaire (SPQ), which covers all nine aspects of *DSM–III–R* schizotypal personality disorder (SPD). A four-factor model (cognitive/perceptual, paranoid, negative, and disorganization schizotypal dimensions) provided a better fit to the data than did other competing models (one-, two-, three-, four, and five-factor models). This result is in agreement with recent findings supporting the notion of a multidimensional construct of the schizotypy and related schizophrenia phenotype.

Keywords: Schizotypy, SPD, dimensions, CFA, SPQ, paranoia.

***Schizophrenia Bulletin*, 30(2):335–350, 2004.**

The study of schizotypal personality traits in apparently normal individuals has received great attention because genetic and epidemiological studies have provided consistent evidence that schizotypal features cluster in subjects with elevated risk for schizophrenia and are prodromal to the subsequent full manifestation of schizophrenia (Maier et al. 1999). Two major theoretical approaches exist to explain the link between schizotypal traits and schizophrenia. The theory of Meehl (1962) proposes that the vulnerability to schizophrenia is the crucial phenotype, which he called schizotypy. He defined schizotypy as an enduring personality condition based on a genetically caused neurointegrative defect (schizotaxia) that gives rise to schizotypal personality traits. This profile, in synergy with other polygenic potentiators and adverse life experiences, gives rise in a small percentage of these individuals to the clinical syndrome of schizophrenia. In his model, schizotypy is an extension of the psychotic *disease* process, of which *formes frustes* (attenuated disease expression) may exist in the general population (Claridge 1997). Meehl's model implies that the structure of liability for schizophrenia in the general population is rather dichotomous because a "schizogene" determines membership in a latent class, or taxon (Lenzenweger and Korfine 1992; Korfine and Lenzenweger 1995).

The second theoretical approach to schizotypal traits favored by Eysenck (Eysenck and Eysenck 1976) states that personality traits such as those that define psychoticism are on a continuum from health to schizophrenia with no need to introduce arbitrary cutoff points above which schizotypy lies (Claridge 1994). According to this view, certain dimensions of personality are to be found in the general population and their extremes constitute risk factors, or lead to the symptoms of a disease state such as schizophrenia. Within this framework, schizotypal traits in the general population can be grouped into dimensions using factor models. This strategy might help to elucidate how many and which underlying factors constitute the phenomenological substrate of schizotypal traits. Also, if certain phenomenological characteristics within the schizotypal construct prove to be more related to schizophrenia than others, this may facilitate early intervention strategies in high-risk individuals who exhibit these traits.

In schizotypy research, exploratory and confirmatory factorial studies have proposed two (Allen et al. 1987; Muntaner et al. 1988; Raine and Allbutt 1989), three (Hewitt and Claridge 1989; Raine et al. 1994; Joseph and Peters 1995; Bergman et al. 1996; Wolfradt and Straube

Send reprint requests to Dr. N. Stefanis, Athens University Medical School, Eginition Hospital, 72-74 Vas. Sophias Ave., Athens 11528, Greece; e-mail: nistefan@med.uoa.gr.

1998; Bergman et al. 2000; Reynolds et al. 2000; Venables and Rector 2000; Vollema and Hoijtink 2000; Rossi and Daneluzzo 2002), four (Claridge et al. 1996; Gruzelier and Doig 1996), six (Battaglia et al. 1999), and even seven (Kendler et al. 1996) dimensions. These studies are not directly comparable because of differences in assessment instruments measuring schizotypy, differences in populations under study, and methodological differences in analysis (older studies using exploratory factor analysis vs. recent studies favoring confirmatory factor analysis [CFA]). Nevertheless, an influential three-factor model seems to stand out from these studies, proposing that schizotypal traits can be divided into positive, negative, and disorganized factors (Raine et al. 1994). The model has received independent validation in different populations (Gruzelier 1996; Chen et al. 1997; Reynolds et al. 2000; Rossi and Daneluzzo 2002), with different instruments (Bergman et al. 2000), and with different analyses (Vollema and Hoijtink 2000).

This study will report on the underlying dimensional structure of schizotypal traits as they emerge from applying CFA on a self-rated schizotypy questionnaire. For hypothesis testing purposes, CFA is superior to exploratory factor analysis, which identifies possible factors that account for covariance among items in a sample but may give only a very rough idea of true underlying dimensions in the population (Bollen 1989). CFA is a robust statistical tool that allows for direct comparison of an unlimited number of alternative models based on preexisting theories or empirical evidence on the factorial structure of the construct under investigation. To perform this analysis, we used factor models of schizophrenia and schizotypy that have been proposed in the relevant literature. This inference is based on the dimensional approach to schizotypal traits, as stated previously, and should be viewed with caution because even an apparent similarity of structures found in schizotypy and schizophrenia does not necessarily imply the existence of common etiologic factors of the two diagnoses (Venables and Rector 2000).

The aim was to test competing models of the factor structure of schizotypal personality using the Schizotypal Personality Questionnaire (SPQ) (Raine 1991), which assesses all nine aspects of *DSM–III–R* (American Psychiatric Association 1987) schizotypal personality disorder (SPD), in a large, unselected sample of apparently healthy young males who are on the one hand at an age of heightened risk for schizophrenia and on the other experiencing a stressful change in life circumstances. In light of the considerations outlined above, we sought to determine whether the dominant model of three distinct but related dimensions of schizotypal traits (positive, negative, and disorganization) would be more consistent with the data than alternative competing models are.

Methods

Subjects. In eight separate waves, between January 1999 and March 2000, exactly 2,243 randomly selected young male conscripts aged 18 to 24 years were recruited from the Greek Air Force during their first 2 weeks of admission in the National Basic Air Force Training Centre. This sample was chosen because there is consistent evidence that individuals at this age are most likely to display the clinical and subclinical experiences of psychosis, thus increasing the statistical power (Claridge et al. 1996; Verdoux et al. 1998; Peters et al. 1999; van Os et al. 2000). It should be mentioned that the service is obligatory in Greece and all healthy males are recruited and randomly assigned to the different army corps. All conscripts had already been screened by a standard interview-based procedure performed by a team of medical doctors of all specialties (military personnel) and were evaluated as not suffering from a medical condition. During a followup phase of the Athens Study of Psychosis Proneness and Incidence of Schizophrenia (ASPIS), 43 conscripts were eventually admitted to the psychiatry or neurology clinic of the Air Force general hospital with preexisting diagnoses. These individuals have not been excluded from the present study. Conscripts underwent an extensive interview of computerized neurocognitive abilities and a self-rated psychometric evaluation. Conscripts provided written informed consent after agreeing to participate in an anonymous survey assessing the general psychological state of new recruits in conjunction with attention and memory skills, on which they would receive feedback on their performance. Twenty-four of the initially contacted conscripts refused to participate in the study. Finally, 2,142 subjects performed at least some of the eye movement tasks (smooth eye-pursuit, saccade, antisaccade, visual fixation) and cognitive tasks assessing vigilance of attention and aspects of working memory, and 1,955 conscripts participated by filling in a psychometric battery of self-administered questionnaires.

Some of the results of the eye movement tests have already been presented (Evdokimidis et al. 2002; Smyrnis et al. 2002; Smyrnis et al. 2003), while for the other tests analysis is in progress (Stefanis et al. 2001; Avramopoulos et al. 2002). The psychometric assessment battery included questionnaires on (1) current psychopathology with the Symptom Checklist–90–R (SLR–90–L) scale (Derogatis 1993) translated and standardized in the Greek population (Donias et al. 1991); (2) self-rated schizotypy with the Perceptual Aberration Scale (PAS; Chapman et al. 1978) and the SPQ; (3) self-rated psychotic-like symptoms with the Community Assessment of Psychic Experiences (CAPE) (Stefanis et al. 2002); and (4) per-

sonality characteristics with the Temperament and Character Inventory (TCI; Cloninger et al. 1994). All questionnaires were translated into Greek by three bilingual members of our team trained abroad (N.C.S., N.S., and D.A.), and, in a separate process, back-translation was performed by an independent official translator. Comparison of original and first English draft produced a second modified Greek version that received minor further changes when administered to a test sample of 15 young employees of the University Mental Health Research Institute (UMHRI). In the case of PAS, SPQ, and TCI, the second back-translation was sent to authors for approval, which was granted (Kwapil, T.; Raine, A.; and Cloninger, C.R., personal written communication, January 1999).

Instruments. The SPQ (Raine 1991) is a 74 "dichotomous" item (yes/no) questionnaire that assesses all nine aspects of *DSM–III–R* SPD. It can be used as a screening instrument in the general population for the identification of individuals with broad schizotypal traits (according to the author, 55% of top SPQ scorers obtained an interview-based diagnosis of SPD) and may measure individual differences in schizotypal personality. Full reliability and validity information is provided in Raine (1991). Subscale scores were expressed as proportions of the sum of positive responses divided by the number of items of each subscale minus missing values. This approach is more plausible and interpretable. Moreover, it considers all nine subscale scores of the SPQ to have equal weight in the analysis. To compare SPQ scores with the corresponding results of other authors, we present the raw SPQ scores.

Description and Motivation of Fitted Models. We compared 13 competing models of schizotypal dimensions (table 1) based on previous work in the field. The one-factor model assumes that one latent trait underlies all nine traits of SPD as measured with the SPQ. The second model is constructed on the basis of the "positive" versus "negative" distinction (Crow 1980). The third model is a modification of the second because suspiciousness and social anxiety are allowed to load on both positive and negative schizotypal traits (Kendler et al. 1991).

The fourth model, the "disorganized" three-factor model (Raine et al. 1994), is by far the most popular and the most extensively replicated in schizotypy studies to date. Three underlying dimensions constitute schizotypal traits: a "positive/perceptual" factor (magical ideation, unusual perceptual experiences, suspiciousness, and ideas of reference), a negative factor (social anxiety, constricted affect, and no close friends), and a "disorganization" factor (odd speech and odd behavior). In this model suspiciousness is allowed to load both on the cognitive-perceptual factor and negative factor. The fifth model is a "paranoid" three-factor model proposed by Bergman et al. (1996); it is derived from CFA of a sample of outpatients with various personality disorders. It proposes that "positive" schizotypal traits are split into a "cognitive/perceptual" factor encompassing magical thinking and unusual perceptual experiences and a paranoid factor receiving maximum loadings from ideas of reference, suspiciousness, and to a lesser extent social anxiety.

The sixth model is another three-factor model proposed by Battaglia et al. (1997), in which a negative schizotypal factor is differentiated from an "odd" factor that receives loadings from odd behavior, odd speech, and constricted affect. Another version of the three-syndrome model of schizophrenia is that of Strauss et al. (1974), where the third syndrome is that of "disorder of relating" rather than disorganization. In this seventh model, the schizotypal counterpart factor of "disorder of relating" receives loadings from social anxiety, odd speech, and odd behavior (Venables and Rector 2000). The eighth model is an adaptation of the preferred three-dimensional K model by Venables and Rector (2000) and is construed based on similarities between the subscale composition of the authors' questionnaire and the SPQ subscales. The ninth model is an adaptation of the preferred three V-3 factor model of Vollema and Hoijtink (2000), where the majority of items related to ideas of reference and suspiciousness load on both positive and negative schizotypal factors.

The tenth four-factor L model by Venables and Rector (2000) is also displayed in table 1. Based on similarities between the content of subscales within the authors' questionnaire and SPQ subscales, the negative schizotypal factor was allowed to receive loadings from no close friends and constricted affect subscales. Social anxiety and constricted affect load on a "social impairment" factor. The eleventh model is an adaptation of the Strauss-Peralta four-factor model of schizophrenia based on CFA of Positive and Negative Syndrome Scale (PANSS) subscales (Cuesta and Peralta 1995). Here, the schizotypal counterpart of the "disorder of relating" factor encompassing two PANSS subscales is the SPQ subscales of no close friends and constricted affect. The twelfth model is an adaptation proposed by Fogelson et al. (1999) and in particular based on the distribution of the nine SPD traits among relatives of patients with schizophrenia or schizoaffective disorder. The nine SPD traits were spread across five dimensions: a schizoid, a paranoid, an avoidant, a positive, and a disorganization factor.

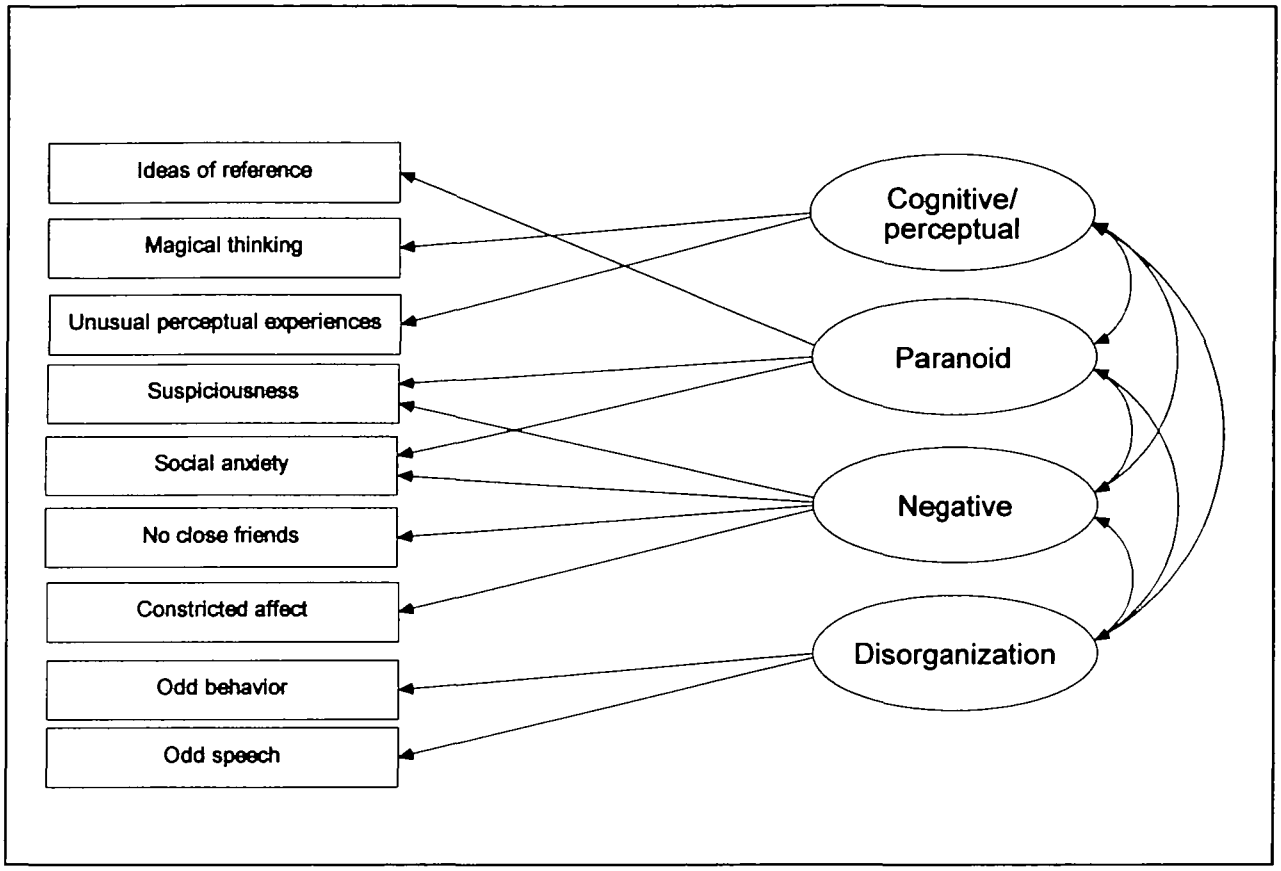
The thirteenth model is our proposed four-factor construction of schizotypal dimensions (figure 1). We hypothesized based on previous empirically driven studies in schizophrenia and in schizotypy (table 2) that a split of positive schizotypal traits into a paranoid and a cognitive/perceptual factor might provide a better fit to our

Table 1. Table of fitted factor models

Model	Factor	IR	MT	UPE	S	SA	NCF	CA	OB	OS
1 One factor	1	*	*	*	*	*	*	*	*	*
2 Crow 2-factor (Crow 1980)	1 positive	*	*	*	*				*	*
	2 negative					*	*	*		
3 Kendler 2-factor	1 positive	*	*	*	*	*				*
(Kendler et al. 1991)	2 negative				*	*	*	*	*	
4 Disorganized 3-factor	1 positive	*	*	*	*					
(Raine et al. 1994)	2 negative				*	*	*	*		
	3 disorganized							*	*	
5 Paranoid 3-factor	1 paranoid	*			*	*				
(Bergman et al. 1996)	2 positive		*	*						
	3 negative						*	*	*	*
6 Odd 3-factor	1 positive	*	*	*	*					
(Battaglia et al. 1997)	2 negative				*	*				
	3 odd							*	*	*
7 Strauss 3-factor	1 positive	*	*	*	*					
(Strauss et al. 1974)	2 negative					*	*	*		
	3 relating					*			*	*
8 K 3-factor	1 positive	*	*	*	*				*	*
(Venables and Rector 2000)	2 negative						*	*		
	3 social impairment				*		*			
9 V 3-factor	1 positive	*	*	*	*					
(Vollema and Hoijtink 2000)	2 negative	*			*	*	*	*		
	3 disorganized							*	*	
10 L 4-factor	1 positive	*	*	*	*					
(Venables and Rector 2000)	2 disorganized								*	*
	3 negative						*	*		
	4 social impairment					*		*		
11 Strauss-Peralta 4-factor	1 positive	*	*	*	*					
(Cuesta and Peralta 1995)	2 disorganized								*	*
	3 negative					*		*		*
	4 relating						*	*		
12 Fogelson et al. 5-factor	1 paranoid	*			*					
(Fogelson et al. 1999)	2 positive	*	*	*						
	3 schizoid						*	*		*
	4 avoidant	*				*				
	5 disorganized				*			*	*	
13 "Paranoid" 4-factor	1 cognitive/ perceptual		*	*						
(Stefanis et al., this article)	2 negative				*	*	*	*		
	3 disorganized								*	*
	4 paranoid	*			*	*				

Note.—CA = constricted affect; SA = social anxiety; IR = ideas of reference; MT = odd beliefs or magical thinking; NCF = no close friends; OB = odd behavior; OS = odd speech; S = suspiciousness; UPE = unusual perceptual experiences.

Figure 1. Path representation of paranoid four-factor model



data. Thus suspiciousness, ideas of reference, and social anxiety were allowed to load on the paranoid factor, in accordance with Bergman et al. (1996) and most studies presented in table 2, in which it was demonstrated that these three components tend to segregate in the same paranoid factor. Suspiciousness was also allowed to load on the negative schizotypal factor in accordance with Tsuang et al. (1991), Raine et al. (1994), Gruzelier (1996), and most subsequent CFA of the SPQ.

Analysis. CFA was conducted via the structural equation modeling approach (Bollen 1989) using AMOS 3.6 (Arbuckle 1997) statistical software. In this study, we focus on the comparison between and the plausibility of various hypotheses and models. For this reason, we use various measures for the goodness of fit and the comparison of models. Although the most popular way to assess the goodness of fit of a model is the chi-square significance test and its associated p value, in recent years many social (including psychometric) researchers have pointed out the general inadequacy of the significance tests and their associated p values. These difficulties are more apparent when a large amount of data are considered as in psychometric research and can be summarized in "rejection of the null hypothesis even when the null model seems reasonable theoretically" (Raftery 1995), which leads to selection of overparameterized nonparsimonious models (also see Bentler and Bonnet 1980, for additional arguments). For the above reasons, we use alternative measures proposed in the CFA literature. These measures can be divided into two categories: (1) goodness of fit indexes and (2) information theoretical measures for model comparison.

The goodness of fit measures Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Tucker-Lewis Index (TLI), and Normed Fit Index (NFI) indicate good models for values higher than 0.90 (for details, see Arbuckle [1997] and references therein). Root mean square error of approximation (RMSEA) values of 0.05 or less have been proposed as indicative of reasonable fit between model and data (Browne and Cudeck 1993).

The most popular information theoretical measure in latent factor models is the Akaike information criterion (AIC; Akaike, 1973, 1987). We additionally consider

Table 2. Paranoid factor in schizotypy, independent of a cognitive/perceptual factor

Reference	Sample details	Diagnostic instrument	Statistical method	Factors	Variance[1] (%)	Paranoid factor
Rosenberger and Miller (1989)	106 psychology students scoring over the 90th percentile across various psychometric scales	SPD from SIDP	PCA	3 (eigenvalue > 1)	21.9/63.0	Undue social anxiety, suspiciousness, ideas of reference
Hewitt and Claridge (1989)	210 adult twin pairs from population-based study	STA	PCA	3	—	Paranoid ideation, suspiciousness
Kendler et al. (1995)	1,272 first degree relatives of psychotic and nonpsychotic probands	SIS	FA	7	6.1/53.0	Suspicious behavior
Joseph and Peters (1995)	268 normal subjects	STA	PCA	3	—	Paranoid ideation, suspiciousness
Bergman et al. (1996)	213 subjects with personality disorders	SIDP	CFA	3	NA	Ideas of reference, suspiciousness, social anxiety
Gruzelier (1996)	151 medical students	SPQ, EPQ, and physical anhedonia	PCA	4	9.0/60.5	Neuroticism, social anxiety, suspiciousness
Wolfradt and Straube (1998)	1,362 adolescents	STA	PCA	3	5/57.7	Suspiciousness
Verdoux et al. (1998)	444 GP attendants	PDI–21	PCA	7	19.0/55.3	Suspiciousness and persecutory ideas
Battaglia et al. (1999)	59 twin pairs drawn from population registry	SPD from SIDP–R	LCA	3	NA	Social anxiety, ideas of reference, suspiciousness
Fogelson et al. (1999)	307 first degree relatives and siblings of schizophrenia probands	SCID–II	EFA	6 (eigenvalues > 1)	9.0/40.0	Suspiciousness, paranoid ideation, etc.
Peters et al. (1999)	272 healthy subjects	PDI	PCA	11 (eigenvalue > 1)	13.6/59.1 (3 factors related to paranoia)	Persecution, suspiciousness, paranoid ideation, ideas of reference[2]
Suhr and Spitznagel 2001	348 students, high scorers on schizotypy scales	SPQ, PAS, MIS	EFA	4	-/65.5	Ideas of reference, suspiciousness
Fossati et al. (2001)	564 inpatients and outpatients	SCID–II	LCA	4 (classes)	NA	Suspiciousness, ideas of reference, no close friends

Note.—CFA = confirmatory factor analysis; EFA = exploratory factor analysis; FA = factor analysis; GP = general practitioner; LCA = latent class analysis; MIS = Magical Ideation Scale; NA = not applicable; PAS = Perceptual Aberration Scale; PCA = principal component analysis; PDI = Peters Delusional Inventory; SCID–II = Structured Interview for *DSM–III–R* Personality Disorders; SIDP–R = Structural Interview for *DSM–III–R* Personality Disorders; SIS = Structured Interview for Schizotypy; SPD = schizotypal personality disorder; SPQ = Schizotypal Personality Questionnaire; STA = Schizotypal Personality Scale.

[1] Percentage of total variance explained by a paranoid factor/percentage of total variance explained by the selected factors.

[2] Three factors were related to paranoia out of 11 selected components derived from CFA.

Bayes Information Criterion (BIC) introduced by Schwarz (1978) and strongly supported by Raftery (1993, 1995). Consistent AIC (CAIC, Bozdogan 1987) and Browne and Cudeck (1989) Criterion (BCC) are modifications of the above measures. BIC has gained significant attention due to consistent results obtained, amenable to sample size changes. Moreover, it tends to support less complicated models (i.e., models with fewer dimensions of schizotypal traits) than AIC. All the information theoretical measures are indicators of model comparison (not goodness-of-fit indexes). Lower values of these theoretical measures indicate better models. Finally, the multiple R^2 for each SPQ subscale are also reported in order to access the percentage of variation of each subscale that is explained by the proposed model (see, for details, Bollen 1989).

Results

Sample Special Characteristics (Correct vs. Random Responders). To verify the degree of collaboration with the self-report scales, we used the four validity items of the TCI to exclude 544 subjects from 1,955 (27.8%) that responded incorrectly to at least one of these items (random responders). The 1,411 individuals (72.2%) who had correctly ticked the boxes on all four questions were initially included in the analyses of psychometrically defined schizotypal traits. From the 1,411 conscripts who correctly responded to the four validity questions, 56 conscripts (4.0%) failed to respond to at least two items of any specific SPQ subscale or to more than seven items in the total SPQ questionnaire and were excluded. Thus, the subscale scores of 1,355 conscripts were eventually included for CFA. Compared with the 1,355 correct responders, the 544 random responders were significantly younger (mean age = 20.3 years, SD = 1.8 years, vs. mean age = 20.9 years, SD = 1.9 years, $p < 0.001$) and had fewer years of formal education (mean = 11.9 years, SD = 2.7 years, vs. mean = 13.0 years, SD = 2.2 years, $p < 0.001$). Moreover, the mean score of PAS was significantly higher than for the correct responders group (mean PAS = 8.9, SD 6.3, vs. mean PAS = 5.2, SD = 5.2, $p < 0.001$). Total and subscale mean SPQ scores of correct responders were very similar to the ones identified in population studies in the United States (Raine 1991) and Mauritius (Reynolds et al. 2000) (mean SPQ = 27.6, SD = 12.3, Cronbach's coefficient alpha = 0.91, subscale alpha coefficients ranging from 0.58 to 0.80). Statistically significant differences regarding the SPQ were identified between the random and correct responders (mean SPQ for random responders = 31.1, SD = 12.3, $p < 0.001$). Random responders also exhibited substantially worse performance than correct responders in all neurocognitive tasks. On the other hand, from the nine SCL–90–R dimensions assessing current psychopathology, random responders differed on only the phobic anxiety dimension (mean = 0.44, SD 5.7, vs. 0.33, SD 4.3, $p < 0.001$), indicating an augmented avoidance and escape behavior (Derogatis 1993) in this group.

Goodness of Fit and Model Selection. Analytic details of goodness of fit indexes and information theoretical measures of model comparison are presented in table 3. Considering the rule of thumb that GFI, AGFI, NFI, and TLI should exceed at least 0.90, six equally well-fitted

Table 3. Table of model comparison and goodness of fit indexes

		Information Theoretic Measures				Goodness of Fit Indexes				
	Models	AIC	BCC	BIC	CAIC	GFI	AGFI	NFI	TLI	RMSEA
1	One-factor	819.97	820.24	953.22	931.67	0.88	0.80	0.80	0.74	0.144
2	Crow 2-factor	448.18	448.46	588.83	566.08	0.94	0.89	0.90	0.85	0.105
3	Kendler 2-factor	628.24	628.56	783.70	758.56	0.91	0.84	0.90	0.77	0.132
4	Disorganized 3-factor	326.65	326.98	489.51	463.18	0.99	0.98	0.98	0.97	0.092
5	Paranoid 3-factor	628.40	628.72	783.86	758.72	0.90	0.81	0.85	0.78	0.132
6	Odd 3-factor	641.62	641.94	797.08	771.94	0.91	0.82	0.85	0.78	0.113
7	Strauss 3-factor	354.14	354.47	517.00	490.66	0.95	0.91	0.92	0.88	0.096
8	K 3-factor	376.45	376.77	531.91	506.77	0.95	0.90	0.91	0.88	0.098
9	V 3-factor	325.20	325.55	495.47	467.93	0.96	0.91	0.93	0.89	0.093
10	L 4-factor	270.38	270.75	457.40	426.28	0.97	0.92	0.95	0.91	0.087
11	Strauss-Peralta 4-factor	264.93	265.32	457.40	426.28	0.97	0.92	0.95	0.91	0.087
12	Fogelson et al. 5-factor	148.81	149.28	378.30	341.19	0.99	0.95	0.98	0.95	0.062
13	Paranoid 4-factor	117.65	118.04	310.12	278.99	0.99	0.98	0.98	0.97	0.043

Note.—AGFI = Adjusted Goodness of Fit Index; AIC = Akaike Information Criterion; BCC = Browne and Cudeck (1989) Criterion; BIC = Bayes Information Criterion; CAIC = consistent AIC; GFI = Goodness of Fit Index; NFI = Normed Fit Index; RMSEA = root mean square error of approximation; TLI = Tucker–Lewis Index.

models were distinguished: the disorganized three-factor model (Raine et al. 1994), the Strauss three-factor model (Strauss et al. 1974), the V three-factor model (Vollema and Hoijtink 2000), the L four-factor model (Venable and Rector 2000), the Strauss–Peralta four-factor model (Cuesta and Peralta 1995), and the paranoid four-factor model (Stefanis et al., this article). On the other hand, the only model that adequately fits the data according to RMSEA index (RMSEA < 0.05) as suggested by Browne and Cudeck (1993) is the proposed "paranoid" four-factor model.

The observation of the information theoretical measures (AIC, BCC, BIC, CAIC) indicates that the disorganized and V three-factor models are indeed better than other proposed three-factor models. There was no clear distinction between these two models, in statistical power (AIC and BCC support the V three-factor model, while BIC and CAIC support the disorganized model) or theoretical grounds (identical factor distribution with items related to paranoia loading on positive and negative dimensions). The paranoid four-factor model was the best model fitting our data, demonstrating much lower measures than the a priori supported disorganized three-factor model (AIC was reduced by 64% and BIC by 37%). Therefore, having an additional paranoid factor appeared to improve the model fit. From the above, we conclude that the paranoid four-factor model should be selected.

Factor Loadings and Estimated Correlation Matrix. Maximum likelihood factor loadings of the dominating paranoid four-factor model are presented in table 4. The first factor was derived by substantial factor loadings on magical thinking and unusual perceptual experiences (0.55 and 0.84), indicating a latent pattern of cognitive/perceptual deficits. The second factor consisted of factor loadings from suspiciousness, social anxiety, no close friends, and constricted affect, which ranged from 0.25 to 0.84. This latent pattern was similar to the second factor of the popular disorganized three-factor model and can be interpreted, according to Raine et al. (1994), as deficits in interpersonal relationships (negative factor). The third factor was again similar to the "disorganization" factor within the disorganized three-factor model and was defined by high loads from odd behavior and odd speech "suggesting cognitive and behavioural disorganization" (Raine et al. 1994, p. 196). The last factor was defined by high loads on ideas of reference and suspiciousness and by lower but significant loading on social anxiety ($p < 0.001$). This factor was labeled as the paranoid factor. Note that the proposed model is a generalization of the popular disorganized three-factor model of schizophrenia introduced by Liddle (1987). The negative and disorganization factors are the same in the two modeling approaches, while the first factor (cognitive/perceptual) of the disorganized model is divided in two new ones, indicating a relative independence of cognitive/perceptual deficits from paranoid beliefs and experiences.

Generally, the proposed model managed to account well for the variation of the scores measuring ideas of reference, constricted affect, and unusual perceptual experiences (multiple R^2 of 0.750, 0.711, and 0.709, respectively). The variance of odd speech, no close friends, odd behavior, and suspiciousness was between 40 percent and 60 percent. Finally, the variability of social anxiety and magical thinking was 38 percent and 30 percent, respectively. Note that multiple squared correlations of the corresponding disorganized three-factor model were considerably lower, ranging from 0.245 to 0.663.

The estimated correlations between the latent factors are given in table 5 and range from 0.33 to 0.71. The paranoid factor and the disorganization factor were found to be highly correlated (0.71). The disorganization factor was also correlated with the other two latent factors: cognitive/perceptual ($r = 0.69$) and negative ($r = 0.63$). The

Table 4. Standardized factor loadings for paranoid four-factor model

SPQ subscales	Cognitive/perceptual (factor 1)	Negative (factor 2)	Disorganized (factor 3)	Paranoid (factor 4)
Ideas of reference				0.87
Magical thinking	0.55			
Unusual perceptual experiences	0.84			
Suspiciousness		0.25		0.54
Social anxiety		0.47		0.28
No close friends		0.71		
Constricted affect		0.84		
Odd behavior			0.69	
Odd speech			0.78	

Note.—SPQ = Schizotypal Personality Questionnaire.

first finding is in partial agreement with the results of Raine et al. (1994), in which similar correlation patterns (0.71 and 0.74) were found between the positive and the disorganization factor (in our disorganized three-factor model the corresponding correlation is 0.81). Also, a high correlation (r = 0.66) was found between the cognitive/perceptual factor and the paranoid factor. The remaining two correlations of the negative factor with the cognitive/perceptual factor and paranoid factor are relatively low: 0.41 and 0.33, respectively.

Generally, sample size influences the complexity of the selected model. BIC is the measure that is consistent and more robust to sample sizes. To check whether the selection of the four-factor model was due to the large sample size (1,355 subjects), we divided the original sample into four subsamples and we compared the AIC and BIC measures for the disorganized three-factor model and the paranoid four-factor model. In all four samples, the paranoid four-factor model was superior, and hence the large sample size was not so influential as to change the selected model. Details are given in table 6.

In table 7 we present the goodness of fit indexes of the paranoid four-factor model in comparison with other studies in which CFA of schizotypal traits was used. On the whole, the paranoid four-factor model provided comparable performance with preferred models in other studies with different assessment instruments and different populations.

Discussion

In this study, we analyzed the factorial structure of self-rated schizotypal traits as defined by responses of 1,355 conscripts in the Greek Air Force to the SPQ. Results from our study using CFA indicate that a disorganized three-factor model (positive, negative, and disorganization factors) provided a good fit to our data, as it had to the data of Raine et al. (1994), Reynolds et al. (2000), and Vollema and Hoijtink (2000). A four-factor model where positive schizotypal traits where further divided into a paranoid and a cognitive/perceptual factor provided a better fit to the data than a three-factor model, while other competing models (one-, two-, three-, four-, and five-factor models) failed to produce better indexes of fit (table 3). This result is in agreement with recent findings in schizotypy research supporting the notion of a multidimensional construct of positive symptoms (table 2). The finding of a more complex structure of schizotypal dimensions than previously acknowledged is in line with the

Table 5. Intrafactor correlation matrix for the paranoid four-factor model

SPQ subscales	Cognitive/perceptual (factor 1)	Negative (factor 2)	Disorganized (factor 3)	Paranoid (factor 4)
Cognitive/perceptual (factor 1)	1.00			
Negative (factor 2)	0.41	1.00		
Disorganized (factor 3)	0.69	0.63	1.00	
Paranoid (factor 4)	0.66	0.33	0.71	1.00

Table 6. Comparison of paranoid four-factor model and disorganized three-factor model in random subsamples

		BIC		AIC	
Sample	Sample size	Paranoid 4-factor	Disorganized 3-factor	Paranoid 4-factor	Disorganized 3-factor
1	350	246.9	256.4	89.5	123.1
2	357	233.9	263.3	76.0	130.9
3	351	234.7	268.4	77.2	135.1
4	295	243.5	276.9	90.5	147.5

Note.—AIC = Akaike Information Criterion; BIC = Bayes Information Criterion.

Table 7. Comparative table of goodness of fit indexes

	Goodness of Fit Indexes						
	GFI	AGFI	NFI	TLI	CFI	CCFI	RMSEA
Lenzenweger et al. (1991)	0.87			0.70			
Raine et al. (1994)	0.96	0.91	0.93	0.90			
Bergman et al. (1996)					0.74	0.76	
Chen et al. (1997)	0.94	0.88	0.90	0.87			
Bergman et al. (2000)	0.96		0.92	0.98	1.00		0.048
Venables and Rector (2000)	0.99	0.98	0.99		1.00		
Reynolds et al. (2000)			0.94	0.92	0.95		0.090
Stefanis et al., this article—ASPIS disorganized 3-factor model	0.99	0.98	0.98	0.97	0.93		0.092
Stefanis et al., this article—ASPIS paranoid 4-factor model	0.99	0.98	0.98	0.97	0.99		0.043

Note.—AGFI = Adjusted Goodness of Fit Index; ASPIS = Athens Study of Psychosis Proneness and Incidence of Schizophrenia; GFI = Goodness of Fit Index; NFI = Normed Fit Index; RMSEA = root mean square error of approximation; TLI = Tucker–Lewis Index.

current understanding of schizophrenia as a multidimensional construct at the phenomenological level.

Distinction of Positive and Paranoid Factors. Recent CFA studies on schizotypal dimensions favor a three-factor solution in which suspiciousness loads consistently on both cognitive/perceptual factor and negative factor (Raine et al. 1994; Gruzelier 1996; Bergman et al. 2000; Reynolds et al. 2000; Vollema and Hoijtink 2000). For example, Vollema and Hoijtink (2000) demonstrated a substantial improvement of indexes of fit to their three-dimensional model when items related to referential thinking and paranoia were allowed to load on both positive and negative factors. In most of these studies, the relative correlation of suspiciousness to the positive factor is roughly double the corresponding correlation of the negative factor. This has been taken invariably as evidence that suspiciousness is a variant of positive schizotypal traits. Alternatively, it would have been possible to hypothesize that suspiciousness is an overt constituent of a dormant paranoid factor that includes aspects from the cognitive/perceptual factor as well as from the negative factor and is "suppressed" in a three-factor solution. In our study, we found that within a three-factor model solution, the paranoid model provides worse indexes of fit than the disorganized model. This indicates that within a forced three-factor solution, the integrity of a unitary positive schizotypal factor better explains the data at hand than a model whose constituents (cognitive/perceptual and paranoid) are upgraded to independent factors. Thus, within a three-factor solution, the discrimination between a paranoid factor and a cognitive/perceptual factor is not supported. On the other hand, the paranoid four-factor model in which paranoid and cognitive/perceptual factors are considered as distinct components of schizotypal traits better describes our data than the three-factor "disorganized" model. The relatively high interfactor correlation between the cognitive/perceptual factor and the paranoid factor ($r = 0.66$) does not necessarily imply that the paranoid factor does not exist as a separate entity. It merely indicates that while they are distinct latent constructs within a four-factor solution, their variance overlaps because of trait common variance. The relative distinction between these two positive factors offers a greater explanatory power than their collapse into one unitary positive factor. Thus, paranoia could be viewed as an important underlying construct of schizotypal traits in our sample.

The existence of a paranoid factor within the schizotypy literature has largely been neglected (Rawlings and Freeman 1997), although there is ample historical and empirical evidence of its relevance in the schizophrenia literature. The continued importance of paranoia within psychiatric classification is illustrated by the fact that *DSM–IV* (APA 1994) includes five mental disorders that contain "paranoia" constructs. Positive symptoms of schizophrenia have largely been considered as a unidimensional construct, but the study of the psychometric properties of the scales measuring them has shown that these symptoms might not compose a homogeneous

group. Their heterogeneity is shown by the very low internal consistency of the main positive symptom rating scale, the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen 1984; Minas et al. 1992; Stuart et al. 1995; Vàzquez-Barquero et al. 1996; Lin et al. 1998; Peralta and Cuesta 1999). According to Stuart et al. (1995), the principal deficiency with the subscale structure of the SAPS, as well as the "three-syndrome" model of schizophrenia, is the lack of a separate scale that measures paranoia. When Liddle (1987) used the Present State Examination (Wing et al. 1974) instead of the Scale of Assessment of Negative Symptoms (SANS)-related Comprehensive Assessment of Symptoms and History (CASH), a four- rather than three-factor structure was found in the same sample of schizophrenia subjects. In this four-factor solution, bizarre delusions and auditory hallucinations loaded on a separate factor from delusions of reference and persecution. Several subsequent studies (Kay and Sevy 1990; Minas et al. 1992; Shtasel et al. 1992; Silver et al. 1993; Bassett et al. 1994; Stuart et al. 1995; Cardno et al. 1996; Vazquez-Barquero et al. 1996; Cardno et al. 1997; Toomey et al. 1997; Kitamura et al. 1998; Lin et al. 1998; Peralta and Cuesta 1998, 1999; Cardno et al. 2001) have supported the multidimensionality of positive symptomatology and proposed that paranoia might constitute a distinct dimension within the schizophrenia spectrum separate from a dimension encompassing first rank Schneiderian symptoms ("loss of ego boundary" dimension).

This distinction between positive symptoms in schizophrenia has been retained in several studies where "toned down" versions of psychotic experiences or schizotypal traits have been assessed in normal populations or in relatives of patients with schizophrenia (table 2). These studies also appear to indicate that the underlying factorial structure of "positive" schizotypal traits can also be divided into at least two major dimensions: a dimension that encompasses a toned-down version of Schneiderian first rank symptoms (cognitive/perceptual factor) and a dimension related to paranoid ideation and suspiciousness. Regarding the first of these dimensions, high correlations between magical ideation and perceptual aberration scales have been found in previous studies (Chapman et al. 1982; Raine and Allbutt 1989; Kendler and Hewitt 1992), suggesting that "together they form a positive (cognitive–perceptual) schizotypy dimension" (Kendler et al. 1996). In short, several studies have suggested that a paranoid factor might be an integral part of both schizophrenia and schizotypal phenomenology, standing apart from a positive dimension thought to encapsulate the core features of psychosis or psychosis proneness.

The "split" of positive schizotypal traits in these two dimensions raises questions regarding the origin and formation of delusional beliefs in otherwise healthy individuals under psychological pressure. Maher (1988) has proposed that delusions arise as reasonable explanations of abnormal perceptual experiences; Zigler and Glick (1988), on the other hand, have proposed that delusions of grandiosity and paranoia seem much more to reflect a psychological motivation, serving a protective role against threats to the individual's sense of self. The relative independence between abnormal perceptual experiences and paranoid beliefs in our sample appears to favor less Maher's hypothesis.

Methodological Limitations. Our sample consisted of young males that were drafted into the military service. Thus, our findings cannot be directly generalized to the normal population (men and women of every age). It could be argued, for example, that a gender effect might also be responsible for the emergence of the paranoid factor in our study. Although this possibility cannot be excluded, a recent CFA study (Reynolds et al. 2000) does not support a different composition of schizotypal factors when the sex effect has been examined separately.

Rawlings and Freeman (1997) comment on accumulated evidence that paranoia is more evident in groups undergoing severe rapid cultural changes involving relocation of many people. Altrocci (1980) argues that the association between paranoia and relocation may result from such factors as social estrangement, language difficulties, and difficulties competing for jobs and status in a new culture. The emergence of a paranoid factor might thus reflect an underlying difference in the magnitude of such experiences in our population. They might experience higher levels of paranoia during the first week of draft recruitment because of a commonly believed highly stressful change in environmental circumstances. In this new environment, where by default individuality is discouraged and insubordination is severely disciplined, it would be expected that fear responses, suspiciousness, and ideas of reference would be augmented.

Another potential problem in this study was the unusually high percentage of random responders. According to the results, random responders had significantly augmented schizotypal scores compared to correct responders that were eventually considered for CFA. This might imply that the most deviant group went undetected during the study. We believe this is unlikely because of the fact that random responders exhibited significantly higher avoidance and escape patterns while not differing from correct responders in other dimensions of SCL–90–R state psychopathology such as paranoid ideation, psychoticism, or depression. It is therefore plausible that random responders' participation and worse performance in the study were mainly due to secondary gains

related to avoidance of military drills during the day of examination, and subsequent indifference during testing procedures, and not due to genuine psychometrically deviant performance.

It could be argued that models with more factors produce better fit to the data. As shown in table 1, we have included alternative four-factor models and a five-factor model to protect our results from such an effect. Although these models represent mere adaptations of other instruments to the SPQ subscales, they provide a worse fit than the paranoid four-factor model.

We focus on the analysis of subscales rather than the individual items of the SPQ primarily because of reasons of compatibility with the large amount of published work using the same approach. This approach is more restrictive and leads to loss of information with respect to items, because it is limited by the fact that schizotypal subscales (not items) are seen as the unit of information on which dimensions are construed. Nevertheless, analysis of binary outcomes (e.g., SPQ items) requires more advanced methodological techniques than analysis of subscales (e.g., generalized multidimensional Rasch models) (Vollema and Hoijtink 2000) and is an interesting and challenging prospect for further research.

We would also point to a theoretical limitation of our study derived from the adoption of SPQ in assessing the underlying factorial structure of schizotypal dimensions. The SPQ inherently restricts the dimensions of schizotypal traits proposed in this study. Although the SPQ assesses all nine aspects of SPD, it does not permit comparisons of models that endorse psychological constructs thought to be important in the schizotypal spectrum, such as impulsiveness/nonconformity (Claridge et al. 1996) or premorbid social isolation, as proposed by Lenzenweger and Dworkin (1996). Even more relevant is the limitations of the SPQ in assessing an affective component in schizotypal traits. Indeed, there is considerable evidence that an affective component is an integral aspect of the psychotic phenomenology, and several large-scale studies have now been conducted that show remarkable convergence in demonstrating a four-factor or possibly five-factor solution, in which depressive and manic factors are readily recognizable (Kitamura et al. 1995; McGorry et al. 1998; van Os et al. 1999; Stefanis et al. 2002). In addition, according to the intrafactor correlation (table 5), the disorganization factor shares the highest correlation with the other factors, implying a low-level discrimination of this factor from the other three. This is in accordance with the proposition that the disorganization factor, encompassing oddities in speech and behavior, cannot be self-rated reliably (Bergman et al. 1996; Kendler et al. 1996; Vollema and Ormel 1999). Moreover, self-report questionnaires might not be able to capture aspects of schizotypal traits that are usually elicited through direct interviewing (e.g., negative traits, disorganization traits). Kendler et al. (1996) and Bergman et al. (1996) have argued that self-report measurements are not well suited for the measurement of subtle thought disorder and odd speech. Vollema and Ormel (1999), using simultaneously the SPQ and direct interview, have found that subtle deviance in formal thought processes cannot be measured with the SPQ.

Validation of the Four-Factor Model. While our four-factor model of schizotypal traits awaits external and predictive validation from comparison with cross-sectionally and longitudinally derived markers from our ongoing study, indirect validation for the significance of preexisting paranoid traits as relevant to schizophrenia is provided by two recent studies that examined components of the SPQ in relatives of schizophrenia patients (Kremen et al. 1998; Yaralian et al. 2000). These studies suggest that subscales related to paranoid ideation differentiate relatives of schizophrenia patients from controls, implying that this aspect of positive schizotypal traits segregates in family members of schizophrenia patients. A recent study (Weiser et al. 2001) confirms that both SPD and paranoid personality disorder increase substantially the probability of subsequently developing schizophrenia, with an odds ratio equal to 21.5. It would then be reasonable to suggest, given that paranoia is the common denominator between the two personality disorders, that paranoid personality traits (ideas of reference, suspiciousness) might be of particular relevance to this increase in probability of developing the disorder. This issue remains controversial because several studies seem to suggest that "positive" schizotypal traits are not elevated in family members of schizophrenia patients and that, on the contrary, "negative" features of schizotypy appear to be the most transmissible personality traits in first degree relatives of individuals with schizophrenia (Tsuang et al. 1991; Kendler et al. 1996).

References

Akaike, H. Information theory and an extension of the maximum likelihood principle. In: Petrov, B.N., and Csaki, F., eds. *Proceedings of the 2nd International Symposium on Information Theory.* Budapest, Hungary: Akademiai Kiado, 1973. pp. 267–281.

Akaike, H. Factor analysis and AIC. *Psychometrika,* 52:317–332, 1987.

Allen, J.J.; Chapman, L.J.; and Chapman, J.P. Cognitive slippage and depression in hypothetically psychosis-prone college students. *Journal of Nervous and Mental Disease,* 175:347–353, 1987.

Altrocci, J. *Abnormal Behaviour.* New York, NY: Harcourt Brace Jovanovich, 1980.

American Psychiatric Association. *DSM–III–R: Diagnostic and Statistical Manual of Mental Disorders.* 3rd ed., revised. Washington, DC: APA, 1987.

American Psychiatric Association. *DSM–IV: Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: APA, 1994.

Andreasen, N.C. *The Scale for the Assessment of Positive Symptoms (SAPS).* Iowa City, IA: University of Iowa, 1984.

Arbuckle, J.L. *AMOS Users Guide Version 3.6.* Chicago, IL: Smallwaters Corporation, 1997.

Avramopoulos, D.; Stefanis, N.C.; Hantoumi, I.; Smyrnis, N.; Evdokimidis, I.; and Stefanis, C.N. Higher scores of self reported schizotypy in healthy young males carrying the COMT high activity allele. *Molecular Psychiatry,* 7(7):706–711, 2002.

Bassett, A.S.; Bury, A.; and Honer, W.G. Testing Liddle's three syndrome model in families with schizophrenia. *Schizophrenia Research,* 12:213–221, 1994.

Battaglia, M.; Cavallini, M.C.; Macciardi, F.; and Bellodi, L. The structure of DSM-III-R schizotypal personality disorder diagnosed by direct interviews. *Schizophrenia Bulletin,* 23(1):83–92, 1997.

Battaglia, M.; Fossati, A.; Torgersen, S.; Bertella, S.; Bajo, S.; Maffei, C.; Bellodi, L.; and Smeraldi, E. A psychometric genetic study of schizotypal disorder. *Schizophrenia Research,* 37(1):53–64, 1999.

Bentler, P.M., and Bonnet, D.G. Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin,* 88:588–606, 1980.

Bergman, A.J.; Harvey, P.D.; Mitropoulou, V.; Aronson, A.; Marder, D.; Silverman, J.; Trestman, R.; and Siever, L.J. The factor structure of schizotypal symptoms in a clinical population. *Schizophrenia Bulletin,* 22(3):501–509, 1996.

Bergman, A.J.; Silverman, J.M.; Harvey, P.D.; Smith, C.J.; and Siever, L.J. Schizotypal symptoms in the relatives of schizophrenia patients: An empirical analysis of the factor structure. *Schizophrenia Bulletin,* 26(3):577–586, 2000.

Bollen, K.A. *Structural Equations With Latent Variables.* New York, NY: Wiley and Sons, 1989.

Bozdogan, H. Model selection and Akaike's information criterion (AIC): The general theory and its analytical extensions. *Psychometrika,* 52:345–370, 1987.

Browne, M.W., and Cudeck, R. Single sample cross-validation indexes for covariance structures. *Multivariate Behavioral Research,* 24:45–55, 1989.

Browne, M.W., and Cudeck, R. Alternative ways of assessing model fit. In: Bollen, K.A., and Long, J.S., eds. *Testing Structural Equation Models.* Newbury Park, CA: Sage Publications, 1993. pp. 136–162.

Cardno, A.G.; Holmans, P.A.; Harvey, I.; Williams, M.B.; Owen, M.J.; and McGuffin, P. Factor derived subsyndromes of schizophrenia and familial morbid risks. *Schizophrenia Research,* 23(3):231–238, 1997.

Cardno, A.G.; Jones, L.A.; Murphy, K.C.; Asherson, P.; Scott, L.C.; Williams, J.; Owen, M.J.; and MacGuffin, P. Factor analysis of schizophrenic symptoms using the OPCRIT checklist. *Schizophrenia Research,* 22(3):233–239, 1996.

Cardno, A.G.; Sham, P.C.; Murray, R.M.; and McGuffin, P. Twin study of symptom dimensions in psychosis. *British Journal of Psychiatry,* 179:39–45, 2001.

Chapman, L.J.; Chapman, J.P.; and Miller, E.N. Reliabilities and incorrelations of eight measures of proneness to psychosis. *Journal of Consulting and Clinical Psychology,* 50:187–195, 1982.

Chapman, L.J.; Chapman, J.P.; and Raulin, M.L. Body image aberration in schizophrenia. *Journal of Abnormal Psychology,* 87:399–407, 1978.

Chen, W.J.; Hsiao, C.K.; and Lin, C.C. Schizotypy in community samples: The three-factor structure and correlation with sustained attention. *Journal of Abnormal Psychology,* 106(4):649–654, 1997.

Claridge, G. Theoretical background and issues. In: Claridge, G. ed. *Schizotypy—Implications for Illness and Health.* Oxford, U.K.: Oxford University Press, 1997. pp. 3–19.

Claridge, G.; McCreery, C.; Mason, O.; Bentall, R.; Boyle, G.; Slade, P.; and Popplewell, D. The factor structure of 'schizotypal' traits: A large replication study. *British Journal of Clinical Psychology,* 35:103–115, 1996.

Claridge, G.S. Single indicator of risk for schizophrenia: Probable fact or likely myth? *Schizophrenia Bulletin,* 20(1):151–168, 1994.

Cloninger, C.R.; Przybeck, T.; Svrakic, D.; and Wetzel, R. The Temperament and Character Inventory (TCI): A guide to its development and use. St. Louis, MO: Center for Psychobiology of Personality, 1994.

Crow, T.J. Molecular pathology of schizophrenia: More than one disease process? *British Medical Journal,* 280:66–69, 1980.

Cuesta, M.J., and Peralta, V. Psychopathological dimensions in schizophrenia. *Schizophrenia Bulletin,* 21(3):473–482, 1995.

Derogatis, L.R. *Symptom Checklist–90–R (SCL–90–R).* Minneapolis, MN: Computer Systems, 1993.

Donias, S.; Karastergiou, A.; and Manos, N. Standardization of the Symptom Checklist–90–R rating scale in a Greek population. *Psychiatriki*, 2:42–48, 1991.

Evdokimidis, I.; Smyrnis, N.; Constantinidis, T.S.; Stefanis, N.C.; Avramopoulos, D.; Paximadis, C.; Theleritis, C.; Efstratiadis, C.; Kastrinakis, G.; and Stefanis, C.N. The antisaccade task in a sample of 2,006 young men: I. Normal population characteristics. *Experimental Brain Research*, 147(1):45–52, 2002.

Eysenck, H.J., and Eysenck, S.B.G. *Psychoticism as a Dimension of Personality.* London, U.K.: Hodder and Stoughton, 1976.

Fogelson, D.L.; Nuechterlein, K.H.; Asarnow, R.F.; Payne, D.L.; Subotnik, K.L.; and Giannini, C.A. The factor structure of schizophrenia spectrum personality disorders: Signs and symptoms in relatives of psychotic patients from the UCLA family members study. *Psychiatry Research*, 87(2–3):137–146, 1999.

Fossati, A.; Maffei, C.; Battaglia, M.; Bagnato, M.; Donati, D.; Donini, M.; Fiorilli, M.; and Novella, L. Latent class analysis of *DSM–IV* schizotypal personality disorder criteria in psychiatric patients. *Schizophrenia Bulletin*, 27(1):59–71, 2001.

Gruzelier, J.H. The factorial structure of schizotypy: I. Affinities with syndromes of schizophrenia. *Schizophrenia Bulletin*, 22(4):611–620, 1996.

Hewitt, J.K., and Claridge, G.S. The factor structure of schizotypy in a normal population. *Personality and Individual Differences*, 10:323–329, 1989.

Joseph, S., and Peters, E. Factor structure of schizotypy with normal subjects: A replication of Hewitt and Claridge 1989. *Personality and Individual Differences*, 18:437–440, 1995.

Kay, S.R., and Sevy, S. Pyramidical model of schizophrenia. *Schizophrenia Bulletin*, 16(3):537–545, 1990.

Kendler, K.S., and Hewitt, J.K. The structure of self-report schizotypy in twins. *Journal of Personality Disorders*, 6:1–17, 1992.

Kendler, K.S.; McGuire, M.; Gruenberg, A.M.; and Walsh, D. Schizotypal symptoms and signs in the Roscommon family study. *Archives of General Psychiatry*, 52(4):296–303, 1995.

Kendler, K.S.; Ochs, A.L.; Gorman, A.M.; Hewitt, J.K.; Ross, D.E.; and Mirsky, A.F. The structure of schizotypy: A pilot multitrait twin study. *Psychiatry Research*, 36(1):19–36, 1991.

Kendler, K.S.; Thacker, L.; and Walsh, D. Self-report measures of schizotypy as indexes of familial vulnerability to schizophrenia. *Schizophrenia Bulletin*, 22(3):511–520, 1996.

Kitamura, T.; Okazaki, Y.; Fujinawa, A.; Takayanagi, I.; and Kasahara, Y. Dimensions of schizophrenic positive symptoms: An exploratory factor analysis investigation. *European Archives of Psychiatry and Clinical Neuroscience*, 248:130–135, 1998.

Kitamura, T.; Okazaki, Y.; Fujinawa, A.; Yoshino, M.; and Kashahara, Y. Symptoms of psychosis: A factor analytic study. *British Journal of Psychiatry*, 166(2):236–240, 1995.

Korfine, L., and Lenzenweger, M.F. The taxonicity of schizotypy: A replication. *Journal of Abnormal Psychology*, 104(1):26–31, 1995.

Kremen, W.S.; Faraone, S.V.; Toomey, R.; Seidman, L.J.; and Tsuang, M.T. Sex differences in self-reported schizotypal traits in relatives of schizophrenic probands. *Schizophrenia Research*, 34(1–2):27–37, 1998.

Lenzenweger, M.F., and Dworkin, R.H. The dimensions of schizophrenia phenomenology: Not one or two, at least three, perhaps four. *British Journal of Psychiatry*, 168(4):432–440, 1996.

Lenzenweger, M.F.; Dworkin, R.H.; and Wethington, E. Examining the underlying structure of schizophrenic phenomenology: Evidence for a three process model. *Schizophrenia Bulletin*, 17(3):515–524, 1991.

Lenzenweger, M.F., and Korfine, L. Confirming the latent structure and base rate of schizotypy: A taxometric analysis. *Journal of Abnormal Psychology*, 101(3):567–571, 1992.

Liddle, P.F. The symptoms of chronic schizophrenia. A re-examination of the positive-negative dichotomy. *British Journal of Psychiatry*, 151:145–151, 1987.

Lin, A.S.; Chen, C.H.; Hwu, H.G.; Lin, H.N.; and Chen, J.A. Psychopathological dimensions in schizophrenia: A correlational approach to items of the SANS and SAPS. *Psychiatry Research*, 77(2):121–130, 1998.

Maher, B. Anomalous experience and delusional thinking: The logic of explanation. In: Olthmans, T.F., and Maher, B.A., eds. *Delusional Beliefs.* New York, NY: Wiley and Sons, 1988.

Maier, W.; Falkai, P.; and Wagner, M. Schizophrenia spectrum disorders: A review. In: Maj, M., and Sartorius, N., eds. *WPA Series Evidence and Experience in Psychiatry.* Vol. 2. *Schizophrenia.* Chichester, U.K.: Wiley and Sons, 1999. pp. 311–371.

McGorry, P.D.; Bell, R.C.; Dudgeon, P.L.; and Jackson, H.J. The dimensional structure of first episode psychosis: An exploratory factor analysis. *Psychological Medicine*, 28(4):935–947, 1998.

Meehl, P.E. Schizotaxia, schizotypy, schizophrenia. *American Psychologist*, 17:827–838, 1962.

Minas, I.H.; Stuart, G.W.; Klimidis, S.; Jackson, H.J.; Singh, B.S.; and Copolov, D.L. Positive and negative symptoms in the psychosis: Multidimensional scaling of SAPS and SANS items. *Schizophrenia Research,* 8(2):143–156, 1992.

Muntaner, C.; Garcia-Servilla, L.; Fernandez, A.; and Torrubia, R. Personality dimensions of schizotypal and borderline personality traits and psychosis proneness. *Personality and Individual Differences,* 9:257–268, 1988.

Peralta, V., and Cuesta, M.J. Factor structure and clinical validity of competing models of positive symptoms in schizophrenia. *Biological Psychiatry,* 44(2):107–114, 1998.

Peralta, V., and Cuesta, M.J. Dimensional structure of psychotic symptoms: An item-level analysis of SAPS and SANS symptoms in psychotic disorders. *Schizophrenia Research,* 38(1):13–26, 1999.

Peters, E.R.; Joseph, S.A.; and Garety, P.A. Measurement of delusional ideation in the normal population. Introducing the PDI. *Schizophrenia Bulletin,* 25(3):553–576, 1999.

Raftery, A.E. Bayesian model selection in structural equation models. In: Bollen, K.A., and Long, J.S., eds. *Testing Structural Equation Models.* Newbury Park, CA: Sage Publications, 1993. pp. 163–180.

Raftery, A.E. Bayesian model selection in social research. In: Marshden, P.V., ed. *Sociological Methodology.* Oxford, U.K: Blackwell, 1995.

Raine, A. The SPQ: A scale for the assessment of schizotypal personality based on DSM–III–R criteria. *Schizophrenia Bulletin,* 17(4):555–564, 1991.

Raine, A., and Allbutt, J. Factors of schizoid personality. *British Journal of Clinical Psychology,* 28:31–40, 1989.

Raine, A.; Reynolds, C.A.; Lencz, T.; Scerbo, A.; Triphon, N.; and Kim, D. Cognitive perceptual interpersonal and disorganized features of schizotypal personality. *Schizophrenia Bulletin,* 20(1):191–201, 1994.

Rawlings, D., and Freeman, J.L. Measuring paranoia/suspiciousness. In: Claridge, G., ed. *Schizotypy: Implications for Illness and Health.* Oxford, U.K.: Oxford University Press, 1997. pp. 38–60.

Reynolds, C.A.; Raine, A.; Mellingen, K.; Venables, P.H.; and Mednick, S.A. Three-factor model of schizotypy personality: Invariance across culture, gender, religious affiliation, family adversity, and psychopathology. *Schizophrenia Bulletin,* 26(3):603–618, 2000.

Rosenberger, P.H., and Miller, G.A. Comparing borderline definitions: *DSM–III* borderline and schizotypal personality disorders. *Journal of Abnormal Psychology,* 98:161–169, 1989.

Rossi, A., and Daneluzzo, E. Schizotypal dimensions in normals and schizophrenic patients: A comparison with other clinical samples. *Schizophrenia Research,* 54(1–2):67–75, 2002.

Schwarz, G. Estimating the dimension of a model. *Annals of Statistics,* 6:461–464, 1978.

Shtasel, D.L.; Gur, R.E.; Gallacher, F.; Heimberg, C.; Cannon, T.; and Gur, R.C. Phenomenology and functioning in first-episode schizophrenia. *Schizophrenia Bulletin,* 18(3):449–462, 1992.

Silver, H.; David, D.; Kaplan, M.; Hadjez, J.; Tubi, N.; Darnel, A.; Calev, A.; and Lerer, B. Factor analysis of schizophrenic symptoms and comparison of different rating scales. *Schizophrenia Research,* 10(1):67–75, 1993.

Smyrnis, N.; Evdokimidis, I.; Stefanis, N.C.; Avramopoulos, D.; Constandinidis, T.S.; Stavropoulos, A.; and Stefanis, C.N. Antisaccade performance in 1,273 men: Effects of schizotypy, anxiety, and depression. *Journal of Abnormal Psychology,* 112(3):403–414, 2003.

Smyrnis, N.; Evdokimidis, I.; Stefanis, N.C.; Constantinidis, T.S.; Avramopoulos, D.; Theleritis, C.; Paximadis, C.; Efstratiadis, C.; Kastrinakis, G.; and Stefanis, C.N. The antisaccade task in a sample of 2,006 young males: II. Effects of task parameters. *Experimental Brain Research,* 147(1):53–63, 2002.

Stefanis, N.C.; Hanssen, M.; Smyrnis, N.; Avramopoulos, D.; Evdokimidis, I.; Stefanis, C.N.; Verdoux, H.; and van Os, J. Evidence that three dimensions of psychosis have a distribution in the general population. *Psychological Medicine,* 32:347–358, 2002.

Stefanis, N.C.; Smyrnis, N.; Evdokimidis, I.; Avramopoulos, D.; Stavropoulos, A.; and Stefanis, C.N. Association between dimensions of schizotypy and neurocognitive deficits in a large non-clinical male population. [Abstract]. *Schizophrenia Research,* 49(1–2):122, 2001.

Strauss, J.S.; Carpenter, W.T.; and Bartko, J.J. The diagnosis and understanding of schizophrenia: III. Speculations on the processes that underlie schizophrenic symptoms and signs. *Schizophrenia Bulletin,* 11:61–76, 1974.

Stuart, G.W.; Malone, V.; Currie, J.; Klimidis, S.; and Minas, I.H. Positive and negative symptoms in neuroleptic-free psychotic inpatients. *Schizophrenia Research,* 16(3):175–188, 1995.

Suhr, J.A., and Spitznagel, M.B. Factor versus cluster models of schizotypal traits: I. A comparison of unselected and highly schizotypal samples. *Schizophrenia Research,* 52(3):231–239, 2001.

Toomey, R.; Kremen, W.S.; Simpson, J.C.; Samson, J.A.; Seidman, L.J.; Lyons, M.J.; Faraone, S.V.; and Tsuang,

M.T. Revisiting the factor structure for positive and negative symptoms: Evidence from a large heterogeneous group of psychiatric patients. *American Journal of Psychiatry,* 154(3):371–377, 1997.

Tsuang, M.T.; Gilbertson, M.W.; and Faraone, S.V. Genetic transmission of negative and positive symptoms in the biological relatives of schizophrenics. In: Marneros, A.; Andreasen, N.C.; and Tsuang, M.T., eds. *Negative Versus Positive Schizophrenia.* Berlin, Germany: Springer, 1991. pp. 265–291.

van Os, J.; Gilvarry, C.; Bale, R.; Van Horn, E.; Tattan, T.; White, I.; and Murray, R. A comparison of the utility of dimensional and categorical representations of psychosis. UK700 Group. *Psychological Medicine,* 29:595–606, 1999.

van Os, J.; Hanssen, M.; Bijl, R.V.; and Ravelli, A. Strauss (1969) revisited: A psychosis continuum in the general population? *Schizophrenia Research,* 45(1–2):11–20, 2000.

Vazquez-Barquero, J.L.; Lastra, I.; Cuesta Nunez, M.J.; Herrera Castanedo, S.; and Dunn, G. Patterns of positive and negative symptoms in first episode schizophrenia. *British Journal of Psychiatry,* 168(6):693–701, 1996.

Venables, P.H., and Rector, N.A. The content and structure of schizotypy: A study using confirmatory factor analysis. *Schizophrenia Bulletin,* 26(3):587–602, 2000.

Verdoux, H.; van Os, J.; Maurice-Tison, S.; Gay, B.; Salamon, R.; and Bourgeois, M. Is early adulthood a critical developmental stage for psychosis proneness? A survey of delusional ideation in normal subjects. *Schizophrenia Research,* 29(3):247–254, 1998.

Vollema, M.G., and Hoijtink, H. The multidimensionality of self-report schizotypy in a psychiatric population: An analysis using multidimensional Rasch models. *Schizophrenia Bulletin,* 26(3):565–575, 2000.

Vollema, M.G., and Ormel, G. A multitrait-multimethod analysis of three dimensions of schizotypy. In: Vollema, M.G., ed. *Schizotypy: Toward the Psychological Heart of Schizophrenia.* Maastricht, The Netherlands: Shaker Publishing, 1999. pp. 87–102.

Weiser, M.; Reichenberg, A.; Rabinowitz, J.; Kaplan, Z.; Mark, M.; Bodner, E.; Nahon, D.; and Davidson, M. Association between non-psychotic psychiatric diagnosis in adolescent males and subsequent onset of schizophrenia. *Archives of General Psychiatry,* 58(10):959–964, 2001.

Wing, J.K.; Cooper, J.E.; and Sartorius, N. *Measurement and Classification of Psychiatric Symptoms: An Introduction Manual for the PSE and CATEGO Program.* Cambridge, U.K.: Cambridge University Press, 1974.

Wolfradt, U., and Straube, E.R. Factor structures of schizotypal traits among adolescents. *Personality and Individual Differences,* 24:201–206, 1998.

Yaralian, P.S.; Raine, A.; Lencz, T.; Hooley, J.M.; Bihrle, S.E.; Mills, S.; and Ventura, J. Elevated levels of cognitive-perceptual deficits in individuals with a family history of schizophrenia spectrum disorders. *Schizophrenia Research,* 46(1):57–63, 2000.

Zigler, E., and Glick, M. Is paranoid schizophrenia really camouflaged depression? *American Psychologist,* 43:284–290, 1988.

Acknowledgments

This work was supported by the grant EKBAN 97 to Professor C.N. Stefanis from the General Secretariat of Research and Technology of the Greek Ministry of Development. Intrasoft Co. provided the technical support for this project. We would like to thank the following colleagues who helped in data acquisition and preprocessing: Theodoros S. Constantinidis, Ioannis Giouzelis, Georgios Kastrinakis, Emanouil Kattoulas, Catherine Paximadis, and Christos Theleritis. We would also like to thank Professor Jim van Os for his contribution to the preparation of this manuscript.

The Authors

Nicholas C. Stefanis, M.D., is Assistant Professor of Psychiatry, Athens University Medical School, and Senior Researcher, University Mental Health Research Institute, Athens, Greece. Nikolaos Smyrnis, M.D., is Lecturer in Psychiatry, Athens University Medical School. Dimitrios Avramopoulos, M.D., is Lecturer, Johns Hopkins Medical School, Baltimore, MD. Ioannis Evdokimidis, M.D., is Associate Professor of Neurology, Department of Neurology, Athens Medical School, and Senior Researcher, University Mental Health Research Institute. Ioannis Ntzoufras, Ph.D., is Lecturer, Quantitative Methods and Statistics, University of the Aegean, Chios, Greece. Costas N. Stefanis, M.D., is Professor of Psychiatry and Director, University Mental Health Research Institute.