Search for Schizotypic and Nonschizotypic Taxonomies in a College Population[1]

Geoffrey S. Lowrie and Michael L. Raulin

State University of New York at Buffalo

The statistical search technique, MAXCOV-HITMAX, was conducted to identify schizotypic and nonschizotypic taxonomies using four self-report measures of schizotypic signs. Estimates were made of the base rate of schizotypy in the population under study and cuts were identified for each scale that would maximize the number of correct classifications. The results indicated that researchers studying persons at risk for schizophrenia should consider using scale-specific cutoff scores when selecting potential high-risk subjects.

Schizophrenia is a genetically transmitted disease that severely impairs the normal functioning of those who suffer from it. Although the mode of inheritance is as yet unknown, many investigators assume a single dominant gene model (Meehl, 1989). Its advantage over a polygenic model lies in parsimony and the ability to make precise predictions according to the laws of Mendelian genetics. Recent biochemical studies have reported evidence of the existence of a gene locus with a dominant schizophrenia-susceptibility allele (Sherrington et al., 1988; Gurling, 1989). Although there is some dispute concerning the linkage of this particular gene locus to schizophrenia (Kennedy et al., 1988; Detera-Wadleigh et al., 1989), such research emphasizes that the model of genetic homogeneity of schizophrenia is important.

It is widely believed, however, that this inherited predisposition is not sufficient for the development of the disease. A random survey of members of the American Psychiatric Association, for example, shows that the great majority endorse a combined biogenic/environmental perspective (Gallagher, Jones, & Barakat, 1987). Most researchers adopt this interactional view which is most often expressed in terms of a diathesis/stress model (Hans & Marcus, 1987). That is, both a genetic vulnerability (diathesis) and a stressful environment are necessary for the full expression of the disease. More importantly, the viability of the model continues to be supported by empirical evidence [for example, Baron & Gruen (1988); Walker, Downey, & Bergman (1989)].

Considerable research, based on a diathesis/stress model, focuses upon diagnosed schizophrenics and those genetically at risk for the development of the disease. The high-risk groups are usually children of schizophrenics (Rosenthal, 1970). Offspring of schizophrenics who are raised by their parents are approximately ten times more likely to develop the disease than persons randomly selected from the general population (Rosenthal, 1970). Given conservative estimates of the prevalence of the disorder ranging from .2% to 1.0% (American Psychiatric Association, 1987), one would expect that only 10% or so of these high-risk cases will eventually develop the disease.

This low rate presents a considerable impediment to schizophrenia research that adopts this high-risk approach. In order to obtain a schizophrenic sample of a sufficient size to allow statistically meaningful inferences to be made, an initial sample of several hundred high-risk subjects would be necessary. Clearly, even a single longitudinal study is an expensive undertaking. Although the yield of this

[1]Correspondence concerning this paper should be sent to Michael L. Raulin, University at Buffalo, State University of New York, Buffalo, N.Y. 14260. The source code and documentation for the computer programs are available upon request.

high-risk approach is superior to methods that rely on randomly selected individuals, research could be vastly improved if it were possible to select cases for study who have a much higher probability of developing the disease.

A potential method for identifying persons who are at significantly higher risk for developing schizophrenia stems from the work of Paul Meehl. Meehl (1962) has proposed a diathesis/stress model of schizophrenia that remains influential. The genetic predisposition, or diathesis, is labelled schizotaxia. Individuals possessing the pathogenic gene, Meehl theorizes, develop a distinctive type of personality organization that he calls schizotypy. Only those schizotypes who experience excessive degrees of stress will decompensate to the state of being diagnosable as schizophrenic. It is important to note that, since schizotypy is a personality type, the behavioral characteristics of these individuals should be enduring, stable traits in compensated and decompensated schizotypes alike.

Meehl (1964) has described a number of behavioral signs by which schizotypes may be identified. Self-report measures have been developed to measure many of these signs, including Physical and Social Anhedonia (Chapman, Chapman, & Raulin, 1976), Perceptual Aberration (Chapman, Chapman, & Raulin, 1978), Somatic Symptoms (Raulin, Chapman, & Chapman, 1978), Magical Ideation (Eckblad & Chapman, 1983), Intense Ambivalence (Raulin, 1984), Social Fear (Raulin & Wee, 1984), Distrust (Raulin, 1982), Rage (Raulin, 1982a), Cognitive Slippage (Miers & Raulin, 1984), and Schizotypal Ambivalence (Raulin, 1986). Each scale was developed to have high internal consistency and minimal method variance. Test-retest reliabilities suggest that these traits are stable within normal populations and within schizophrenic populations, regardless of fluctuations in expressed symptomatology (Mahler, Raulin, O'Gorman, & Furash, 1987).

Furthermore, subjects with elevations on one or more of these scales have been shown to display, to a greater degree than normals, impairment in functioning characteristic of schizophrenic patients. Specifically, the areas investigated have been social functioning (Chapman, Edell, & Chapman, 1980), social skills (Haberman, Chapman, Numbers, & McFall, 1979), social deficits (Numbers & Chapman, 1982), social discomfort (Raulin & Wee, 1984), interpersonal feelings (Raulin, 1984), psychotic and psychotic-like symptomatology (Chapman & Chapman, 1980; Chapman, Edell, & Chapman, 1980; Fujioka & Chapman, 1984; Allen, Chapman, Chapman, Vuchetich, & Frost, 1987), communication styles (Adamski, 1978; Raulin & Adamski, 1981), communication effectiveness (Martin & Chapman, 1982), and attentional & neurological deficits (Raulin & Chapman, 1977; Simons, MacMillan, & Ireland, 1982). The results of the above studies are consistent with Meehl's conceptualization of the schizotypic personality and suggest that the self-report measures are useful tools for identifying schizotypes.

The development of the schizotypy scales provides the means for adopting a behavioral high-risk approach to the study of schizophrenia. A particular advantage over the genetic high-risk approach is that it allows subjects to be selected from the general population. If the model is accurate, compensated schizotypes can be identified, thus expanding the pool of potential high-risk subjects. Persons who do not have a schizophrenic parent can then be studied (95% of all schizophrenics).

The method of selecting samples of high-risk cases will directly influence the conclusions that can be drawn from behavioral high-risk studies. To understand why this is so requires that a model of schizotypy in the general population be made explicit.

Taxonomic Model of Schizotypy in the General Population and Statistical Power

Meehl (1965) proposed that the general population consists of members of two distinct groups, schizotypes and nonschizotypes. Each group is assumed to be an empirical class, or taxon, whose members differ from one another on a set of measurable characteristics. The observed, or manifest, distribution of scores on a measure of any one of these characteristics in the general population is, then, a composite of the distributions of the measure within the two underlying, or latent, taxa.

Ideally, a measure would perfectly discriminate between the two latent taxa so that all cases lying beyond a certain cutoff score would be schizotypes and all cases below that cutoff would be nonschizotypes. In reality, however, we assume that our measures are only moderately valid indicators of schizotypy, meaning that the distributions for schizotypes and nonschizotypes overlap. Using a single cutoff score to define the two taxa will necessarily result in cases being misclassified in at least one, if not both, of the groups. Misclassification can seriously limit our ability to detect true differences between schizotypes and nonschizotypes.

For example, suppose a researcher hypothesizes that schizotypes will have a higher score than nonschizotypes on a measure of some trait or ability. The presence of nonschizotypes among the schizotypic group will lower the mean for that group. Similarly, the mean of the nonschizotypic group will be raised by the inclusion of schizotypes. Therefore, the difference between the means will be attenuated and a true difference, if it exists, will be more difficult to detect. In other words, behavioral high-risk studies that utilize moderately valid indicators may be characterized by insufficient statistical power.

Much research continues to be done using the schizotypy scales to identify potential schizotypes (e.g., Bernstein & Riedel, 1987; O'Gorman et al., 1988; Propper et al., 1987; Raulin & Henderson, 1987; Raulin, Mahler, O'Gorman, Furash, & Lowrie, 1987; Schuldberg, French, Stone, & Heberle, 1988). A method of choosing cutoff scores in behavioral high-risk studies that maximize the number of correct classifications, and thus maximize statistical power, will have considerable impact on the advancement of knowledge of schizotypy and schizophrenia.

Two Approaches to Reducing Misclassifications

One approach to the misclassification problem is to identify a cutoff score for which the rate of correct classification of schizotypes and nonschizotypes is at a maximum. In considering this solution, two potential problems must be borne in mind. First, the more the distributions of the latent taxa overlap, the lower the total number of correct classifications will be. Second, as previously mentioned, the base rate of schizotypy is believed to be relatively low. The overall rate of correct classifications (hit rate) has two components; the number of correctly classified schizotypes and the number of correctly classified nonschizotypes. The marked asymmetry in the hypothesized proportions of schizotypes (.10) and nonschizotypes (.90) in the general population means that a cutoff that maximizes the overall number of correct classifications is influenced mostly by the number of correctly classified nonschizotypes. It is possible, therefore, that the number of correct classification of schizotypes resulting from the cutoff is well below an acceptable level.

Despite these difficulties, such a cutoff will be useful as a reference point for assessing the adequacy of the cutoff scores actually used is past and future research. Tests of significance based on cutoffs which fail to meet this modest criterion are not likely to result in the rejection of the null hypothesis.

A second method of increasing the rate of correct classifications is to use two cutoff scores. Cases falling below the lower cutoff are labelled nonschizotypes and cases falling above the upper cutoff score are labelled schizotypes. No classification errors will be made if the upper cutoff is above the upper limit of the nonschizotypic distribution and the lower cutoff is below the lower limit of the schizotypic distribution. Setting the lower cutoff at 0.5 standard deviations above the mean will ensure a reasonably homogeneous group of nonschizotypes.

Defining an optimal upper cutoff is more of a concern, due, once more, to the low estimated base rate of schizotypy in the general population. To obtain as many schizotypes as possible for study, a cutoff is required that is as low as possible without producing an unacceptable number of misclassifications. Typically, researchers label cases as schizotypic if their scores fall beyond 2.0 or 1.5 standard deviations above the mean. Clearly, the higher the cutoff, the greater the probability of correctly classifying schizotypes. However, we still have no way of knowing how many nonschizotypes are being misclassified as schizotypes when these criteria are used. So, once again, it is not possible to ascertain the statistical power of these studies.

Both of the above methods are limited by our inability to determine the rates at which subjects are correctly classified. To estimate the proportion of true schizotypes and nonschizotypes identified by any given cutoff score, it is necessary to identify the schizotypic and nonschizotypic taxa. In other words, the distributions of schizotypy scale scores that characterizes each taxon must be identified.

Knowing the distributions has a number of additional benefits. First, the mean for each taxon and the number of schizotypes and nonschizotypes in the population under study can be determined. Estimates of the base rate of schizotypy in the general population can then be calculated by dividing the number of schizotypes by the total number of cases in the sample. Second, for a individual with a given score on a measure, the probability of belonging to the schizotypic taxon can be estimated. If data for more than one scale are available, Bayes Theorem can be applied to derive the probability that a person with a specific pattern of scores is schizotypic. Probabilities derived from multiple measures have greater accuracy than those based upon single measures alone.

The purpose of the present study is to (1) locate scale cutoff scores that maximize the number of correct classifications; (2) arrive at an estimate of the base rate of schizotypy; (3) identify the latent means and distributions of several schizotypy scales for the hypothesized schizotypal and nonschizotypal taxa in a mixed taxonomic population. The procedure used to identify the two latent taxa stems from the work of Paul Meehl.

Taxonomic Search Method

Meehl (1965, 1968, 1977) has developed a number of taxonomic search methods that rely solely upon the mathematical relationships between two or more schizotypic indicators. The method of Maximum Covariance (dubbed MAXCOV-HITMAX by Meehl, 1965) used in this study, relies on three assumptions. The first assumption is that there exists a set of indicator variables that have considerable construct validity in the sense that they discriminate between two latent taxa, namely schizotypes and nonschizotypes. Second, within each taxon the indicator variables are independent of one another, i.e., the correlation between each pair of indicators is zero. Third, the frequency distribution of each indicator variable is unimodal within each taxon. No further assumptions are made about the characteristics of the distributions of the indicators within the two latent taxa.

In a series of Monte Carlo trials, the Maximum Covariance method produced accurate estimates of the proportion of cases in each taxon (Golden & Meehl, 1973b; Golden, Tyan, & Meehl, 1974c). Additional support for the utility of the MAXCOV-HITMAX method derives from studies in which the sexes (male and female taxa) and the schizoid taxon were successfully identified (Golden & Meehl, 1973a; Golden & Meehl, 1974; Meehl, Lykken, Burdick, & Schoener, 1969). The procedure is robust to violations of the intrataxon independence assumption (the second assumption described above), provided that the correlations of each indicator pair within each taxon are approximately equal and less than .4 (Meehl, 1965).

The Maximum Covariance method is applicable to a wide variety of taxonomic search problems. For the sake of clarity, however, the following explanation of the procedure will be made in terms of the specific problem addressed in this study, rather than in general terms.

The Maximum Covariance Method

Suppose that we have a distribution of scores on a quantitative indicator of schizotypy (we will label this indicator z) and wish to define a cut above which cases will be labelled schizotypic. Suppose further that we want this cut to maximize the total number of correct classifications or hits (valid positives plus valid negatives). If we consider the hypothesized latent situation (see Figure 1) we see that the optimal cut will be in the interval (a single score or range of scores) on the abscissa at which the two distributions intersect, that is, the interval within which the number of schizotypes and nonschizotypes is equal. This cut is designated the HITMAX cut on z. Given that the latent frequency functions are unknown, a method is required by which the HITMAX cut can be determined from the manifest, or mixed, distribution.

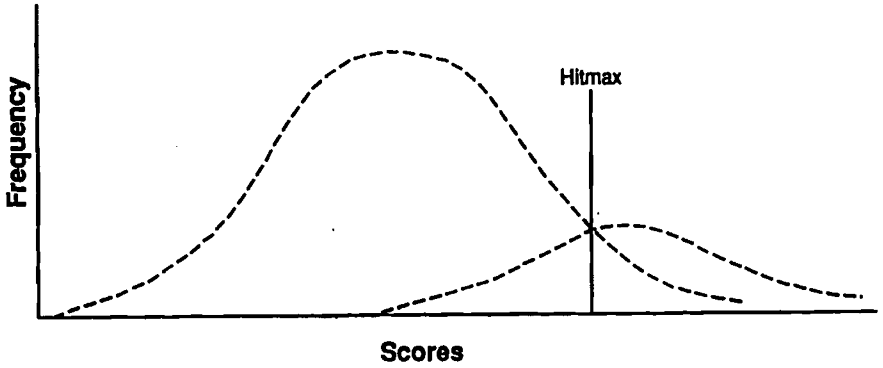

Figure 1. The hypothesized underlying distributions of schizotypes and normals.

Now consider two other indicators of schizotypy, x and y. Under the idealized assumption that the correlation between each pair of indicators is zero within each taxon, the covariance between the indicators in a subpopulation will be a function of the mixture of schizotypes and nonschizotypes. If a subpopulation were composed entirely of cases from one taxon or the other, the covariance between x and y will be zero. As the degree of taxon mixture increases, the covariance between the two indicators will increase and will be at a maximum when the

proportion of schizotypes and nonschizotypes is equal. Since we have defined the HITMAX cut on z as being in the interval on z that has an equal number of schizotypes and nonschizotypes, we can combine these two facts to arrive at a method for locating the HITMAX cut on z as follows.

The mixed population is subdivided by taking successive intervals of scores on indicator z. Within each interval the covariance between x and y is computed. As we progress from the lowest interval to the highest, the taxon mixture will gradually increase to a maximum where the subpopulation is equally composed of schizotypes and nonschizotypes and then will decrease. Thus, the covariance between x and y will also increase to a maximum and then decrease. The interval on z at which the xy covariance is a maximum will, therefore, be the HITMAX cut on z.

Once the HITMAX cut on z is located, it is possible to estimate the base rate of schizotypy (p), plot the latent frequency functions of the schizotypic and nonschizotypic taxa, and estimate the latent means of x and y within each taxon. The procedure for doing this is as follows.

In general, the covariance between two indicator variables x and y in a mixed population can be expressed as,

$$COV(xy) = p(COV_s(xy)) + q(COV_n(xy)) + pq(X_s\text{-}X_n)(Y_s\text{-}Y_n) \quad [1]$$

where p = proportion of schizotypes, q = 1 - p = proportion of nonschizotypes, $(X_s\text{-}X_n)$ and $(Y_s\text{-}Y_n)$ are the latent mean differences on x and y, $COV_s(xy)$ and $COV_n(xy)$ are the covariances between x and y for schizotypes and nonschizotypes, respectively. Under the assumption of zero intrataxon correlations between variable pairs, the equation simplifies to

$$COV(xy) = pq(X_s\text{-}X_n)(Y_s\text{-}Y_n) \quad [2]$$

Since the latent mean differences are constants, their product will be a constant and equation [2] reduces to

$$COV(xy) = Kpq \quad [3]$$

At the HITMAX cut on z, p = q = .5, and the equation becomes

$$COV_h(xy) = (.25)K \quad [4]$$

Having located the HITMAX cut on z, $COV_h(xy)$ is an observed value so it is possible to solve equation [4] for the constant K.

The next step in the procedure is to obtain an estimate of the base rate, p, of schizotypy in this population. On the assumption of zero intrataxon correlation between x and y, the general expression

$$Kp^2 - Kp + COV(xy) = 0 \quad [5]$$

can be written for any interval on z. For each z interval we can solve for the proportion of schizotypes using the observed xy covariance in the interval and the obtained estimate of K from Equation [4]. Multiplying p by the observed number of cases in each interval gives an estimate of the number of schizotypes within each interval. Summing these products over the entire z range will provide an estimate of the total number of schizotypes in the population. Finally, dividing the sum by the total number of cases in the population provides an estimate of the base rate of schizotypy in the population from which the samples were drawn. The number of schizotypes and nonschizotypes in each interval may be plotted to produce the frequency distributions of the two latent taxa.

The final step is to obtain estimates of the latent means of the output variables x and y. The observed grand mean of x, $\bar{X}_t$, is a weighted mean of the latent means, the weights being the base rates P and Q.

$$\bar{X}_t = P\bar{X}_s + (1-P)\bar{X}_n \quad [6]$$

The observed mean of x for cases lying in the HITMAX interval on z, can be expressed as

$$\bar{X}_h = (.5)\bar{X}_s + (.5)\bar{X}_n \quad [7]$$

From [6] and [7] equations can be derived that can be solved for X_s and X_n.

$$\bar{X}_n = \frac{\bar{X}_t - P(2\bar{X}_h)}{(1 - 2P)} \quad [8]$$

$$\bar{X}_s = \frac{\bar{X}_t - (1-P)(2\bar{X}_h)}{(2P - 1)} \quad [9]$$

By substituting $\bar{Y}_t$ for $\bar{X}_t$ and $\bar{Y}_h$ for $\bar{X}_h$ in equations [8] and [9], estimates of $\bar{Y}_n$ and $\bar{Y}_s$ can be obtained.

Method

Subjects

Subjects were 3260 college students who completed the schizotypy research forms as a requirement of the undergraduate introductory psychology course at the State University of New York at Buffalo. Subjects were retained for use in the study only if two criteria were met. First, of the total 166 scale items, no more than 10 items (6 percent) were left unanswered. Second, the score on the 5-item Infrequency Scale had to be less than 2. The Infrequency Scale, designed to detect random responding, contains items that are endorsed in the keyed direction by fewer than one percent of respondents (e.g. "I find that I often walk with a limp which is the result of a skydiving accident"). A total of 576 subjects were dropped by one or the other criteria, most often because the subject did not complete the measure, leaving 2684 cases for analysis (1405 males, 1269 females).

Procedure

Indicator Set. Three schizotypy scales were used: Perceptual Aberration (PA), Magical Ideation (MI), and Cognitive Slippage (CS). A brief description of each scale appears in Table 1. Meehl (1964) suggested that measures of cognitive slippage and anhedonia were suitable candidates for inclusion in the indicator set to be used in the MAXCOV-HITMAX procedure. Factor analytic research (Propper et al., 1987), however, suggests that anhedonia seems to be sensitive to a different underlying dimension than cognitive slippage and the other schizotypy scales used in the current study. The other two measures used in this study were perceptual aberration and magical ideation, both of which are considered to be prominent signs of schizotypal functioning. These three scales are widely used in research and measure traits that are thought to be relatively independent indicators of schizotypy.

Using three or more indicators has two advantages over using a single indicator variable. First, separate estimates can be made of the latent parameters. Agreement between estimates provides a means of assessing the success of the search procedure. Second, once optimal cutoff scores and parameter estimates are obtained, it is possible to compute the inverse probability that a given case is schizotypic.

Table 1
Brief Descriptions of Schizotypy Measures

Perceptual Aberration (PA) - Deviant or distorted perceptions, feelings, and beliefs in relation to one's body. (e.g., I sometimes have the feeling that my body is misshapen.)

Magical Ideation (MI) - A belief in causal connections between behavior and events that are not, in reality, related. (e.g., If reincarnation were true, it would explain a number of unusual experiences that I have had.)

Cognitive Slippage (CS) - Unusual aberration in the perception and awareness of reality; a mild form of thought disorder. (e.g., Often when I am talking I feel that I am not making sense.)

Sex Differences. There were very small differences between males and females on the three schizotypy scales used in this study. Although the differences were statistically significant because of the very large sample sizes, they were not large enough to be clinically significant. Therefore, the males and females were combined in a single set of analyses.

Input Intervals. In the simplest case, the covariance between the two output variables is computed for each single value of the input variable. It was anticipated that the covariance curve produced would be somewhat erratic as a result of fluctuations due to measurement, sampling, and grouping errors. Therefore, in addition to singular input variable values, a number of wider intervals were used to smooth out the curve. Two types of intervals, sliding and fixed, were run to provide different kinds of information about the behavior of the covariance between the output variables.

For **sliding intervals**, each successive interval on the input variable is determined by adding one to the upper and lower bounds of the interval. For example, intervals of 3 would begin with 0-2 and proceed 1-3, 2-4, 3-5, . . ., until the upper limit reaches the maximum scale score. The midpoint of each interval is taken to be the value of the input variable. The total number of intervals so defined is only slightly less than the number of single values on the input variable so that the resulting covariance curve is highly detailed.

Sliding intervals provide a good general picture of how two output variables covary over the range on the input variable, and may be used to locate the HITMAX cut. However, the data obtained from sliding intervals cannot be used to compute estimates of the latent parameters. A fundamental step in computing the parameter estimates is calculating the number of schizotypes present in the population under investigation. This is achieved by summing the number of schizotypes in each interval on the input indicator obtained by equation [5]. If cases are common to more than one interval, as is true for sliding cuts, the same individuals will be counted more than once. Thus, the estimate of the total number of schizotypes present will be grossly inflated and subsequent parameter estimates will reflect this inaccuracy. For this reason MAXCOV-HITMAX runs using fixed intervals were also executed.

Fixed Intervals are defined by adding the interval width to the upper and lower bounds of the preceding interval. Again using a width of 3, for example, the intervals would be 0-2, 3-5, 6-8, and so on. In this case, the total number of fixed intervals possible is approximately one third of the range on the input variable. Since the frequency distributions of the schizotypy scales have marked positive skews, the lowest interval for each run started with zero to maximize the total number of cases included in the initial procedure and consequent parameter estimates.

For each input variable and output variable pair the MAXCOV-HITMAX procedure was run using fixed intervals of 1, 2, and 3, and sliding intervals of 3 and 5. These five types of intervals should provide adequate data for locating the HITMAX cut and estimating the latent means and base rate of schizotypy.

Available statistical software does not lend itself to the repetitive calculations of the MAXCOV-HITMAX method. Programs were written under Ashton-Tate's dBASE IV language to execute these procedures on an AT class personal computer. The source code and documentation for the programs are available upon request.

Results

MAXCOV-HITMAX. Results of the MAXCOV-HITMAX procedure for the Perceptual Aberration, Magical Ideation, and Cognitive Slippage Scales are presented in Figures 2 through 4 for a fixed interval of width 2 and Figures 5 through 7 for a sliding interval of width 3. Covariances between output indicators are plotted only for intervals that contain ten or more cases. A summary of the HITMAX cuts is presented in Table 2.

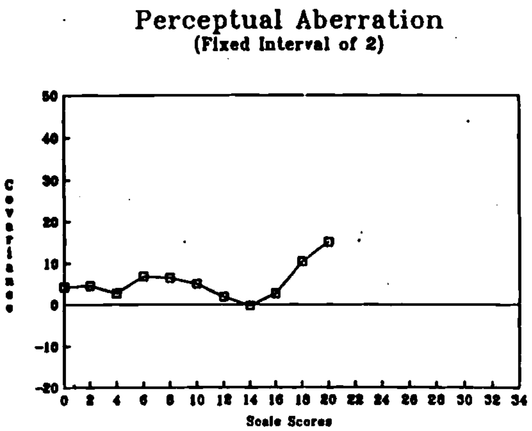

Figure 2. Covariance of Magical Ideation and Cognitive Slippage (the output variables) for the successive intervals on the Perceptual Aberration Scale (using a fixed interval size of 2).

Under the assumptions of the MAXCOV-HITMAX procedure, as the input interval moves from left to right there should be a gradual increase in covariance to a maximum, and then a gradual decrease. Given that the base rate of schizotypy presumed to be between 5 and 10% and schizotypes are indicated by elevated scale scores, the interval within which covariance is at a maximum should be located in the upper range of scores on the input variable. Thus, the covariance curves should be unimodal and negatively skewed. This prediction was generally confirmed for both Perceptual Aberration and Magical Ideation. Covariance computations were computed only for those intervals in which there were at least 10 subjects. Note

that the covariance estimates after the HITMAX interval tend to be more variable than before the HITMAX cut because the sample sizes in the intervals after the HITMAX cut are often quite small. The data were somewhat less clear for the Cognitive Slippage Scale. There appear to be two peaks for the Cognitive Slippage Scale--one at at 18 and another at 28. It could be that there is a serious violation of the assumptions occurring for this scale. One possibility is that the Cognitive Slippage Scale is sensitive to more than two taxonomies, each with a different distribution. This possibility is discussed later.

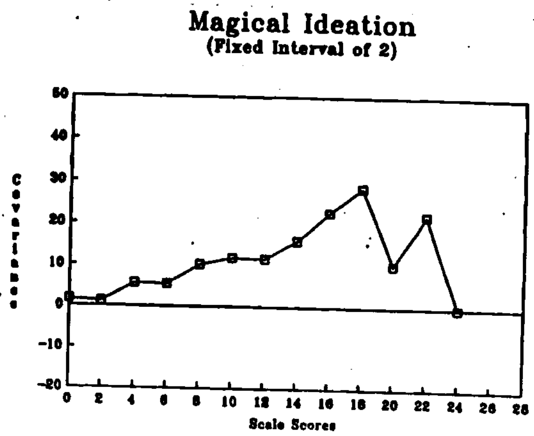

Figure 3. Covariance of Perceptual Aberration and Cognitive Slippage (the output variables) for the successive intervals on the Magical Ideation Scale (using a fixed interval size of 2).

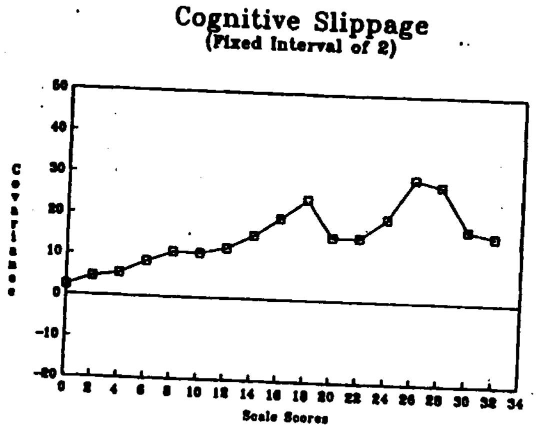

Figure 4. Covariance of Perceptual Aberration and Magical Ideation (the output variables) for the successive intervals on the Cognitive Slippage Scale (using a fixed interval size of 2).

Table 2
HITMAX Cut Estimates on Three Schizotypy Scales

	Perceptual Aberration (PA)	Magical Ideation (MI)	Cognitive Slippage (CS)
Fixed Interval	19-20	17-18	25-26
Sliding Interval	18-20	17-19	26-28
Z-Score	2.8	1.7	2.4

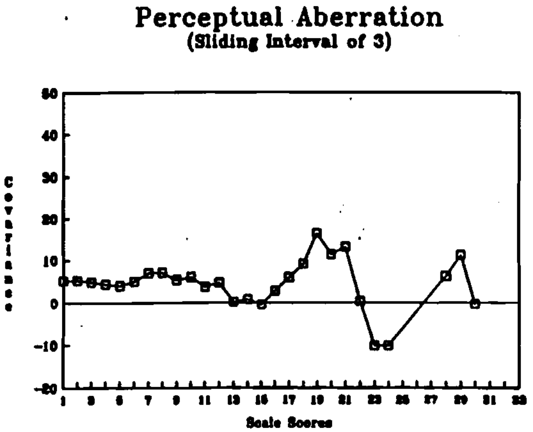

Figure 5. Covariance of Magical Ideation and Cognitive Slippage (the output variables) for the successive intervals on the Perceptual Aberration Scale (using a sliding interval size of 3).

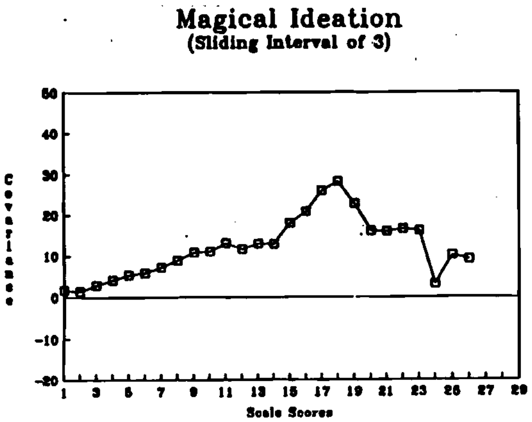

Figure 6. Covariance of Perceptual Aberration and Cognitive Slippage (the output variables) for the successive intervals on the Magical Ideation Scale (using a sliding interval size of 3).

Base Rate Estimates for Schizotypy. Using Equation [5], it is possible to compute estimates of the base rates of schizotypy from each of the three indicator variables. If these estimates agree with one another and with external estimates from other data sources (e.g., genetic studies), then one can be more confident of the results. The base rate estimates are as follows: based on the data from the Perceptual Aberration Scale, the base rate is estimated to be 9%; based on the data from both the Magical Ideation and Cognitive Slippage Scales, the base rate is estimated to be 10%. These estimates of the base rate of schizotypy are not only consistent with one another, but also consistent with other data sources.

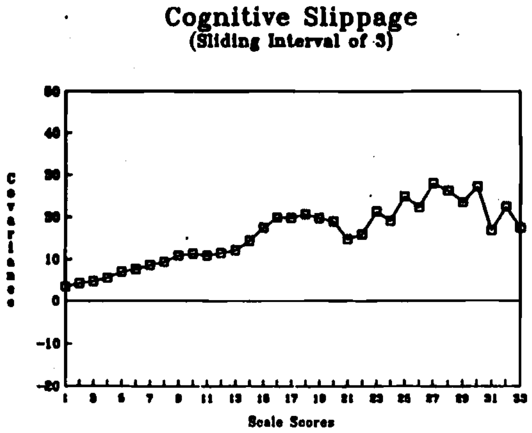

Figure 7. Covariance of Perceptual Aberration and Magical Ideation (the output variables) for the successive intervals on the Cognitive Slippage Scale (using a sliding interval size of 3).

Discussion

The results of the present study imply that the criteria by which experimental subjects are identified as belonging to the schizotypic taxonomy need to be carefully examined. Traditionally, schizotypes have been selected for high risk studies by selecting people who score 2.0 standard deviations or more above the mean on a scale, and some studies have used cutoffs as low as 1.5 standard deviations above the mean. The data in Table 2 suggests that these cutoffs may not be optimal. This is especially true for the Perceptual Aberration and Cognitive Slippage Scales. One implication of using non-optimal cutoff scores for selecting high risk subjects is that the large number of nonschizotypes incorrectly identified as schizotypic will obscure any hypothesized differences between the two taxonomic groups. Pending the attainment of more accurate estimates of the HITMAX cuts and the associated latent parameters, it would be prudent to employ selection criteria of no less than 2 standard deviations above the mean in future research.

The MAXCOV-HITMAX method appears to be a promising technique for identifying schizotypic individuals in the general population. The covariance curves obtained and the estimates of the base rate of schizotypy derived from them roughly conform to expectations. The shortcomings of the method in it's application with the schizotypy scales used in this study may be addressed in a number of ways. Some of the underlying assumptions may be testable directly. For example, it may be possible to obtain relatively pure samples of schizotypes and normals by taking extreme groups to test the hypothesis that the intrataxon correlation between variables is zero. This would be easier to do within the normal taxon because the low base rate of schizotypy would suggest that any cutoff, even an extreme one, would likely give us a large number of false positives (normals incorrectly classified as schizotypes). Another approach is to test the convergent validity of these findings by using alternative taxonomic search techniques. Meehl and his colleagues have suggested a number of potential approaches and we are working on still other approaches in our laboratory.

One advantage of this taxonomic search approach is that it offers a method to bootstrap our way to more refined measures of schizotypy. By using the information from initial taxonomic search analyses with promising measures of schizotypy, we can perform item analyses designed to create revised measures that conform more closely to the underlying mathematical assumptions. For example, items on a given scale that are highly correlated with items on the other scales could be identified and dropped. The scales might also be improved if items with very high or very low endorsement rates were also removed. This procedure would serve to improve the construct validity of the measures in the sense of discriminating between the two hypothesized latent taxa. It is theoretically conceivable that one could use population parameter estimates based on moderately valid measures used with very large samples of subjects to guide the construction of refined measures that would give better prediction. This process could simply be repeated several times, creating the bootstrapping effect that Meehl (Dawes & Meehl, 1966) has argued is possible.

Despite the substantial pool of subjects used in this study, the pronounced positive skew of the scale score distributions imposes limitations upon the upper range of scores. Increasing the sample size, perhaps doubling it, would provide a more complete and reliable picture of the behavior of the schizotypy scales studied. In some ways this is the most limiting aspect of these techniques. Taxonomic search techniques, even under the best of circumstances, are inherently large sample techniques. Samples as large as 5000 subjects are not unreasonable, and as base rates move away from .5, larger sample sizes become even more important. We had previous tried the MAXCOV-HITMAX technique with sample sizes about half as large as used in this study. It was our experience that stable estimates of population parameters cannot be obtained until the sample size reaches at least 2500.

It is possible that the constructs measured by the scales are characteristic of individuals whose pathology is not schizotypy specific. There has been speculation recently that the scales, in fact, are more appropriately called measures of psychosis proneness, a broader, less homogeneous construct. It is not unreasonable to speculate that schizotypy is itself a heterogeneous construct. It may be that the population under investigation is comprised of three or more taxonomies, a situation to which the techniques employed herein are not suited. We are specifically working on the development of taxonomic search techniques that will allow us to directly test for the existence of more than two taxonomic categories being tapped by a given schizotypy measure. We currently speculate that the problem noted in the Cognitive Slippage Scale may be due to the scale being sensitive to at least three taxonomies (for example, normals, schizotypes, and individuals at risk for bipolar disorder). Certainly we can learn something about psychopathology if we can detect people at risk for either schizophrenia or bipolar disorder and follow these subjects longitudinally, but we could learn a lot more about schizophrenia if we could develop measures of risk that are specific to schizophrenia and therefore gave us a more pure high-risk group to study.

One must not overlook the possibility that the model upon which this search procedure is based may not be an accurate representation of the state of nature. If the results of subsequent studies, using more refined versions of these measures, do not represent a substantial improvement, it may be a reflection of the inadequacies of the model being used.

In addition to MAXCOV-HITMAX, Meehl has developed other taxonomic search methods, as well as a number of consistency tests of latent parameter estimates, which may be employed in further studies of the present nature. All of these procedures are data intensive and require samples of several hundred cases for interpretable results to be obtained. The potential benefits to schizotypy research are great enough to justify the costs of continued studies employing taxonomic search methods.

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