

## EXTENDED REPORTS

# The Psychometric Detection of Schizotypy: Do Putative Schizotypy Indicators Identify the Same Latent Class?

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The authors examined whether three indicators of schizotypy, the Revised Social Anhedonia Scale (RSAS), Magical Ideation Scale (MIS), and Perceptual Aberration Scale (PAS), identify a common latent class or taxon as conceptualized by P. E. Meehl (1962, 1990). The separate and joint latent structures of these scales were evaluated using taxometric methods in two large, independent samples. Replicating prior findings, the RSAS and PAS each identified latent taxa with base rates approximating .10. Results for the taxonicity of the MIS were less consistent. Analyses of joint latent structure indicated that the RSAS-identified taxon was essentially independent of constructs measured by the PAS or MIS. Measures commonly thought to tap the same latent class, conjectured to be schizotypy, do not share this property.

The accurate identification of individuals prone to the development of schizophrenia is key to the study of environmental and biological factors that heighten or reduce the probability of developing schizophrenia-related disorders. One strategy for identifying schizophrenia-prone individuals is the psychometric high-risk paradigm (for reviews, see J. P. Chapman & Chapman, 1996; Grove, 1982). In this approach, personality characteristics thought to be associated with risk for the development of schizophrenia are measured with self-report questionnaires. Much of this research has been informed by Meehl's (1962, 1990) proposal that a personality organization (schizotypy) is manifest in those individuals with the genetic liability for schizophrenia. According to this proposal, individuals with this genotype (schizotaxia), which constitutes a necessary but not sufficient condition for the development of schizophrenia-related disorders, are members of a latent class or taxon within the general

population. As originally described by Meehl (1962), core features of schizotypy include anhedonia (pleasure deficit), cognitive slippage, ambivalence, and interpersonal aversiveness.

Among the most widely used questionnaires for assessing schizotypy or, more generally, psychosis proneness, are three scales developed by L. J. Chapman, J. P. Chapman, and their colleagues: the Perceptual Aberration Scale (PAS; L. J. Chapman, Chapman, & Raulin, 1978a, 1978b), the Magical Ideation Scale (MIS; Eckblad & Chapman, 1983), and the Revised Social Anhedonia Scale (RSAS; Eckblad, Chapman, Chapman, & Mishlove, 1982). An accumulation of evidence on these and other questionnaires in nonclinical populations suggests that schizotypy is a multifactorial construct composed of three to four factors (for a review, see Vollema & van den Bosch, 1995). The PAS and MIS are highly intercorrelated (their correlations typically exceed .65; Edell, 1995) and load strongly on a "positive schizotypy" factor characterized by odd beliefs and unusual sensory experiences. The RSAS loads on a "negative schizotypy" factor reflecting social avoidance, which is typically uncorrelated with the positive schizotypy factor. The multifactorial nature of schizotypy raises the question of whether positive and negative schizotypy traits are both core manifestations of schizotaxia or if one of these factors best reflects the proposed genetic liability to schizophrenia.

Over the last 20 years, a number of studies have supported the concurrent and predictive validity of these three putative psychometric indicators of schizotypy. Individuals with markedly elevated scores on these scales have been reported to exhibit psychological and physiological deficits similar to those seen in schizophrenic patients. Cross-sectional studies have shown that individuals with elevated PAS and/or MIS scores demonstrate deficits in the areas of sustained attention (Lenzenweger, Cornblatt, & Putnick, 1991), working memory (Park, Holzman, & Lenzenweger, 1995), executive functions (Gooding, Kwapil, &

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Tallent, 1999), and eye-tracking and antisaccade performance (Gooding, 1999; O'Driscoll, Lenzenweger, & Holzman, 1998; Simons & Katkin, 1985). Similarly, individuals with elevated RSAS scores demonstrate deficits in sustained attention (Kwapil & Diaz, 2000), working memory (Tallent & Gooding, 1999), executive functioning (Gooding et al., 1999; Tallent & Gooding, 1999), smooth pursuit tracking (Gooding, Miller, & Kwapil, 2000), and antisaccade performance (Gooding, 1999).

Despite the converging evidence reviewed above, the empirical literature also reveals a number of intriguing differences among individuals identified by deviantly high scores on the Chapmans' scales. For example, individuals with elevated RSAS scores report elevated *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (American Psychiatric Association, 1994), schizoid and paranoid personality disorder features compared with controls, whereas those with elevated MIS scores do not (Blanchard & Brown, 1999). Individuals with elevated scores on the RSAS and the PAS and/or MIS also demonstrate different patterns of semantic and affective processing (Kerns & Berenbaum, 2000) and performance on chimeric face tests (Luh & Gooding, 1999). Family studies suggest that the RSAS and the PAS or MIS have differential patterns of correlation within families, with the RSAS appearing to be a more specific indicator of familial liability to schizophrenia-spectrum disorders (Berenbaum & McGrew, 1993; Clementz, Grove, Katsanis, & Iacono, 1991; Craver & Pogue-Geile, 1999; Franke, Maier, Hardt, & Hain, 1993; Grove et al., 1991; Katsanis, Iacono, & Beiser, 1990; Kendler, Thacker, & Walsh, 1996).

Perhaps the most striking evidence of differences between the Chapmans' scales concerns their predictive validity for the development of psychosis and schizophrenia-spectrum disorders. In a 10-year longitudinal study, individuals with deviantly high PAS and/or MIS scores at baseline were found to be at significantly elevated risk for the development of a variety of psychotic (both mood- and non-mood-related) as well as nonpsychotic (e.g., mood, substance use) disorders during the follow-up period (L. J. Chapman, Chapman, Kwapil, Eckblad, & Zinser, 1994). A subgroup of individuals with elevated scores on the MIS who also had elevated RSAS scores was at greatest risk for the development of psychosis at follow-up (L. J. Chapman et al., 1994; Kwapil, Miller, Zinser, Chapman, & Chapman, 1997). Neither PAS nor MIS scores selectively predicted schizophrenia or schizophrenia-spectrum disorders. In subsequent analyses of these longitudinal data, Kwapil (1998) demonstrated that after statistically controlling for the effects of other psychosis-proneness measures, extreme scorers on the RSAS were much more likely than controls to be diagnosed with a schizophrenia-spectrum personality disorder at the 10-year follow-up (24% vs. 1%, respectively). Results from this study suggest that the RSAS may identify individuals at specific risk for the development of schizophrenia-spectrum disorders, in contrast to the predictive validity of PAS and/or MIS scores for the more general development of psychotic and nonpsychotic disorders. Thus, individuals identified by elevated PAS and/or MIS and RSAS scores, although sharing some characteristics, differ in both cross-sectional performance and longitudinal outcomes. Although the PAS, MIS, and RSAS are jointly referred to as indicators of schizotypy, it is not at all clear that these measures identify a common group of individuals who constitute the same (presumably genetically determined; Meehl, 1962, 1990) latent class or taxon.

Findings from examinations of the latent structures of these scales using taxometric methods (Waller & Meehl, 1998) are

consistent with the hypothesis that these psychometric indicators independently identify a latent class that has a base rate approximating that conjectured for schizotypy (Meehl, 1962). A series of studies by Lenzenweger and Korfine (1992; Korfine & Lenzenweger, 1995) demonstrated that the PAS taps a taxon with a base rate approximating Meehl's (1962) estimated 10% base rate for schizotypy. Lenzenweger (1999) subsequently reported that the PAS, MIS, and Referential Thinking Scale (Lenzenweger, Bennett, & Lilienfeld, 1997) jointly tap a taxon with a comparable base rate (13%). Recently, Blanchard, Gangestad, Brown, and Horan (2000) reported that the construct measured by the RSAS also appears to tap a latent taxon with a base rate approximating 10%.

As previously noted by Blanchard et al. (2000), although these findings are consistent with the notion that the PAS, MIS, and RSAS may be indicators of Meehl's conjectured schizotypy taxon, findings to date do not directly address whether the positive and negative traits assessed by these scales measure a common taxon. No study has simultaneously examined the independent and joint latent structures of the PAS, MIS, and RSAS. Taxometric analyses can determine whether these three scales tap the same latent class, which would be expected if they are indeed indicators of a common schizotypy taxon. Furthermore, this would provide for a clarification of social anhedonia's taxonic status. Meehl (2001) recently noted that although social anhedonia has been shown to have a taxonic structure (Blanchard et al., 2000), it may not be independently taxonic but may derive its statistical taxonicity from other latent quantitative factors that themselves are taxonically distributed. Applying this recent clarification to the taxometric findings from the Chapman scales (Blanchard et al., 2000; Lenzenweger, 1999) leads to the question: Does the social anhedonia taxon exist independently of the PAS and/or MIS taxon?

In the present research, we used taxometric methods to examine the independent and joint latent structures of the RSAS, MIS, and PAS in two large samples of students from public universities. First, we sought to replicate the finding of Blanchard et al. (2000) that the latent structure of the RSAS is taxonic with a base rate of approximately .10. Second, we sought to determine if the RSAS, MIS, and PAS share a latent taxonic structure, with these measures jointly identifying the same latent class with a base rate approximating .10. In addition, with this study, we examined issues raised by Meehl (2001) regarding the relationship between the social anhedonia taxon and alternative putative indicators of the schizotypy taxon. Specifically, we examined whether negative schizotypy traits assessed by the RSAS demonstrate statistical taxonicity independent of any association with the positive schizotypy traits associated with the PAS and/or MIS taxon.

## Study 1

### Methods

**Participants.** Participants were undergraduates enrolled in psychology courses at the University of New Mexico who participated for course credit. All participants were informed that their participation was voluntary and that their responses were confidential. The RSAS and MIS were completed as part of a battery of measures that was administered to groups of up to about 100 participants. The Chapman Infrequency Scale (L. J. Chapman & Chapman, 1983) was included to eliminate participants demonstrating evidence of invalid test-taking patterns. Participants with a score greater than 2 on the Chapman Infrequency Scale were eliminated from the sample, which resulted in our dropping 48 participants. To replicate a previous MAXCOV (an abbreviation for *maximum covariance, making*

*hits maximum*; also called MAXCOV–HITMAX) analysis of subscales derived from the RSAS, a new sample of 715 participants completed the RSAS and the MIS. All other taxometric analyses were based on this new sample as well as a sample of 845 participants from the original report by Blanchard et al. (2000) who completed both the RSAS and the MIS. Of the total sample of 1,560 participants, 68.6% were women, and ethnicity characteristics were as follows: 55.7% Caucasian, 1.8% African American, 34.3% Hispanic, 4.5% Asian, and 3.7% other.

*Schizotypy indicators.* The RSAS (Eckblad et al., 1982) is a 40-item, true–false questionnaire intended to measure decreased pleasure derived from interpersonal sources. This scale also taps disinterest in social relationships and schizoid withdrawal, as distinguished from social anxiety (Mishlove & Chapman, 1985). The MIS (Eckblad & Chapman, 1983) is a 30-item questionnaire intended to measure belief in superstitious or magical forms of causation that are regarded as invalid by conventional standards. In this sample, we focused on the MIS rather than the PAS because the combination of the MIS and RSAS but not the PAS and RSAS has been found to be associated with the highest rates of psychosis (L. J. Chapman et al., 1994; Kwapil et al., 1997). In addition, the MIS has been shown to tap a taxon, in conjunction with the PAS, conjectured to be that of schizotypy (Lenzenweger, 1999). An extensive body of research has documented the reliability and validity of the RSAS and the MIS, and reviews of this literature can be found elsewhere (J. P. Chapman, Chapman, & Kwapil, 1995; Edell, 1995). Items from both scales, as well as the Chapman Infrequency Scale (L. J. Chapman & Chapman, 1983), were interspersed in a single questionnaire. Internal consistency estimates (coefficient alpha) were good for both the RSAS ( $\alpha = .84$ ) and the MIS ( $\alpha = .84$ ).

*Taxometric procedures.* Meehl and his colleagues have developed a number of taxometric procedures (collectively referred to as “coherent cut kinetic” methods) to detect a conjectured latent class structure in sets of relevant empirical observations (Meehl, 1995a; Meehl & Golden, 1982; Waller & Meehl, 1998). The application of these methods requires a set of indicators believed to discriminate (albeit imperfectly) two conjectured classes within a mixed population of taxon and nontaxon members. Within taxometrics, the two major questions presented by a data set are: (a) Does a latent taxon exist? and (b) If so, what is the relative frequency of taxon members (i.e., the base rates of the latent taxa)? Taxometric methods have been shown to be robust in not often yielding results falsely suggestive of taxonicity using quantitative indicator variables (Lenzenweger, 1999; Meehl & Yonce, 1996). We applied two different taxometric methods to address these questions using putative schizotypy indicators derived from the RSAS and the MIS: (a) the MAXCOV–HITMAX method (Meehl, 1973; Meehl & Golden, 1982) and (b) the MAMBAC method (an abbreviation for *mean above minus below a cut*; Meehl & Yonce, 1994). These methods have been used to investigate the latent structures of a variety of psychopathological constructs (e.g., Gleaves, Lowe, Snow, Green, & Murphy-Eberenz, 2000; Harris, Rice, & Quinsey, 1994; Ruscio & Ruscio, 2000; Waller & Ross, 1997). In-depth discussions of the philosophical rationale and computational formulae associated with taxometrics may be found elsewhere (Meehl, 1992; Meehl, 1995a; Meehl, 1999; Waller & Meehl, 1998).

*Data analysis.* Taxometric analyses were conducted in four phases. First, we sought to replicate our previous finding that social anhedonia has a latent taxonic structure by applying MAXCOV to subscales derived from the RSAS in a new sample. MAXCOV analyses of eight RSAS items and MAMBAC analyses of the RSAS subscales were used as consistency tests. Second, we sought to confirm the taxonicity of the MIS by deriving multiple indicators from this measure and applying both MAMBAC and MAXCOV. Third, we applied MAXCOV and MAMBAC to indicators derived from the RSAS and MIS to examine whether these measures jointly tap a common taxon. As an additional consistency test, individuals were classified into taxon and nontaxon latent classes for each of these measures on the basis of Bayesian taxon membership probabilities (Meehl, 1973; Meehl & Golden, 1982; Waller & Meehl, 1998), and the overlap in classification between the two measures was evaluated. Fourth, we used a data analytic strategy proposed by Meehl (2001) to address the primary

versus secondary status of the taxon measured by the RSAS. This strategy involved eliminating cases with high Bayes rule probabilities of MIS taxon membership and rerunning MAXCOV for the RSAS subscales to determine whether evidence of taxonicity would persist in this residual group. Evidence of taxonicity in this residual group would strongly support the independence of the RSAS taxon and argue against the notion that the RSAS demonstrates taxonicity secondary to an association with the traits measured by the MIS.

## Results

*MAXCOV using RSAS subscales.* In an attempt to replicate the previous findings, we analyzed the same four subscales from the RSAS that were identified in Blanchard et al. (2000). These factor analytically derived subscales were interpreted to reflect the following: (a) lack of importance of close friends (five items), (b) lack of involvement with others (seven items), (c) preference for being alone (eight items), and (d) lack of emotional attachment (eight items). Subscale scores were created by summing the items that compose each subscale.<sup>1</sup> In the current sample, alpha coefficients for the four subscales were .68, .58, .64, and .60. We followed the MAXCOV procedures described in the report by Blanchard et al. (2000) and smoothed the curves using Tukey’s (1977) 3RH twice procedure as recommended by Meehl and Yonce (1996). Unsmoothed and smoothed curves were produced by plotting median rather than mean covariance values at each interval in all MAXCOV analyses to minimize effects of potential outliers (Ruscio, 2000). All intervals represent single scores on the input variable except the most extreme high interval, in which extreme scorers were combined to ensure a sample size of at least 20 to obtain a reliable covariance estimate. This standard for determining the extreme cut was adopted in all subsequent MAXCOV analyses.

As can be seen in Figure 1, in all plots, the covariance curve slopes upward to the right end of the scale, consistent with a low base-rate taxon.<sup>2</sup> Base-rate estimates are presented in Table 1. The base rates for the four unsmoothed covariance curves ranged from .06 to .12 and hence are all fairly similar, with a mean value of .08.<sup>3</sup> The mean base-rate estimate for the smoothed curve was also

<sup>1</sup> To determine whether substantial indicator redundancy existed in the taxometric analysis reported in Studies 1 and 2, we compared the sizes of the within-taxon correlations with those of the full sample for each set of indicators. In each case, the within-taxon correlations approached 0.0 and were substantially smaller than those found in the full samples, indicating that excessive redundancy did not exist among the indicators.

<sup>2</sup> Scaling of the covariance axis in MAXCOV plots can affect the apparent peakedness of a covariance curve. Therefore, we standardized the y-axes of all MAXCOV graphs. Specifically, for all analyses using subscales or full scales, the maximum value of the y-axis was set to reflect a correlation between MAXCOV output variables of approximately .60. For one set of analyses (the combined RSAS–MIS–PAS in Study 2), it was necessary to set the maximum y value at a correlation of .75 between output variables to fit in all data points. For item-level analyses, a maximum value of .06 was used for all graphs, which reflects a mean correlation between output items of approximately .40 for RSAS and PAS analyses and .30 for MIS analyses. (Single-item indicators are generally weaker indicators of potential latent classes.)

<sup>3</sup> The MAXCOV–HITMAX base-rate estimations assume that the taxon base rate for the HITMAX interval is .50. In the case of a covariance curve with a marked right-end peak (and a lack of a cusp), the base rates for the taxon and complement are likely not .50/.50 in the final MAXCOV interval, which has been designated the HITMAX interval. Thus, the base rates reported here may be somewhat overestimated.

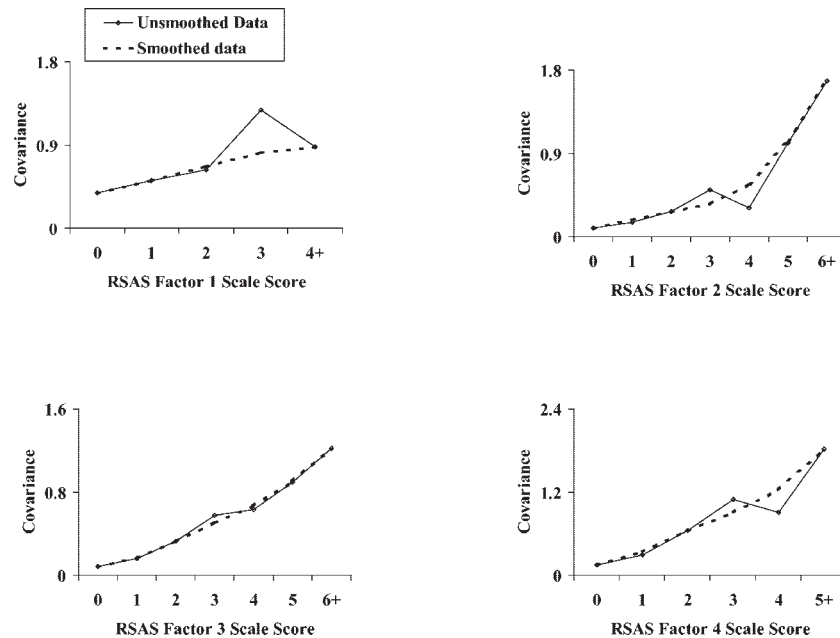


Figure 1. MAXCOV (maximum covariance, making hits maximum) curves for the Revised Social Anhedonia Scale (RSAS) subscales. Each point represents the median covariance value from three pairings of RSAS subscales not used as input.

.08. Because MAXCOV estimates of latent parameters may be biased when taxon indicators covary within taxa, we controlled for this nuisance covariance using procedures recommended by Meehl (1995b). By assuming that the extreme low interval of each indicator contained a pure sample of complement taxon members and therefore could be used to estimate the within-taxon covariances between these other indicators, we derived conservative estimates of the within-taxon covariances. As shown in Table 1, the mean base rate estimate was .05 after controlling for nuisance covariance.

Table 1 also presents estimated indicator validities expressed as  $\gamma$ , the difference between latent means standardized by the within-taxa standard deviations, which is equivalent to an effect size measured in terms of Cohen's  $d$  (Cohen, 1977). Indicator validities are reported as the mean of  $\gamma$  derived from base-rate

estimates adjusted and not adjusted for within-taxon covariance. Computations of  $\gamma$  based on unadjusted and adjusted base rates are sensitive to departures from the assumption of zero nuisance covariance between indicators within taxa but in different directions: The first are underestimates in the face of positive within-taxa covariance and the second are overestimates of such covariance. Thus, the best estimate of indicator validities may be the mean of the two estimates, which is reported in all subsequent estimates of indicator validities. As can be seen, the mean difference is estimated to be approximately 1.67 standard deviations, a large effect size (Cohen, 1977) that is comparable to that found in Blanchard et al. (2000;  $\gamma = 1.45$ ). However, it should be noted that estimates of indicator validities yielded by MAXCOV are not as robust as base-rate estimates (Meehl & Yonce, 1996).

Table 1  
MAXCOV Base-Rate Estimates and Indicator Validities for the Revised Social Anhedonia Scale Factors in Studies 1 and 2

| Input variable                         | Study 1                  |                             |                         | Study 2                  |                             |                         |
|--|--------------------------|-----------------------------|-------------------------|--------------------------|-----------------------------|-------------------------|
|  | Taxon base-rate estimate | Adjusted base-rate estimate | Mean indicator validity | Taxon base-rate estimate | Adjusted base-rate estimate | Mean indicator validity |
| 1. Lack of importance of close friends | .12                      | .05                         | 2.23                    | .12                      | .07                         | 1.74                    |
| 2. Lack of involvement with others     | .06                      | .05                         | 1.48                    | .11                      | .09                         | 1.38                    |
| 3. Preference for being alone          | .09                      | .08                         | 1.39                    | .11                      | .04                         | 1.85                    |
| 4. Lack of emotional attachment        | .06                      | .04                         | 1.62                    | .09                      | .05                         | 1.61                    |
| <i>M</i>                               | .08                      | .05                         | 1.67                    | .11                      | .06                         | 1.48                    |

Note. *Adjusted base-rate estimate* refers to estimates after adjusting for within-taxon nuisance covariance. Indicator validities are expressed as  $\gamma$ , the difference between latent means standardized by the within-taxa standard deviations. MAXCOV = maximum covariance, making hits maximum.



*MAXCOV of the RSAS using an eight-item approach.* We sought to corroborate these results by applying a modified MAXCOV analysis based on eight items from the RSAS to the full sample of 1,560 participants. Although concerns have been raised about possible pseudotaxonicity when using dichotomous indicators (e.g., Golden, 1991; Miller, 1996), Meehl (1996) has noted that false detection is unlikely when multiple procedures indicate taxonicity with similar base-rate estimates and a series of studies demonstrating taxonicity using MAXCOV procedures with dichotomous indicators is corroborated using continuous indicators (Lenzenweger, 1999). Additionally, a recent Monte Carlo investigation supported the use of MAXCOV with dichotomous indicators when sample sizes and indicator validities are reasonably large and reported simulations showing that applying a case-removal consistency test, which we used here, increases the validity of the MAXCOV method based on dichotomous indicators (Ruscio, 2000). Item selection was based on the procedures described by Gangestad and Snyder (1985), who used an item-analysis approach to choose items that correlated highly with the total scale scores (total scale minus the item under consideration). These same procedures have been used in taxometric analyses of the PAS (Korfine & Lenzenweger, 1995; Lenzenweger & Korfine, 1992). We excluded any highly correlated item that was very similar in item content to another item under consideration so as to minimize any existing correlation between two items within the putative classes.

Table 2 contains the eight items we identified as candidate items for taxometric analyses and their observed endorsement frequencies. Covariance curves were based on median covariance values across all 28 pairings for each interval on the corresponding 7-point scale (i.e., each subsample).<sup>4</sup> As can be seen in Figure 2, the curve demonstrates a right-end peak, which is consistent with a taxon with a low base rate. The estimated base rate across all 28 pairings for the unsmoothed curve was .05; after controlling for within-taxon variance, it was .04. The base-rate estimate across all 28 pairings for the smoothed curve was .09, and after controlling for nuisance covariance, it was .06. The mean item validity estimate yielded by MAXCOV was 1.18, a large effect size.

On the basis of Monte Carlo simulations, Ruscio (2000) has recommended that two criteria be used to infer taxonicity. First, the peak covariance for the curve of medians should be at least .05. The peak covariance was .044, just short of .05. As Ruscio (2000) emphasized, however, these rules should not be applied mechanically, particularly when differences between the Monte Carlo simulations and real data exist. In this instance, some of our items had very extreme endorsement rates and hence low variance, which may limit the maximum covariance that can be expected. (The covariance between two items is  $r$  times the product of the items' standard deviations. Although variances for items with extreme endorsements should be higher in the MAXCOV slice, they may still be relatively low.) When the curve was constructed using only covariances between the six items with item-endorsement rates exceeding .10 (the lowest value in Ruscio's simulations was .16), the peak covariance was .054, meeting Ruscio's criterion.

Second, when the taxon base rate is altered by elimination of cases and the method is reapplied, the base-rate estimate in the new sample (based on the unsmoothed curve of medians) should be within .05 of that expected on the basis of the model (Ruscio, 2000). In our analyses, we eliminated half of all cases that, on the

basis of item responses, had less than a .10 probability of being a taxon member. (See the *Bayesian taxon membership probabilities* section below.) This procedure dropped 456 of the original 1,560 cases and should have yielded a taxon base rate of .08 in the remaining cases, according to the taxonic model. The estimated base rate in the new sample was .10, well within Ruscio's criterion of .05 of the expected value.

*MAMBAC of RSAS subscales.* As an additional consistency test, we applied MAMBAC to the RSAS data from the full sample of 1,560 participants. Meehl and Yonce (1994) noted that MAMBAC is likely to work best to estimate latent parameters, such as the base rate, when 10 or more cuts can be made on the input variable. Because it was only possible to make 4–7 cuts on the RSAS subscales, base-rate estimates may be less precise than are those obtained using MAXCOV. Thus, caution is warranted in the interpretation of latent parameter estimates obtained using this procedure. To ensure reasonable sample sizes for base-rate estimates, we chose the extreme high cut on the input variables to include at least 20 individuals above and below the cut. This procedure was used to select the extreme cut on input variables in all subsequent MAMBAC analyses.

As can be seen in Figure 3, the MAMBAC curves are not dish shaped but tend to slope upward toward the right. Upward-sloping MAMBAC curves are characteristic of taxa with low base rates (Meehl & Yonce, 1994), as was expected for the RSAS. The base-rate estimates for the four input variables were moderately higher than those obtained with MAXCOV at .10, .25, .20, and .16 ( $M = .18$ ). The validity estimates for the four RSAS indicators were 1.85, 1.63, 1.99, and 1.69 ( $M = 1.79$ ). Meehl and Yonce (1994) noted that MAMBAC base-rate estimates may be slightly positively biased for low base-rate taxa, and the small number of cuts on the indicator variables could exaggerate this. Overall, the consistency of results across taxometric procedures provides strong evidence for the existence of a social anhedonia taxon.

*MAMBAC of MIS subscales.* To identify multiple correlated indicators of the putative taxon tapped by the MIS, we followed the same factor analytic procedures used in our taxometric analysis of the RSAS. On the basis of factor interpretability, two factors were extracted (using principal axis factoring) and obliquely rotated (using direct oblimin). Items loading on the first factor included "Good luck charms don't work" (reverse coded; Item 13) and "I have wondered whether the spirits of the dead can influence the living" (Item 28). This dimension was interpreted as *Paranormal Beliefs*. The items loading most highly on the second factor were "I have had the momentary feeling that someone's place has been taken by a look-alike" (Item 17) and "Things sometimes seem to be in different places when I get home, even though no one has been there" (Item 6). This factor was interpreted as *Depersonalization*. The factors correlated moderately with each other (.58). To create subscales, we summed all items loading greater than .30

<sup>4</sup> Individual covariance curves for the RSAS were generally consistent in demonstrating curves with right-end peaks. Panels of individual curves for the item-level MAXCOV analyses have been omitted throughout to conserve space. They are available from the authors on request.

Table 2

*Revised Social Anhedonia Scale Item Endorsement Frequencies and Taxon Base-Rate Estimates for Eight-Item MAXCOV Analyses*

| Item content  | Study 1               |                 | Study 2               |                 |
|---|-----------------------|-----------------|-----------------------|-----------------|
|   | Endorsement frequency | Taxon base rate | Endorsement frequency | Taxon base rate |
| 1. I prefer hobbies and leisure activities that do not involve other people. (T)                      | .20                   | .06             | .16                   | .08             |
| 2. Knowing that I have friends who care about me gives me a sense of security. (T)                    | .07                   | .10             | .05                   | .03             |
| 3. When I move to a new city I feel a strong need to make new friends. (F)                            | .28                   | .04             | .29                   | .13             |
| 4. People are usually better off if they stay aloof from emotional involvements with most others. (T) | .23                   | .10             | .17                   | .04             |
| 5. I'm much too independent to really get involved with other people. (T)                             | .15                   | .08             | .05                   | .02             |
| 6. Making new friends isn't worth the energy it takes. (T)  | .06                   | .05             | .07                   | .04             |
| 7. People who try to get to know me better usually give up after a while. (T)                         | .13                   | .09             | .10                   | .07             |
| 8. I don't really feel very close to my friends. (T)  | .15                   | .03             | .15                   | .09             |
| <i>M</i>  |                       | .07             |                       | .06             |
| Mean of 28 unsmoothed curves  |                       | .05             |                       | .05             |
| Mean of 28 smoothed curves  |                       | .09             |                       | .06             |

*Note.* T (true) and F (false) indicate the criterial direction for scoring the item. The taxon base rates associated with each item were derived from the median covariance values across the seven pairings involving a given item. MAXCOV = maximum covariance, making hits maximum. The scale items are from *The Revised Social Anhedonia Scale* by M. L. Eckblad, L. J. Chapman, J. P. Chapman, and M. Mishlove, 1982, unpublished manuscript, University of Wisconsin—Madison. Copyright 1982 by M. L. Eckblad, L. J. Chapman, J. P. Chapman, and M. Mishlove. Reprinted with permission.

on the respective factor in the pattern matrix.<sup>5</sup> Internal consistency estimates for the two subscales were as follows: Paranormal Beliefs,  $\alpha = .77$  (13 items), and Depersonalization,  $\alpha = .60$  (7 items). Because only two MIS subscale indicators were available, we applied MAMBAC to the data with each indicator serving as an input variable and an output variable once, resulting in two curves.

As can be seen in Figure 4, in both curves, the function is not dish shaped but tends to slope upward toward the right. However, the slopes of the curves do not appear remarkably steep. The base-rate estimates of the taxon were .28 and .23, for a best estimate of .25. The validity estimates for the two MIS indicators were 2.79 and 1.69 ( $M = 2.24$ ). Thus, some evidence suggested a taxon with a base rate higher than the anticipated .10.

*MAXCOV of the MIS using an eight-item approach.* We sought to corroborate these results by applying MAXCOV to eight items from the MIS using the same item-analysis approach described above. Table 3 contains the eight items we identified as

candidate items for taxometric analyses and their observed endorsement frequencies. Covariance curves across all 28 pairings for each interval on the corresponding 7-point scale are presented in Figure 5. As can be seen, the curve demonstrates a peak near the center cut, which is consistent with a taxon with a moderate base rate rather than a low base-rate taxon. The base-rate estimates for the unsmoothed curve were .22 and, after controlling for within-taxon variance, .20. For smoothed curves, the base-rate estimates were .23 and, after adjusting for within-taxon covariance, .19. The mean item validity estimate yielded by MAXCOV was .92.

The peak covariance was .037 (.042 after covariances involving one item with an endorsement rate of less than .10 were removed), less than the criterion of .05 recommended by Ruscio (2000). Furthermore, the estimated base rate when half of all cases with a Bayesian probability of being a taxon member of .10 or less were eliminated was .59, far off of the value of .31 predicted by the model.

Overall, the MAMBAC and MAXCOV curves provided evidence only weakly suggestive of taxonicity. The MAMBAC curves were not remarkably steep, the base-rate estimates were consistently higher than predicted, and the item-level MAXCOV analyses did not meet Ruscio's (2000) criteria of those clearly indicating taxonicity.

*Taxometric analyses of the combined RSAS–MIS using MAXCOV and MAMBAC.* Given the evidence of a taxon associated with the RSAS and possible taxonicity associated with the MIS, we assessed whether they tap a common taxon. Although the evidence for a taxon associated with the MIS was weak, taxonicity cannot be ruled out, particularly as the MIS was previously found to tap a taxon common with another putative indicator of the schizotypy taxon, the PAS (Lenzenweger, 1999). Thus, examination of the

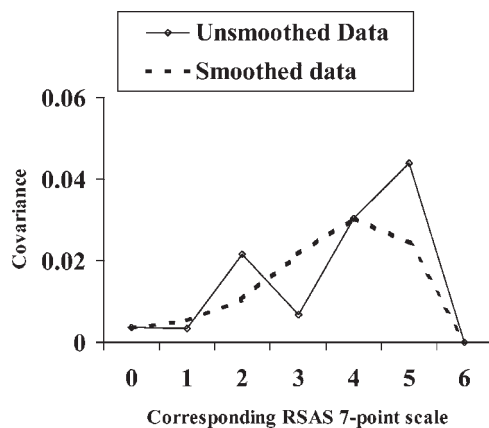


Figure 2. MAXCOV (maximum covariance, making hits maximum) curve for eight items from the Revised Social Anhedonia Scale (RSAS) based on the median covariances across all 28 pairings for each interval on the corresponding 7-point scale.

<sup>5</sup> A full presentation of the pattern matrix loadings is available from the authors.

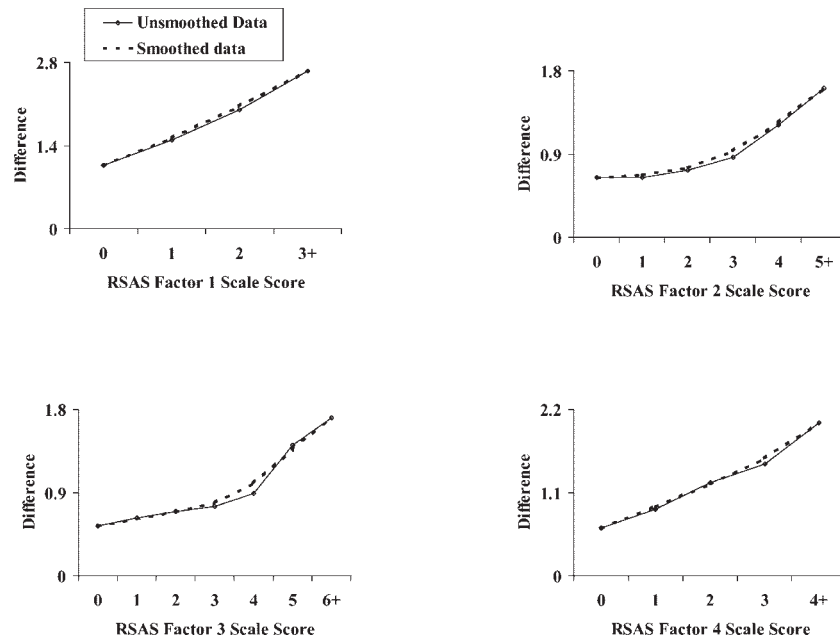


Figure 3. MAMBAC (mean above minus below a cut) results for the Revised Social Anhedonia Scale (RSAS) subscales.

overlap between these measures may be regarded as a conservative test of the independence of the RSAS taxon from traits measured by the MIS.

We first applied the MAXCOV method to the six putative schizotypy indicators derived from our factor analyses of these measures, using four factors from the RSAS and two factors from the MIS. In the MAXCOV procedure, covariances between each pair of output variables are calculated across cuts on each input variable. Because we were interested in examining the shared latent structure of the RSAS and MIS, median covariance compu-

tations across cuts on each input variable included only combinations of input variables and output variables in which indicators from both scales were present. For example, when Factor 1 from the RSAS was used as the input variable, covariances between RSAS Factors 2 and 3, 2 and 4, and 3 and 4 across cuts on RSAS Factor 1 were not included, as indicators from the MIS were not present in these combinations. When Factor 1 from the MIS was used as the input variable, covariances among all remaining pairs of output variables were included in median covariance calculations, as indicators from both scales were present in each combination.

Using each indicator as an input variable, the six covariance curves presented in Figure 6 were generated. Inspection of these curves reveals considerable variability, with curves appearing relatively flat, peaked toward the center, or rising at the right end, which is not consistent with taxonicity. Base-rate estimates ranged from .12 to .21.

As an additional test, we applied MAMBAC to our data using the full RSAS and MIS as indicators (each serving as the input variable and the output variable once), resulting in two curves and two accompanying base-rate estimates. As can be seen in Figure 7, the MAMBAC curves are not consistent across input indicators, with one demonstrating a dish shape and the other sweeping downward toward the right. The base-rate estimates were .67 and .44 for the two unsmoothed curves, which differ considerably from each other, from estimates derived from MAXCOV procedures, and from the base-rate estimates for the taxa underlying the RSAS and MIS individually. The validity estimates were 1.47 and 1.42, respectively ( $M = 1.44$ ). The lack of consistency across MAXCOV and MAMBAC procedures indicates that these scales do not tap a common taxon, which would not be expected if the taxonicity of social anhedonia were secondary to the traits measured by the MIS.

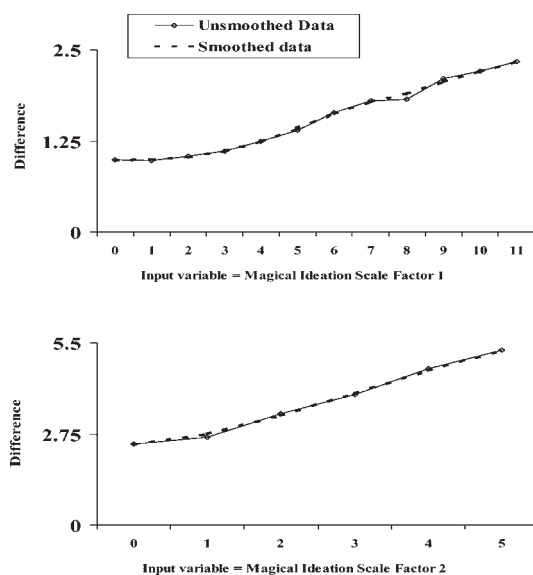


Figure 4. MAMBAC (mean above minus below a cut) results for two subscales derived from the Magical Ideation Scale (MIS).

Table 3

*Magical Ideation Scale Item Endorsement Frequencies and Taxon Base-Rate Estimates for Eight-Item MAXCOV Analyses*

| Item content  | Study 1               |                 | Study 2               |                 |
|---|-----------------------|-----------------|-----------------------|-----------------|
|   | Endorsement frequency | Taxon base rate | Endorsement frequency | Taxon base rate |
| 1. I have felt that there were messages for me in the way things were arranged, like in a store window. (T) | .17                   | .21             | .31                   | .17             |
| 2. I have had the momentary feeling that someone's place has been taken by a look-alike. (T)                | .09                   | .20             | .17                   | .14             |
| 3. It is not possible to harm others merely by thinking bad thoughts about them. (F)                        | .29                   | .21             | .35                   | .37             |
| 4. I have sometimes sensed an evil presence around me although I could not see it. (T)                      | .40                   | .21             | .44                   | .35             |
| 5. I have sometimes had the passing thought that strangers are in love with me. (T)                         | .23                   | .21             | .26                   | .23             |
| 6. I have felt that I might cause something to happen just by thinking too much about it. (T)               | .34                   | .25             | .55                   | .45             |
| 7. I have wondered whether the spirits of the dead can influence the living. (T)                            | .49                   | .21             | .55                   | .30             |
| 8. I have sometimes felt that strangers were reading my mind. (T)   | .18                   | .16             | .35                   | .38             |
| <i>M</i>  |                       | .21             |                       | .30             |
| Mean of 28 unsmoothed curves  |                       | .22             |                       | .35             |
| Mean of 28 smoothed curves  |                       | .23             |                       | .29             |

*Note.* T (true) and F (false) indicate the criterial direction for scoring the item. The taxon base rates associated with each item were derived from the median covariance values across the seven pairings involving a given item. MAXCOV = maximum covariance, making hits maximum. The scale items are from "Magical Ideation as an Indicator of Schizotypy," by M. L. Eckblad and L. J. Chapman, 1983, *Journal of Consulting and Clinical Psychology*, 51, pp. 216–217. Copyright 1983 by the American Psychological Association. Reprinted with permission.

*Bayesian taxon membership probabilities.* To further assess the relationship between the RSAS taxon and the MIS, we computed Bayesian taxon membership probabilities on the basis of each individual's pattern of scoring at or above versus below the HITMAX interval on the indicators used in MAXCOV. It was decided not to follow the common practice of looking for U-shaped distributions of taxon membership probabilities, as concerns have been raised about the validity of this consistency test, which is currently being investigated (P. E. Meehl, personal communication, June 26, 2002).

To examine the overlap between memberships in these putative taxa, individuals were classified as high- versus low-probability taxon members for each scale using a cutoff score of .50, the data were cross-tabulated, and coefficient kappa was computed. The kappa coefficient was disattenuated for error in classification using procedures described by W. M. Grove (personal communication, August 10, 2003). As shown in Table 4, the taxon memberships show only

partial overlap, with the majority of high-likelihood RSAS taxon members not classified as MIS taxon members and the majority of high-likelihood MIS taxon members not classified as RSAS taxon members, attenuated  $K = .08$ .

Finally, we used the data-analytic strategy proposed by Meehl (2001) to aid in distinguishing between a primary and a secondary social anhedonia taxon. Participants with Bayesian probabilities greater than or equal to .50 for MIS taxon membership were excluded from the data set, which resulted in 415 cases being dropped ( $N = 1,145$ ). Although the evidence for a taxon associated with the MIS was somewhat ambiguous, there was some evidence of taxonicity across analyses (e.g., MAMBAC and MAXCOV curves resembling forms associated with taxonicity and relatively consistent, although higher than expected, base-rate estimates). Thus, eliminating cases with high MIS taxon membership probabilities provides a conservative test of whether the RSAS demonstrates taxonicity independent of the traits measured by the MIS. We applied MAXCOV analyses to the RSAS subscales exactly as described above, which resulted in the four covariance curves presented in Figure 8. In all plots, the covariance curve slopes upward to the right end of the scale, although the slope of the curve when using Factor 1 as the input indicator was not as steep as it was in the original analyses. Base-rate estimates derived from the four unsmoothed covariance curves range from .06 to .22, with their mean value of .11 representing a best estimate of the taxon base rate. The mean base-rate estimate for smoothed curves was slightly higher at .13. The consistency of results in a subsample that excluded individuals with high probabilities of MIS taxon membership further supports the existence of a social anhedonia taxon that is not merely a reflection of its association with the taxon measured by the MIS.

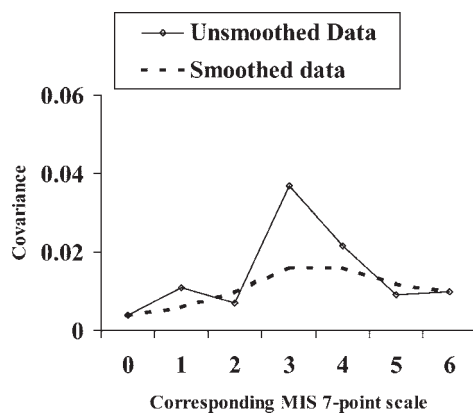


Figure 5. MAXCOV (maximum covariance, making hits maximum) curve for eight items from the Magical Ideation Scale (MIS) based on the median covariances across all 28 pairings for each interval on the corresponding 7-point scale.

### Discussion

Taxometric analyses of the RSAS yielded rather consistent evidence across procedures for the existence of a latent taxon with a base rate of about .07–.11. Taxometric analyses provided only



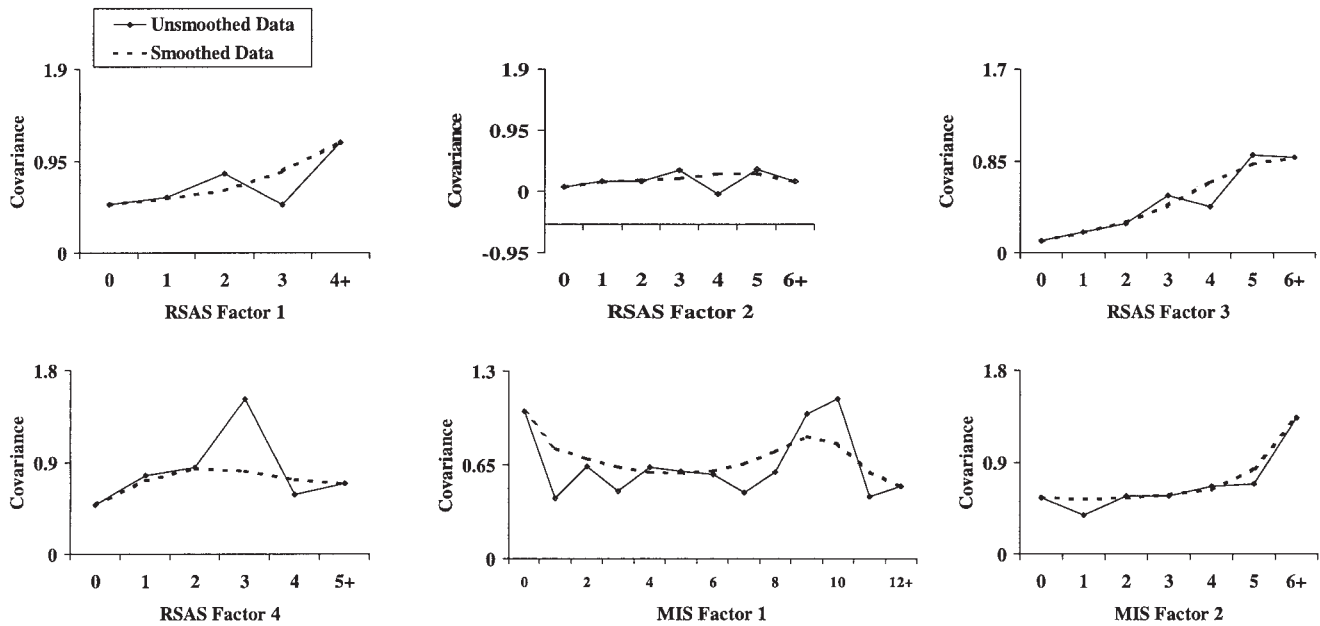


Figure 6. MAXCOV (maximum covariance, making hits maximum) curves for combined Revised Social Anhedonia Scale (RSAS) and Magical Ideation Scale (MIS) data. Each point represents the median covariance from pairings including factors from both the RSAS and the MIS.

weak evidence of a taxon associated with the MIS, which, should it exist, have an estimated base rate of approximately .20–.25, considerably higher than the expected .10. The conjecture that the RSAS and MIS tap a common taxon was clearly not supported,

and there was no evidence that the taxonicity of the RSAS was a reflection of its association with the traits measured by the MIS.

## Study 2

Study 2 was conducted to replicate and extend findings from Study 1 by applying taxometric methods to a large, independent data set collected at institutions in a different geographical area to address two issues. First, we sought to provide an additional replication of the finding that the RSAS taps a latent taxon. Second, we sought to assess the replicability of the finding that the RSAS taxon appears to be relatively independent of the construct measured by the MIS. In addition to the MIS, analyses included the PAS, a putative schizotypy indicator that has been reported to

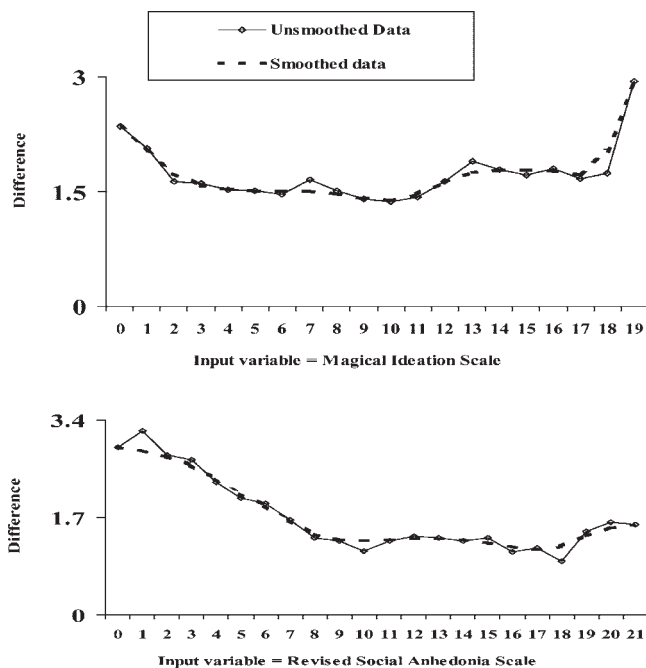


Figure 7. MAMBAC (mean above minus below a cut) results for combined Revised Social Anhedonia Scale (RSAS) and Magical Ideation Scale (MIS) data.

Table 4

*Cross-Tabulation of Social Anhedonia and Magical Ideation Taxon Membership*

| RSAS taxon | MIS taxon |      | Totals |
|------------|-----------|------|--------|
|            | 0         | 1    |        |
| 0          |           |      |        |
| <i>n</i>   | 898       | 247  | 1,145  |
| %          | 57.6      | 15.8 | 73.4   |
| 1          |           |      |        |
| <i>n</i>   | 303       | 112  | 415    |
| %          | 19.4      | 7.2  | 26.6   |
| Totals     |           |      |        |
| <i>N</i>   | 1,201     | 359  | 1,560  |
| %          | 77.0      | 23.0 | 100.0  |

Note. MIS = Magical Ideation Scale; RSAS = Revised Social Anhedonia Scale.

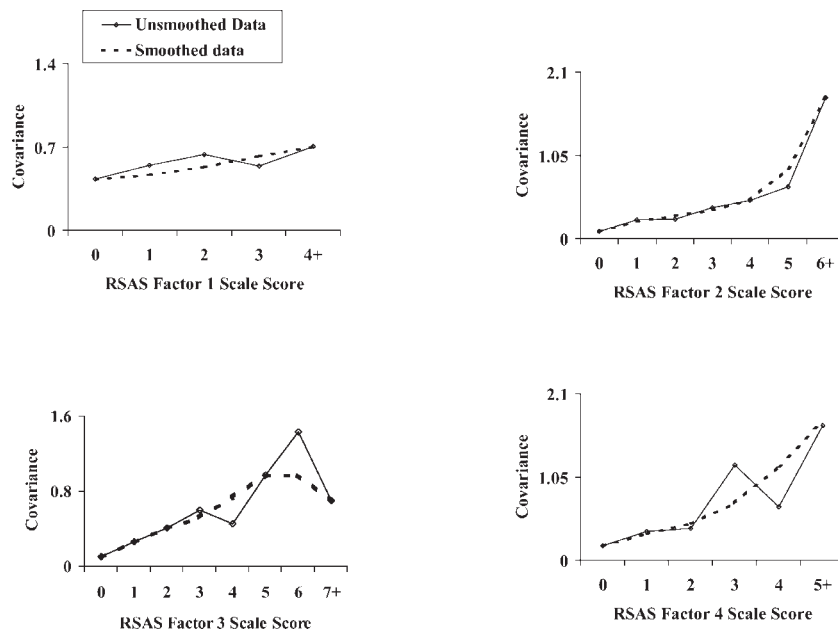


Figure 8. MAXCOV (maximum covariance, making hits maximum) curves for Revised Social Anhedonia Scale (RSAS) subscales after excluding individuals with Bayesian probabilities for Magical Ideation Scale taxon membership greater than or equal to .50. Each point represents the median covariance value from three pairings of RSAS subscales not used as input.

share a common latent taxonic structure (in conjunction with the Referential Thinking Scale; Lenzenweger, Bennett, & Lilenfeld, 1997) with the MIS (Lenzenweger, 1999). Several taxometric data-analytic strategies were applied to full-scale scores on these instruments in light of potential methodological complications associated with the use of dichotomous data (Golden, 1991) to examine whether the RSAS shares a latent taxonic structure with the constructs measured by the MIS and PAS.

## Methods

**Participants.** Participants in this study were undergraduates enrolled in psychology courses at the University of North Carolina at Greensboro, Winston-Salem State University, and North Carolina A&T State University. Assessment procedures were the same as those described in Study 1, and participants who received Chapman Infrequency Scale (L. J. Chapman & Chapman, 1983) scores greater than 2 were omitted from analyses. A final sample of 2,574 satisfied all inclusion criteria, of which 75% were women. Ethnicity characteristics of the final sample were as follows: 67% Caucasian, 27% African American, 1% Hispanic, 1% Asian, and 4% other.

**Schizotypy indicators.** In addition to the RSAS and MIS, the PAS (L. J. Chapman et al., 1978a) was included as a putative indicator of schizotypy or psychosis proneness. The PAS is a 35-item questionnaire intended to measure body image and perceptual distortions. An extensive body of research supports the validity of this scale as a measure of schizotypy or psychosis proneness and demonstrates that this scale possesses good psychometric properties (J. P. Chapman et al., 1995; Edell, 1995; Lenzenweger, 1998). In the current sample, the RSAS ( $\alpha = .83$ ), MIS ( $\alpha = .84$ ), and PAS ( $\alpha = .89$ ) each demonstrated good internal consistency.

## Results

**MAXCOV analyses of RSAS subscales.** MAXCOV analyses followed the identical procedures described in Study 1. Internal

consistency estimates ( $\alpha$ ) for the four RSAS subscales were .63, .61, .63, and .53. As shown in Figure 9, in all plots, the covariance curves slope upward toward the right end of the scale. Base-rate estimates derived from the four unsmoothed covariance curves ranged from .09 to .12, with a mean estimate of .11 (see Table 1). The mean base-rate estimate for smoothed curves was .10. After controlling for nuisance covariance, mean base-rate estimates for smoothed and unsmoothed curves were both slightly lower at .06. The mean validity estimate across the four input variables was approximately 1.48.

**MAXCOV of the RSAS using an eight-item approach.** MAXCOV analyses were applied to the same eight RSAS items examined in Study 1 using the identical procedures. The observed endorsement frequencies and base-rate estimates for the individual items are presented in Table 2. Covariance curves are presented in Figure 10 and demonstrate clear right-end peaks, consistent with a low base-rate taxon. The estimated base rate across all 28 pairings for the unsmoothed curve was .05; after controlling for within-taxon variance, it was also .05. The base-rate estimate across all 28 pairings for the smoothed curve was .06, and after controlling for nuisance covariance, it was .12. The mean item validity estimate yielded by MAXCOV was 1.29.

Criteria recommended by Ruscio (2000) were examined. First, the peak median covariance between the four items with endorsement rates greater than .10 was .052, exceeding Ruscio's (2000) criterion of .05. (It was .044 for all items but, as noted for Study 1, items with very extreme endorsement rates may generally yield lower covariances; Ruscio's simulations had items with base rates of at least .16.) Second, elimination of half of all cases with a .10 or less probability of being a taxon member should have yielded a new taxon base rate of .07, according to the taxonic model. The

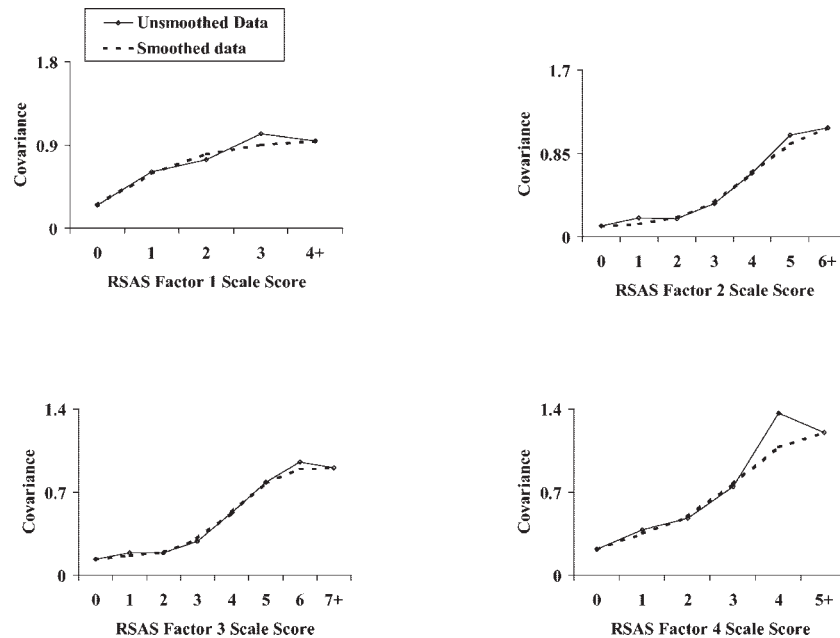


Figure 9. MAXCOV (maximum covariance, making hits maximum) curves for the Revised Social Anhedonia Scale (RSAS) subscales. Each point represents the median covariance value from three pairings of RSAS subscales not used as the input variable.

actual estimated value of .08 was well within Ruscio's criterion of .05 of the expected.

**MAMBAC of RSAS subscales.** MAMBAC analyses were applied to the RSAS subscales using the same procedures described in Study 1. As noted above, caution is warranted in computing estimates of latent parameters using this procedure because of the limited number of cuts that could be derived from the RSAS subscales. As shown in Figure 11, the MAMBAC curves are not dish shaped but rather are sloped upward toward the right, consistent with a low base-rate taxon. The base-rate estimates for the four input variables were more variable and moderately higher than those obtained with MAXCOV at .12, .28, .22, and .13 ( $M = .19$ ). The indicator validities for the four indicators were 1.71, 1.64, 1.98, and 1.63 ( $M = 1.74$ ).

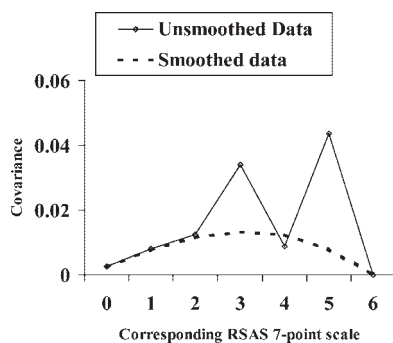


Figure 10. MAXCOV (maximum covariance, making hits maximum) curve for eight items from the Revised Social Anhedonia Scale (RSAS) based on median covariances across all 28 pairings for each interval on the corresponding 7-point scale.

**MAMBAC of MIS subscales.** We applied MAMBAC to the two MIS factors identified in Study 1: Paranormal Beliefs ( $\alpha = .66$ ) and Depersonalization ( $\alpha = .55$ ). As can be seen in Figure 12, in both curves, the function tends to slope upward toward the right with the steepness of the slopes approximating those found in Study 1. The base-rate estimates of the taxon were .31 and .30, for a best estimate of .31. Indicator validities were 2.67 and 2.01 ( $M = 2.34$ ). Again, inconsistencies across procedures and studies do not provide strong support for the taxonicity of the MIS.

**MAXCOV of the MIS.** We applied the identical MAXCOV procedures to the same eight MIS items identified in Study 1 (see Table 3). As shown in Figure 13, the curves demonstrate a peak near the center cut rather than a right-end peak characteristic of a low base-rate taxon. The base-rate estimates were consistently larger than those found in Study 1, at .35 for unsmoothed curves and .33 after adjusting for nuisance covariance. The base-rate estimates were .29 for smoothed curves and .33 after adjusting for within-taxon covariance. A relatively large degree of variability in base-rate estimates existed across individual curves, with estimates for unsmoothed curves ranging from .14 to .45. The mean item-validity estimate yielded by MAXCOV was .70.

The peak covariance was .026, well under the criterion of .05 recommended by Ruscio (2000). Furthermore, eliminating half the cases with Bayesian probabilities of taxon membership less than .10 yielded a base rate of .97, far off the base rate of .45 expected by the taxonic model. Overall, the MAXCOV results did not support the taxonicity of the MIS.

**MAXCOV analyses of the PAS.** To evaluate the relationship between the RSAS and the taxon measured by the PAS and MIS in previous research (Lenzenweger, 1999), we first sought to examine the taxonicity of the PAS and MIS in the current sample. For the PAS, we applied MAXCOV to the same eight items

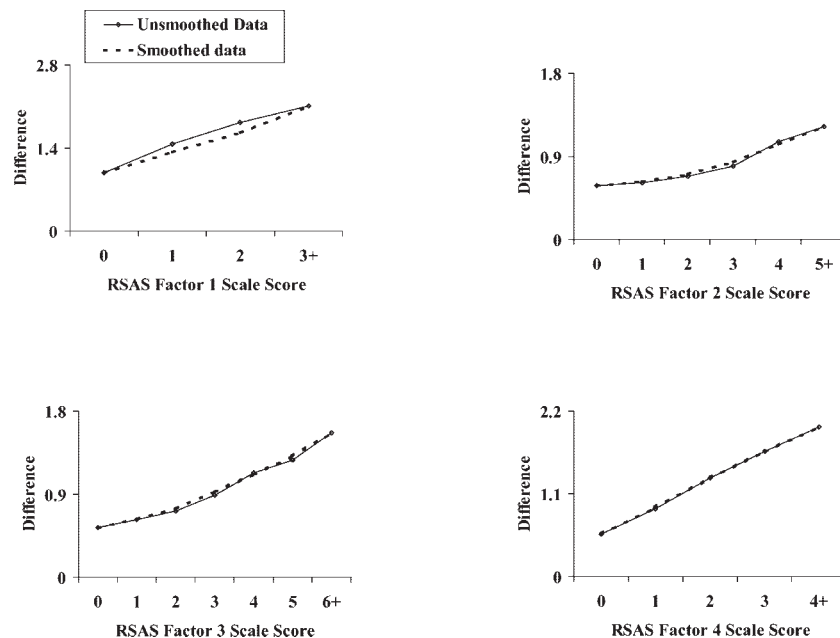


Figure 11. MAMBAC (mean above minus below a cut) results for the Revised Social Anhedonia Scale (RSAS) subscales.

identified by Lenzenweger and Korfine (1992; Korfine & Lenzenweger, 1995) exactly as described by those authors. The eight items and their endorsement frequencies are displayed in Table 5. Covariance curves are presented in Figure 14 and demonstrate clear right-end peaks, which is consistent with a low base-rate taxon. The estimated base rate across all 28 pairings for the

unsmoothed curve was .06; after controlling for within-taxon variance, it was .05. The base-rate estimates across all 28 pairings for the smoothed curve before and after controlling for nuisance covariance were both .06. The mean item validity estimate yielded by MAXCOV was .97.

The peak covariance in these analyses was .030, below the criterion of .05 recommended by Ruscio (2000). (For covariances between only those items with endorsement rates exceeding .10, the peak covariance was similar, .021.) On the basis of the taxonic model, eliminating half the cases with Bayesian probabilities of taxon membership less than .10 should have resulted in a base rate of .08. The actual estimated base rate was nearly identical to this value, .08.

In general, results appear consistent with previous MAXCOV analyses of this scale (Korfine & Lenzenweger, 1995; Lenzenweger, 1999; Lenzenweger & Korfine, 1992). Support must be

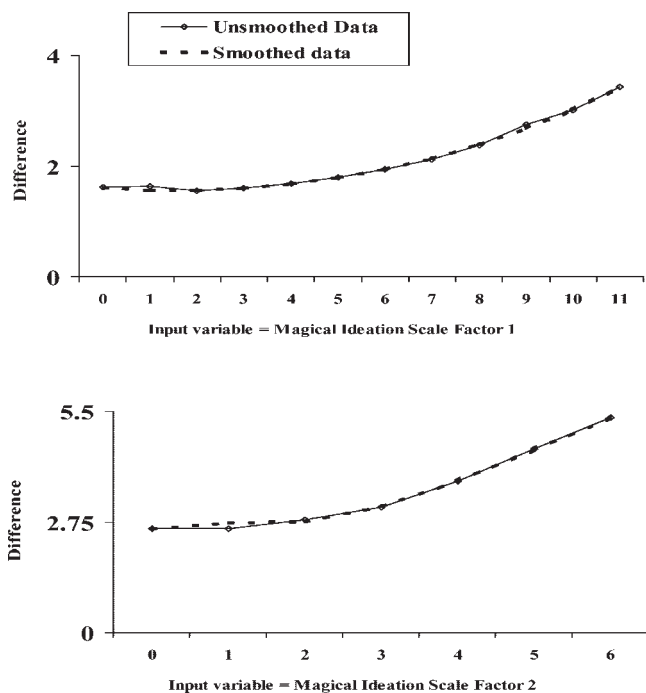


Figure 12. MAMBAC (mean above minus below a cut) results for two subscales derived from the Magical Ideation Scale (MIS).

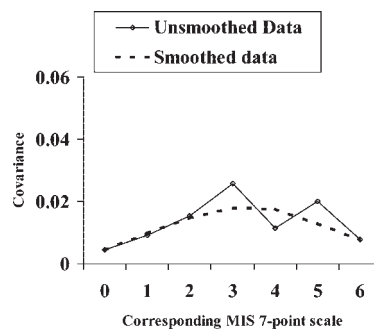


Figure 13. MAXCOV (maximum covariance, making hits maximum) curve for the Magical Ideation Scale (MIS) based on the average covariances across all 28 pairings for each interval on the corresponding 7-point scale.



Table 5  
*Perceptual Aberration Scale Item Endorsement Frequencies and Taxon Base-Rate Estimates for Eight-Item MAXCOV Analyses*

| Item content   | Endorsement frequency | Taxon base rate |
|--|-----------------------|-----------------|
| 1. Parts of my body occasionally seem dead or unreal. (T)                                | .07                   | .07             |
| 2. I have had the momentary feeling that my body has become misshapen. (T)               | .07                   | .07             |
| 3. Now and then when I look in the mirror, my face seems quite different than usual. (T) | .45                   | .10             |
| 4. I have sometimes felt that some part of my body no longer belonged to me. (T)         | .08                   | .03             |
| 5. Sometimes part of my body has seemed smaller than it usually has. (T)                 | .14                   | .06             |
| 6. Sometimes when I look at things like tables and chairs, they seem strange. (T)        | .14                   | .09             |
| 7. The boundaries of my body always seem clear. (F)                                      | .08                   | .03             |
| 8. Occasionally I have felt as though my body did not exist. (T)                         | .21                   | .13             |
| <i>M</i>   |                       | .07             |
| Mean of 28 unsmoothed curves   |                       | .06             |
| Mean of 28 smoothed curves   |                       | .06             |

*Note.* T (true) and F (false) indicate the criterial direction for scoring the item. The taxon base rates associated with each item were derived from the median covariance values across the seven pairings involving a given item for each item. MAXCOV = maximum covariance, making hits maximum. The scale items are from "Perceptual Aberration Scale," by L. J. Chapman, J. P. Chapman, and M. Raulin, 1978, unpublished manuscript, University of Wisconsin—Madison Copyright 1978 by L. J. Chapman, J. P. Chapman, and M. Raulin. Reprinted with permission.

qualified by the fact that the results did not meet both of Ruscio's (2000) criteria for inferring taxonicity from item-level MAXCOV analyses. As Ruscio himself noted, however, his cut-off rules should not be applied mechanically but, rather, results should be evaluated in light of all available evidence. As evidence not based on item-level MAXCOV analyses supports the taxonicity of the PAS, we suggest that the failure to meet Ruscio's rules does not, at this time, justify rejection of the hypothesis that the PAS is taxonic. More empirical work on the PAS, as well as Monte Carlo work on item-level MAXCOV analyses, may be needed.

*MAXCOV analyses of the combined RSAS, MIS, and PAS.* MAXCOV was applied to full-scale scores of the RSAS, MIS, and PAS, using each scale as an input variable, to examine whether these scales jointly share a latent taxonic structure. To obtain multiple intervals for each input variable, the full-scale scores were standardized and partitioned into one-quarter standard deviation

cuts. Covariances between the standardized scores for the remaining two scales (i.e., output variables) were then computed. The three resulting covariance curves are presented in Figure 15. One curve demonstrates a moderate right-end peak (using the RSAS as the input variable), whereas the two additional curves are relatively flat. Base-rate estimates ranged from .08 to .20 for unsmoothed curves and from .08 to .23 for smoothed curves. Overall, results were not consistent across MAXCOV procedures and thus do not support the existence of a joint latent taxonic structure among the RSAS, MIS, and PAS.

*MAMBAC analyses using pairs of indicators from the RSAS, MIS, and PAS.* To additionally test the overlap between the RSAS and the MIS and PAS, we applied MAMBAC to each pair of scales. Consistent with previous research, the RSAS correlated only moderately with the MIS (.21) and PAS (.26). MAMBAC analyses yielded three sets of two curves each (using each indicator as an input variable), which are presented in Figure 16. MAMBAC analyses of the RSAS and PAS resulted in curves that were both relatively flat, with base-rate estimates of .65 and .64 and indicator validities of 1.36 and 1.60 ( $M = 1.48$ ). MAMBAC analyses of the RSAS and MIS resulted in curves that were relatively flat and sloping downward, with base rate estimates of .57 and .81 and indicator validities of 1.71 and 1.33 ( $M = 1.52$ ). Overall, results did not reveal curves that are consistent with a taxonic latent structure, and the base-rate estimates were highly variable and markedly elevated as compared with previous taxometric analyses of putative schizotypy indicators. Thus, MAMBAC analyses did not support the existence of a shared latent taxonic structure between the RSAS and either the PAS or the MIS.

We also examined the joint latent structure of the PAS and MIS using MAMBAC. The scales were highly correlated at .70, consistent with previous research (Edell, 1995). In both curves, the

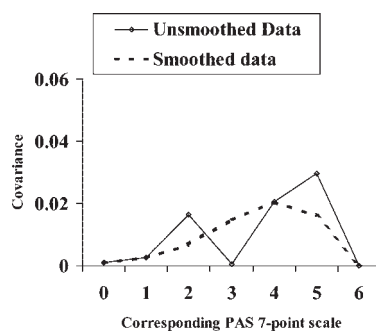


Figure 14. MAXCOV (maximum covariance, making hits maximum) curve for the Perceptual Aberration Scale (PAS) based on the median covariances across all 28 pairings for each interval on the corresponding 7-point scale.

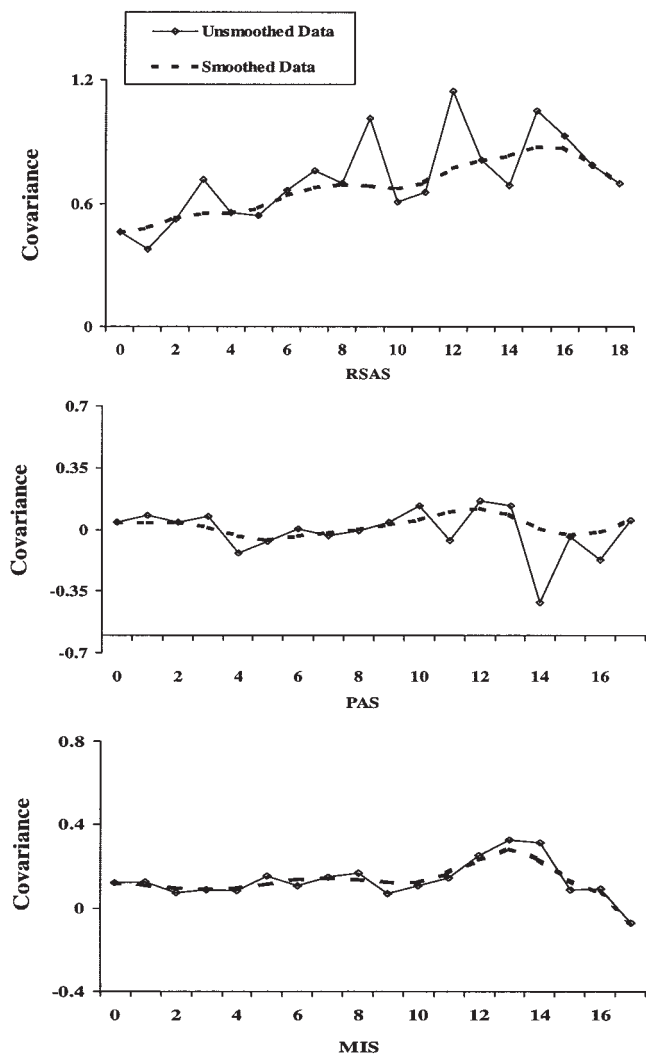


Figure 15. MAXCOV (maximum covariance, making hits maximum) curves for the combined Revised Social Anhedonia Scale (RSAS), Perceptual Aberration Scale (PAS), and Magical Ideation Scale (MIS). Each point represents the median covariance value from pairings of scales not used as the input variable.

function is not dish shaped but rather is sloped upward to the right (see Figure 16). Base-rate estimates were .33 and .24, for a best estimate of .29. Indicator validities were 2.48 and 2.49 ( $M = 2.48$ ). Thus, although the forms of the MAMBAC curves are suggestive of a common PAS and MIS taxon, the relatively higher base-rate estimates as compared with previous studies of the PAS alone (Korfine & Lenzenweger, 1995; Lenzenweger & Korfine, 1992) or the PAS and MIS (Lenzenweger, 1999) do not provide clear and compelling evidence of a shared latent structure.

**Bayesian taxon membership probabilities.** Bayesian taxon membership probabilities were computed and used to classify individuals as high- versus low-probability taxon members for the RSAS, PAS, and MIS using a cutoff of .50, and taxon membership overlap was evaluated using the same procedure described in Study 1. As shown in Table 6, the overlap between the RSAS and PAS was low, with a minority of individuals classified as high-likelihood members of both taxa, attenuated  $K = .24$ . Although

evidence for the taxonicity of the MIS was weak, we also examined the overlap between individuals with high taxon-membership probabilities for this scale and for the RSAS. As shown in Table 7, a small minority of individuals were classified as high-likelihood members of both taxa, attenuated  $K = .08$ .

Finally, we examined the taxonicity of the RSAS in a subsample that excluded individuals with high probabilities of membership in the MIS and/or PAS taxa in order to evaluate the issue of the primary versus secondary status of the social anhedonia taxon (Meehl, 2001). Participants with Bayes probabilities greater than or equal to .50 for MIS or PAS taxon membership were excluded from analyses, which resulted in our dropping 1,150 cases ( $n = 1,424$ ). Although evidence for the taxonicity of the MIS was weak, exclusion of individuals with high taxon-membership probabilities for this scale provides a conservative test of the independence of the RSAS taxon. We applied MAXCOV analyses to the RSAS exactly as described above, which resulted in the four covariance curves presented in Figure 17. In all plots, the covariance curve slopes upward to the right end of the scale, consistent with a low base-rate taxon. Base-rate estimates derived from the four unsmoothed covariance curves ranged from .08 to .12, with their mean value of .10 representing a best estimate. The mean base-rate estimate for smoothed curves was also .10. The consistency of results across MAXCOV procedures in the residual group that excluded individuals with high Bayesian probabilities of MIS and/or PAS taxon membership supports the existence of a social anhedonia taxon that is not merely a reflection of its association with the traits measured by the PAS and/or MIS.

### Discussion

Taxometric analyses in Study 2 provided consistently clear evidence of taxonicity for individual differences measured by the RSAS and evidence arguably consistent with taxonicity for those measured by the PAS. Base-rate estimates were approximately .10 for the RSAS and .09 for the PAS, which are both consistent with Meehl's (2001) hypothesized base-rate estimate of the schizotypy taxon and with prior research. By contrast, evidence for taxonicity of the MIS was not compelling, with considerable variability across base-rate estimates and a mean base-rate estimate of .32, which is higher than the estimate found in Study 1 (.24). MAXCOV and MAMBAC analyses of the combined latent structure of the RSAS, MIS, and PAS did not produce curves consistent with taxonicity and resulted in markedly inconsistent base-rate estimates. Analyses of the associations of taxon membership probabilities also revealed no appreciable overlap between the RSAS and the PAS or MIS, and MAXCOV analyses of the RSAS in a subsample that excluded cases with high probabilities of PAS and/or MIS taxon membership continued to demonstrate clear evidence of taxonicity. Thus, results of Study 2 replicate the taxonicity of the RSAS in a large independent sample and converge with the finding in Study 1 that the RSAS appears to tap a taxon that is relatively independent of traits measured by the PAS and MIS.

### General Discussion

We were able to replicate the findings of Blanchard et al. (2000)—that the latent structure of the RSAS is taxonic—using two large, independent samples. MAXCOV procedures resulted

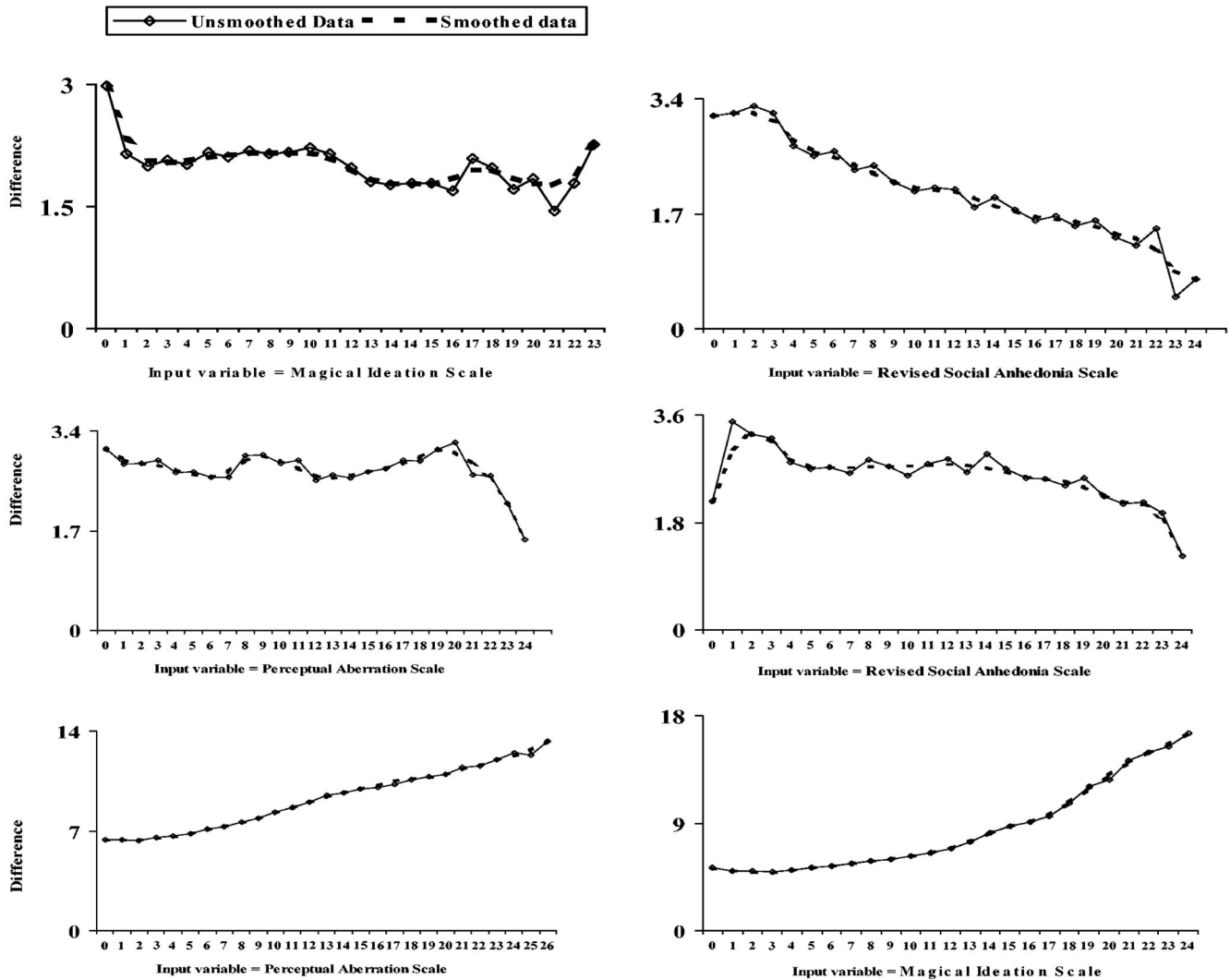


Figure 16. MAMBAC (mean above minus below a cut) results for combined Revised Social Anhedonia Scale (RSAS)–Perceptual Aberration Scale (PAS), Revised Social Anhedonia Scale–Magical Ideation Scale (MIS), and Perceptual Aberration Scale–Magical Ideation Scale.

in covariance curves that were clearly and consistently compatible with taxonicity across studies, and base-rate estimates closely approximated findings from Blanchard et al. (2000; .08 and .09 for unsmoothed and smoothed curves, respectively) as well as Meehl's (1989, 1990) estimated base rate of 10% for the schizotypy taxon in the general population. The replicability of this finding strongly supports the conceptualization of social anhedonia as a taxonic–dimensional construct rather than a dimensional-only one (see Meehl, 2001, Summary Point 2, p. 192). The current findings do not address the precise nature of the relationship between social anhedonia and schizotypy as conceptualized by Meehl. As Meehl (2001) has noted (see Summary Point 3, p. 192), a taxon in the hypohedonic range of this trait could reflect a primary hedonic capacity deficit (e.g., a pleiotropic effect of the schizogene as proposed by Rado, 1956, 1960) or a secondary associated feature of schizotypy (e.g., resulting from aversive drift). However, clarification of the latent structure of social anhedonia does have theoretical

Table 6  
*Cross-Tabulation of Social Anhedonia and Perceptual Aberration Taxon Memberships*

| RSAS taxon | PAS taxon |      | Totals |
|------------|-----------|------|--------|
|            | 0         | 1    |        |
| 0          |           |      |        |
| <i>n</i>   | 1,612     | 399  | 2,011  |
| %          | 62.6      | 15.5 | 78.1   |
| 1          |           |      |        |
| <i>n</i>   | 371       | 192  | 563    |
| %          | 14.4      | 7.5  | 21.9   |
| Totals     |           |      |        |
| <i>N</i>   | 1,983     | 591  | 2,574  |
| %          | 77.0      | 23.0 | 100.0  |

Note. PAS = Perceptual Aberration Scale; RSAS = Revised Social Anhedonia Scale.

Table 7  
*Cross-Tabulation of Social Anhedonia and Magical Ideation  
 Taxon Memberships*

| RSAS taxon | MIS taxon |      | Totals |
|------------|-----------|------|--------|
|            | 0         | 1    |        |
| 0          |           |      |        |
| <i>n</i>   | 1,295     | 716  | 2,011  |
| %          | 50.3      | 27.8 | 78.1   |
| 1          |           |      |        |
| <i>n</i>   | 312       | 251  | 563    |
| %          | 12.1      | 9.8  | 21.9   |
| Totals     |           |      |        |
| <i>N</i>   | 1,607     | 967  | 2,574  |
| %          | 62.4      | 37.6 | 100.0  |

Note. MIS = Magical Ideation Scale; RSAS = Revised Social Anhedonia Scale.

implications for the role of negative schizotypy traits vis à vis positive schizotypy traits in the context of Meehl's theory (see our discussion of positive and negative schizotypy below).

This study also provided evidence consistent with claims that the PAS taps a taxon with a base-rate estimate approximating .10, as have a number of previous taxometric analyses (ranging from .03 to .10; Korfine & Lenzenweger, 1995; Lenzenweger, 1999; Lenzenweger & Korfine, 1992). Taxometric analyses of the MIS failed to provide compelling evidence of taxonicity, with base-rate estimates quite variable across taxometric procedures, generally higher than the rates obtained for the PAS and higher than theoretical estimates for schizotypy (Meehl, 1989, 1990). MAMBAC results in Study 2 provided some

evidence for a shared latent structure between the MIS and the PAS. However, the base-rate estimate from MAMBAC analyses was approximately .29, which is higher than that obtained in previous research (Lenzenweger, 1999). Meehl and Yonce (1994) have noted that base rates may be overestimated by MAMBAC for taxa with low base rates. Other psychometric factors, such as potential nuisance covariance associated with these highly correlated scales, might partially explain the higher than expected base-rate estimates.

The significance of the inconsistent taxometric findings for the MIS in the current research is unclear. Lenzenweger's (1999) recent MAXCOV study, which included both the PAS and the MIS as indicator variables (in conjunction with the Referential Thinking Scale; Lenzenweger, Bennett, & Lilenfeld, 1997), resulted in a considerably lower base-rate estimate of .13. It is possible that the demographic characteristics of the samples in this study may have influenced our base-rate estimates. For example, previous taxometric studies of the PAS and MIS have used samples recruited from highly selective (Ivy League) universities, whereas the current sample was recruited from large public universities with diverse student populations. The considerable ethnic diversity of our sample (e.g., more than 40% of the sample in Study 1 was classified as non-Anglo) may also account for some of the difference (see Chmielewski, Fernandes, Yee, & Miller, 1995). Differences in item content between the PAS and MIS may also be relevant: The PAS taps a rather narrow range of unusual experiences (primarily body image aberration), whereas the MIS includes items more likely to have some degree of subcultural support (e.g., certain spiritual beliefs). In any case, the present findings raise questions about the taxonicity of the individual differences measured by the MIS. Future taxometric studies of the

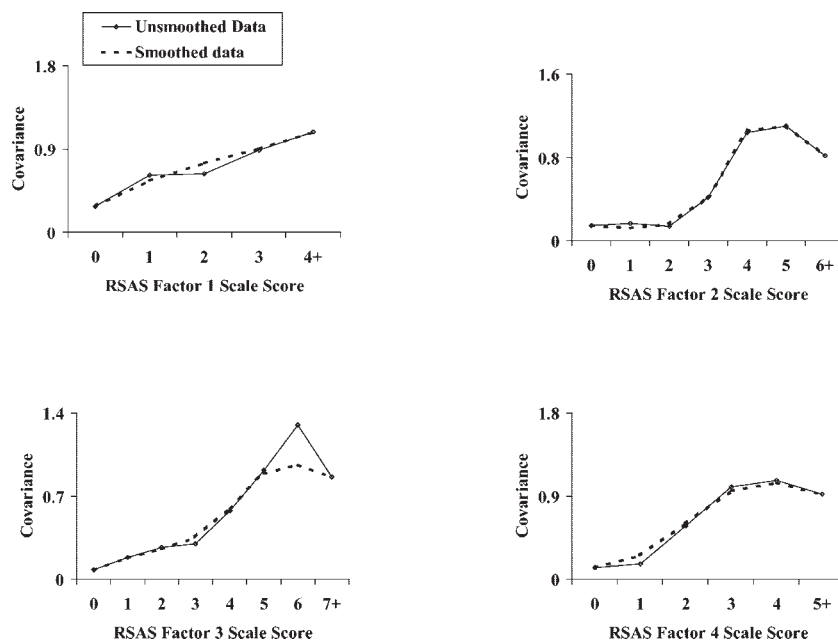


Figure 17. MAXCOV (maximum covariance, making hits maximum covariance) curves for the Revised Social Anhedonia Scale (RSAS) subscales after excluding individuals with Bayesian probabilities for Perceptual Aberration Scale and/or Magical Ideation Scale taxon membership greater than or equal to .50. Each point represents the median covariance value from three pairings of RSAS subscales not used as the input variable.



MIS and its relationship to the PAS using samples representative of the general population will be required to adequately address this issue.

Results of MAMBAC and MAXCOV analyses across studies did not provide support for the conjecture that the RSAS, PAS, and MIS tap a common latent class. Overlap between individuals classified as RSAS taxon members and individuals classified as PAS and MIS taxon members was minimal, according to Bayesian probabilities. In further support of the independence of these taxa, MAXCOV analyses of the RSAS in subsamples that had the individuals with high Bayesian probabilities of taxon membership for the PAS and/or MIS removed (a strategy suggested by Meehl, 2001) provided clear and consistent evidence of RSAS taxonicity in this residual group.

The statistical taxonicity of social anhedonia does not appear to be derived from the other latent quantitative factors associated with odd beliefs and perceptual experiences that themselves are taxonically distributed. These results are incompatible with the notion that the taxonicity of social anhedonia is secondary (see Meehl, 2001) to the positive schizotypy traits measured by the PAS and MIS. Nor are the findings consistent with the original conjecture of Meehl (1962) that these positive and negative schizotypy traits arise from a shared etiological factor (i.e., schizotaxia). Rather, results suggest that independent etiological factors are likely to give rise to the latent discontinuities underlying the positive and negative traits assessed by these scales.<sup>6</sup> Although we have demonstrated that the social anhedonia taxon need not emerge secondary to positive schizotypy, it remains possible that another social anhedonia taxon emerges secondary to aversive drift associated with the PAS/MIS taxon in later adulthood. This possibility could be addressed in part by studying samples of individuals who passed through the period of greatest risk for developing schizophrenia-related psychopathology.

These taxometric findings are interesting to consider in the context of findings indicating the multifactorial nature of traits and symptoms associated with schizotypy (Bergman et al., 1996; Kendler, McGuire, Gruenberg, & Walsh, 1995; Vollema & van den Bosch, 1995) and schizophrenia (e.g., Andreasen, Arndt, Alliger, Miller, & Flaum, 1995; Buchanan & Carpenter, 1994; Kirkpatrick, Buchanan, Ross, & Carpenter, 2001). It is possible that the taxa we have identified reflect independent etiological processes associated with the development of the domains of positive and negative symptoms observed in clinical populations. This conjecture is consistent with results from the Roscommon Family Study (Fanos, Gardner, Walsh, & Kendler, 2001) indicating that positive and negative symptoms in schizophrenia are predictive of corresponding schizotypy traits among probands' relatives and that these symptom domains appear etilogically distinct. Our finding that social anhedonia demonstrates taxonicity independent of the taxon measured by positive schizotypy traits could also be seen as fitting with the proposal that enduring, primary negative symptoms (including anhedonia) are characteristic of a subtype within schizophrenia that has a unique etiology (Kirkpatrick et al., 2001). Future research is required to determine the continuity between the taxa identified in nonclinical populations and the negative and positive symptom domains of schizophrenia and schizophrenia-spectrum disorders.

Our taxometric findings do not address the issue of whether positive or negative schizotypy traits best reflect schizotaxia as described in Meehl's (1962, 1990) theory. However, the finding

that the taxonicity of positive and negative schizotypy traits do not appear to arise from a shared etiological factor does provide guidance for understanding differences in the cross-sectional characteristics and longitudinal outcomes among individuals with elevated RSAS versus PAS and/or MIS scores. These scales may be associated with differential findings because they measure distinct etiological processes within the clinical syndrome of schizophrenia or psychosis proneness more generally. The current findings encourage further investigation of the characteristics and outcomes of individuals who inhabit the taxa measured by both the RSAS and the PAS and/or MIS to understand their respective roles in liability to schizophrenia rather than using these scales as indicators of a common latent class of individuals.

It is important to note the limitations of the present findings. First, as cautioned by Meehl (2001), the statistical findings derived from taxometric procedures are not self-interpreting. The present findings do not provide information about the characteristics of those individuals occupying the identified taxa. Although the indicators of these taxa are conjectured to measure schizotypy (presumably arising from genetic influences), the present data cannot address the validity of this assertion. Genetics may account for taxa (either single genes, thresholds on latent continua, or interactive effects of multiple genetic features), but so too can a discontinuously distributed environmental factor (e.g., a toxin or pathogen) or social processes (Meehl, 1977, 1992).

Second, our study does not thoroughly address Meehl's (2001) conjectures regarding primary and secondary anhedonia. Meehl's (2001) recommendation was to use psychophysiological, cognitive, and soft neurologic indicators to identify schizotaxic individuals and determine the independence of the social anhedonia taxon. Thus, our findings are limited to ascertaining, within the self-report domain, the independence of social anhedonia in relation to the constructs measured by the PAS and MIS.

Third, as with previous taxometric studies of the Chapman questionnaires (e.g., Blanchard et al., 2000; Lenzenweger & Korfine, 1992), the current study was based on college samples. As Blanchard et al. (2000) have previously cautioned, the use of college students may bias the base-rate estimates obtained in taxometric analyses. Individuals who do not attend or fail to complete college are at greater risk for psychiatric disorders (e.g., Newman, Moffitt, Caspi, & Silva, 1998; Robins et al., 1984). If the Chapman questionnaires are related to a latent vulnerability for the development of psychosis, schizophrenia, or schizophrenia-spectrum disorders, the reported base rates for the taxa identified in students may underestimate the true base rates in the general population. Additional research is now required to determine the replicability of taxometric results in samples more representative of the general population.

In summary, the present findings indicate that measures commonly believed to tap the same latent class, conjectured to be schizotypy, actually do not share this property. These data may

<sup>6</sup> The finding of largely independent taxa for social anhedonia and PAS/MIS should not necessarily be interpreted to suggest that membership in these taxa is mutually exclusive. In both studies, a small proportion of individuals occupied both the RSAS and the PAS/MIS taxa. It may be interesting to examine the characteristics of these two-taxa members to determine if they evidence greater psychopathological characteristics and outcomes than do individuals occupying a single taxon.

help in understanding the differential findings associated with individuals identified with these scales and suggest that caution is warranted in how one thinks about the psychometric detection of schizotypy using the Chapman measures. Additional research is required to determine if any of these questionnaires measures a personality organization that reflects a latent genetic vulnerability to developing schizophrenia.

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