

The Abnormality of Normal Comparison Groups: The Identification of Psychosis Proneness and Substance Abuse in Putatively Normal Research Subjects

Robert W. Butler, Ph.D., Melissa A. Jenkins, B.A., and David L. Braff, M.D.

***Objective:** Careful assessment of research subjects is important because the inclusion of subjects who manifest psychopathology and significant substance abuse in normal comparison groups will decrease statistical and experimental power. The current study evaluated the usefulness of an MMPI-derived algorithm in identifying tendencies toward psychosis and substance abuse in putatively normal research volunteers. **Method:** Ninety-eight adults who were recruited as normal comparison research subjects completed the MMPI, psychiatric interviews, questionnaires, and selected neuropsychological tests. The MMPI classified 81 presumed normal subjects into four subgroups: 1) not psychosis prone/substance abuse not likely, 2) not psychosis prone/substance abuse likely, 3) psychosis prone/substance abuse not likely, and 4) psychosis prone/substance abuse likely. **Results:** The MMPI psychosis-prone and substance abuse factors identified significantly distressed and dysfunctional individuals with a relatively high degree of accuracy. **Conclusions:** It is becoming increasingly apparent that the cursory self-report screening of normal subjects may result in unacceptable levels of psychopathology in comparison groups. The current results also indicate that an adequate substance abuse evaluation is extremely important and that brief self-report information may be misleading. Empirically derived assessment tools, such as the MMPI, may prove useful in allowing researchers to more accurately define control parameters and group membership.*

(Am J Psychiatry 1993; 150:1386-1391)

The need for normal comparison groups in clinical research is well recognized. Obtaining subjects who are relatively representative of the "normal" population, however, can be a difficult task. Given that many researchers are university-based, college undergraduate students are often recruited as research subjects. This practice has been criticized for biasing normal comparison group characteristics in a manner that is nonrepresentative of the general population (1). In order to obtain adequate numbers of normal comparison subjects and to obtain samples that are reflective of the general population, researchers have used methods, such as advertising in newspapers (2), that are designed to ensure a reasonable degree of equivalence with the general population. It is important, however, to verify that these subjects are free of significant psychopathology and that they do not manifest significant substance abuse.

Epidemiologic studies have suggested that the incidence of significant psychiatric disturbance, including substance abuse, in the general population is surprisingly high. Robins et al. (3), in a large population study, reported an approximately 30%-40% prevalence of psychiatric diagnoses over a lifetime history. A more recent study indicated that 15% of the subjects in a large, multisite national sample met diagnostic criteria for at least one alcohol/drug abuse or other mental disorder over a 1-month window (4). In addition, Zimmerman and Coryell (5) studied first-degree relatives of a variety of psychiatric patients and reported that approximately 20% of the relatives met DSM-III criteria for a personality disorder diagnosis. Thus, it appears that when individuals are sampled from representative nonpsychiatric populations, one can expect significant psychopathology in at least 10%-20% of these individuals. This estimate increases as one uses relatives of psychiatric patients or lengthens the time window for psychopathology, and it reaches approximately 30%-40% for lifetime prevalence.

It is possible that those individuals who are willing to participate in research studies that require more testing, involvement, and compensation will have prevalence rates of psychiatric disturbances that differ from those of subjects in the epidemiologic surveys. Few reports

Received June 9, 1992; revision received Nov. 20, 1992; accepted Dec. 4, 1992. From the Departments of Pediatrics and Neurology, Memorial Sloan-Kettering Cancer Center; and the Department of Psychiatry, University of California, San Diego. Address reprint requests to Dr. Butler, Department of Pediatrics, Box 181, MSKCC, 1275 York Ave., New York, NY 10021.

Supported in part by NIMH grant MH-42228 and a grant from the Robert Steel Foundation to Dr. Butler.

Copyright © 1993 American Psychiatric Association.

have directly investigated this important question. Several studies have suggested that the prevalence of diagnosable psychopathology in normal research volunteers is significantly higher than epidemiologic estimates, reaching prevalence rates of 40%–65% (6, 7). These older studies, however, generally used poorly defined criteria for the evaluation of psychopathology. Halbreich et al. (8) recognized the need for a current investigation of psychopathology in normal control subjects who had been solicited by newspaper advertisement. They initially screened potential research volunteers with structured telephone interviews. A total of 121 subjects passed the screening interview, and these individuals were then administered the Schedule for Affective Disorders and Schizophrenia (SADS) (9). Approximately 16% of the subjects met DSM-III-R criteria for a current significant psychiatric disorder, and approximately 35% had a history of a mental disorder. Halbreich et al. emphasized the need for a thorough assessment of all putatively normal research volunteers. The study, unfortunately, did not report data on possible cognitive or behavioral dysfunction in the subjects.

Thus, while many individuals will present as free of psychopathology on cursory screening, if subjected to a lengthy and detailed structured interview, approximately one in three will either currently manifest, or have a history of, a mental disorder. This is an extremely important methodological concern, particularly in research that makes comparisons between clinical populations, such as schizophrenic patients, and normal subjects. Specifically, if the comparison group contains subjects with psychotic tendencies or high levels of substance abuse, the probability of failing to identify a significant effect that is present (type II error) may increase accordingly. Considerable effort has been directed toward the need to control for possible generalized performance deficits in schizophrenia (10), thereby reducing the probability of identifying a spurious effect (type I error). Few researchers, however, have addressed the possibilities of masked disorder-specific performance deficits due to psychopathology in putative normal subjects.

We designed a study to determine if presumed psychosis-prone individuals and subjects with a high likelihood of substance abuse could be identified in research volunteers from the community. Our goal was to attempt to obtain greater specificity in the identification of potentially abnormal subjects by restricting the criteria to two clinical syndromes. Furthermore, rather than base our assessment of psychosis and substance abuse tendencies only on structured interviews, we hypothesized that a rationally derived MMPI algorithm would be able to identify four groups of subjects: 1) not psychosis prone/substance abuse not likely, 2) not psychosis prone/substance abuse likely, 3) psychosis prone/substance abuse not likely, and 4) psychosis prone/substance abuse likely. The MMPI was chosen because of its empirical development and because many of the items on the MMPI that are sensitive to psychopathology and substance abuse have a low degree of

face validity (i.e., are subtle in their content), reducing the probability of conscious denial of these items. Furthermore, the MMPI contains validity scales that allow for the identification of falsification response sets. Thus, this measure may have greater sensitivity than direct, more face valid indexes of symptoms. The MMPI algorithm was validated against a variety of structured interviews, self-report questionnaires, and observational psychopathology rating scales. We further hypothesized that the psychosis-prone and substance abuse likely groups would show significantly greater evidence of cognitive impairment on selected neuropsychological tests.

METHOD

Subjects

Putatively normal comparison subjects were recruited by advertisements in a community newspaper and notices placed in work stations and various community facilities. Non-college-student research volunteers were also referred by other researchers at our institution who routinely recruited subjects at welfare and unemployment offices. Potential subjects telephoned a laboratory technician who explained that the purpose of the study involved the need for normal comparison subjects as part of our studies in schizophrenia. Approximately 80% of all potential subjects who contacted our laboratory eventually completed the study. All subjects denied a history of head injury, significant medical and neurological disease, and past psychiatric treatment. Two subjects later admitted to a history of psychiatric hospitalization (posttraumatic stress disorder and suicidality), and one other subject had received treatment for alcohol abuse. Those individuals were excluded from further data analyses. Subjects were paid \$5.00 per hour for participation. A total of 98 subjects completed the study; however, 17 of these subjects were excluded because of either invalid MMPI profiles or profiles that were not classifiable by the MMPI algorithm, leaving a subject pool of 81. There were incomplete data on some variables because of changes in data collection procedures over the course of the study; and this will be noted, as appropriate. Twenty-six (32%) of the 81 subjects admitted to being unemployed and living a homeless lifestyle.

Procedure

The MMPI profiles were judged valid according to Caldwell's criteria (11). MMPI classification criteria for group membership are presented in appendix 1. MMPI criteria were rationally selected for their sensitivity to psychosis, disorganization, and substance abuse. Specifically, the F Scale, the Goldberg Index, and the Psychoticism Scale were used as measures of psychological disorganization and perceptual aberration. All three of these measures have been demonstrated to be sensitive to psychotic processes (12). The MacAndrew Scale was selected as an empirically derived index of the likelihood of significant substance abuse. This scale appears to be especially sensitive to chronic substance abuse, independent of self-report, and has been estimated to correctly identify abuse patterns at a rate of approximately 80% (12). The selection of cutoff scores in the current study was guided by clinical utility and estimates of sensitivity in the normal population (11).

Symptoms suggestive of psychotic processes and psychological distress were assessed by both structured interview (including observational ratings) and self-report methods. Subjects were administered the Scale for the Assessment of Positive Symptoms (13), the Scale for the Assessment of Negative Symptoms (14), the Brief Psychiatric Rating Scale (BPRS) (15), and the Hamilton Depression Rating Scale (16). Self-report measures were the SCL-90 (17) and the Magical Ideation Scale (18). Finally, as a self-report index of sub-

NORMAL COMPARISON GROUPS

TABLE 1. Sociodemographic Characteristics of "Normal" Subjects Who Were or Were Not Prone to Psychosis and Substance Abuse

Item	Not Psychosis Prone				Psychosis Prone			
	Substance Abuse Not Likely (N=39)		Substance Abuse Likely (N=15)		Substance Abuse Not Likely (N=19)		Substance Abuse Likely (N=8)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	33.9	9.0	37.9	7.0	31.9	7.5	34.4	10.1
Education (years)	14.7 ^a	1.9	12.6	2.0	13.2	2.5	10.4	4.4
Socioeconomic status ^b	3.1 ^a	1.2	4.2	0.8	4.4	0.9	4.4	0.5

^ap=0.01, Student's t test.

^bHollingshead-Redlich criteria.

stance abuse, the Modified Michigan Alcoholism Screening Test (MAST) (19) was administered.

Subjects were administered two subtests from the WAIS-R (20), the vocabulary and digit span subtests. Subjects were also administered the Wisconsin Card Sorting Test (21), Verbal Fluency Test (22), Nonverbal Fluency Test (23), and the Visual-Verbal Test (24). The WAIS-R vocabulary subtest provides an estimate of general verbal intelligence, and the digit span subtest is an index of attention/concentration. The Wisconsin Card Sorting Test assesses flexible problem solving ability. It was scored for perseverative responses and was administered and scored in the standard, manual-described fashion (21). The Verbal Fluency Test and Nonverbal Fluency Test are measures of fluency and are thought to be associated with frontal brain function (22, 23). The Visual-Verbal Test is a measure of concept formation and abstraction, and evidence suggests that patients with chronic schizophrenia perform poorly on this test (25).

Subjects were administered all measures over a 1-day session. This typically involved a time commitment of 4 to 6 hours. Subjects were allowed to take rest periods as needed. All measures, including the structured interviews, were obtained by trained laboratory technicians with at least 1 year of experience in the administration of the interviews and tests.

RESULTS

The MMPI algorithm classified 1) 39 of the subjects as not psychosis prone/substance abuse not likely, 2) 15 of the subjects as not psychosis prone/substance abuse likely, 3) 19 of the subjects as psychosis prone/substance abuse not likely, and 4) eight of the subjects as psychosis prone/substance abuse likely. Descriptive characteristics of the groups are presented in table 1. Because of the relatively large number of comparisons conducted, an alpha level of 0.01 was used as the criterion for statistical significance in order to decrease the probability of spurious findings.

The groups were not significantly different in age but did significantly differ in years of education and socioeconomic status according to Hollingshead-Redlich criteria (26) (education: F=6.92, df=3, 76, p<0.0001; socioeconomic status: F=9.25, df=3, 77, p<0.0001). Subjects without evidence of psychosis or substance abuse, as defined by the MMPI algorithm (group 1), had more years of formal education and a higher socioeconomic status than the other three groups. No other group difference reached statistical significance.

The groups were compared on the various symptom and cognitive measures with 2x2 factorial analysis of variance. The factors were the presence or absence of a designation of psychosis prone and/or substance

abuse likely. On the Scale for the Assessment of Positive Symptoms, the psychosis-prone groups (groups 3 and 4) had significantly higher ratings than the groups that were not psychosis prone (F=15.80, df=1, 77, p<0.001). The substance abuse likely groups (groups 2 and 4) were not significantly different from the substance abuse not likely groups (groups 1 and 3). There was a significant interaction, with the psychosis-prone/substance abuse likely group (group 4) manifesting greater positive symptom ratings than all other groups (F=6.43, df=1, 77, p=0.01). The psychosis-prone groups also had significantly higher ratings on the Scale for the Assessment of Negative Symptoms (F=10.74, df=1, 77, p=0.002), the BPRS (F=18.81, df=1, 77, p<0.001), the Hamilton depression scale (F=11.10, df=1, 77, p=0.001), and the SCL-90 (F=20.73, df=1, 77, p<0.001). The substance abuse designation did not result in significant differences on these variables. The psychosis-prone groups had significantly greater scores on the Magical Ideation Scale than the groups that were not psychosis prone (F=21.91, df=1, 29, p<0.001); this was also true of the substance abuse likely groups (F=12.81, df=1, 20, p<0.001) when compared to the substance abuse not likely groups. Means and standard deviations for all symptom measures are listed in table 2.

Group comparisons were made on the measures of cognitive functioning. On the WAIS-R variables, there was a trend for the substance abuse likely factor to be associated with lower vocabulary scores (F=5.96, df=1, 75, p=0.02). The groups did not significantly differ on the digit span subtest. The psychosis-prone groups did not manifest greater perseverative responses on the Wisconsin Card Sorting Test, but the substance abuse likely groups were characterized by a significantly greater amount of perseverative responses (F=9.57, df=1, 76, p=0.003). The groups did not significantly differ on the Verbal Fluency Test. On the Nonverbal Fluency Test, the psychosis-prone group evidenced a trend toward less fluency (F=5.29, df=1, 74, p=0.02). Those subjects identified as psychosis prone also had more errors on the Visual-Verbal Test (F=7.12, df=1, 59, p=0.01), and subjects identified as substance abuse likely were also more impaired on the Visual-Verbal Test (F=11.78, df=1, 59, p=0.001). Group means for the cognitive functioning measures are presented in table 3.

TABLE 2. Symptom Measures of "Normal" Subjects Who Were or Were Not Prone to Psychosis and Substance Abuse

Measure	Not Psychosis Prone				Psychosis Prone			
	Substance Abuse Not Likely (N=39)		Substance Abuse Likely (N=15)		Substance Abuse Not Likely (N=19)		Substance Abuse Likely (N=8)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Scale for the Assessment of Positive Symptoms	0.3	1.3	0.7	2.3				
Scale for the Assessment of Negative Symptoms	1.6	3.4	5.0	6.8	4.5	7.0	14.9	21.1
BPRS	5.7	4.7	6.7	4.5	8.8	11.4	7.1	10.1
Hamilton depression scale	4.7	4.3	4.6	3.2	11.8	8.5	14.8	11.1
SCL-90	123.9	31.9	116.6	15.6	9.0	8.4	9.8	7.7
Magical Ideation Scale	3.3 ^b	3.0	6.7 ^c	4.0	167.5 ^a	55.1	149.0	39.4
MAST	5.8 ^e	10.1	11.7	13.2	8.3 ^c	5.0	17.3 ^d	4.8
					24.9	17.8	21.3	20.1

^aN=18.

^bN=16.

^cN=7.

^dN=3.

^eN=15.

TABLE 3. Cognitive Functioning Measures of "Normal" Subjects Who Were or Were Not Prone to Psychosis and Substance Abuse

Measure	Not Psychosis Prone				Psychosis Prone			
	Substance Abuse Not Likely (N=39)		Substance Abuse Likely (N=15)		Substance Abuse Not Likely (N=19)		Substance Abuse Likely (N=8)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
WAIS-R								
Vocabulary	11.8 ^a	3.1	9.8	2.2	10.3 ^b	3.4	9.4	2.8
Digit span	11.1	2.5	10.0	2.6	9.8	2.3	9.0	3.3
Wisconsin Card Sorting Test	6.1 ^a	9.0	12.9	16.5	7.1	8.2	12.3	9.0
Verbal Fluency Test	44.2 ^a	10.0	43.7	11.0	41.6	10.4	40.3	15.3
Nonverbal Fluency Test	19.9 ^a	11.3	15.7 ^c	10.0	13.6	8.2	12.3 ^d	4.7
Visual-Verbal Test	11.4 ^c	4.8	15.9 ^f	6.2	14.6 ^c	4.6	22.5	11.3

^aN=38.

^bN=18.

^cN=14.

^dN=7.

^eN=26.

^fN=12.

DISCUSSION

The results of this study support the validity of the MMPI-derived algorithm as a means of identifying putatively normal individuals who have significant clinical and cognitive problems. The individuals identified as psychosis prone by the MMPI consistently had higher scores on measures of positive and negative symptoms, global psychological distress, and magical thinking. The psychosis-prone groups also scored significantly higher on the Hamilton depression scale, but their ratings appear to be "subclinical." As an additional check on the effects of depression, we compared all groups on their mean score on the depression scale (scale 2) from the MMPI; no significant differences were found. Possibilities for the elevated Hamilton depression scale scores in the psychosis-prone groups include contributions from those items that reflect psychotic-like symptoms (e.g., paranoid ideation, derealization) and the positive correlation between some symptoms of depression and the negative symptoms of psychosis.

It should be emphasized that we do not claim that we have identified individuals who meet DSM-III-R criteria for schizophrenia, other psychotic disorders,

or any formal psychiatric diagnosis. In fact, it is highly likely that many of the subjects in the psychosis-prone groups do not meet criteria for schizophrenia. This likelihood is reflected in the magnitude of the psychosis-prone group symptom measures, which are generally lower than those found in clinical populations. We do believe, however, that individuals manifest symptoms of psychosis in a spectrum of varying degrees. Siever (27) has commented on the prevalence of schizotypal personality disorder and has observed that individuals with this disorder appear to be similar to patients with schizophrenia on some neurobiological measures. It is certainly possible that a number of the psychosis-prone subjects in the current study are similar to schizotypal patients. Our results suggest that putatively normal control subjects who deny a history of psychiatric disturbance can be separated out into subgroups that significantly differ on measures of symptoms that are usually linked to psychosis. These results will need to be replicated and extended in order to determine their stability and generalizability, particularly in light of the relatively large number of statistical analyses that were conducted on the data set. We are encouraged, however, by these initial findings that are

NORMAL COMPARISON GROUPS

generally in agreement with the findings of Halbreich et al. (8).

Also of interest in the symptom measures are the apparent effects of substance abuse. While self-report of substance abuse does not necessarily reflect predictions of substance abuse based on the more empirically derived MacAndrew Scale, it does appear that the psychosis-prone groups had a tendency to admit to greater degrees of substance abuse than the other subjects. In addition, the combination of an elevated substance abuse probability and the psychosis-prone factor was associated with increases in positive symptoms. One possible interpretation of this trend is that the psychosis-prone/substance abuse likely group is indeed using excessive amounts of substances which, in turn, are lowering the threshold for the emergence of positive psychotic symptoms. This trend was not seen in negative symptoms. These data are rather heuristic in nature but do indicate the potential value of further empirical research on the interrelationships between various abused substances and types of psychotic symptoms in clinical populations.

The results from the cognitive functioning measures are less clear and consistent than those found with the symptom variables. Several trends appear to be present and may be of importance, even though they are not necessarily statistically significant. First, without fail, the group that was not psychosis prone performed in a superior direction on all measures. This may be related to the fact that this group also had more education and had, correspondingly, a higher socioeconomic status than the other groups. On the other hand, the groups were not significantly different on the WAIS-R measures. This suggests that less education and lower socioeconomic status may be a function of symptoms. For these reasons, covariance analyses were avoided (28). Second, the substance abuse likely factor, rather than the psychosis-prone factor, appears to account for most of the relative cognitive dysfunction. To the extent that our subgroups are, in fact, using significant amounts of substances that are neurotoxic, this is consistent with data that support neuropsychological deficits in patients with chronic substance abuse (29). Finally, the psychosis-prone/substance abuse likely group consistently performed in an inferior direction on the cognitive measures, even when compared to the psychosis-prone/substance abuse not likely and the not psychosis-prone/substance abuse likely groups.

The MMPI classification scheme identified 33% of the cohort as psychosis prone. This is a large number and deserves further comment. As stated earlier, 32% of the total cohort admitted to unemployment and a homeless lifestyle. When we investigated the percentage of homeless persons by group, we observed a clear trend. The psychosis-prone/substance abuse likely subjects had the highest concentration of the homeless (75%), followed by the psychosis-prone/substance abuse not likely group (42%), the not psychosis-prone/substance abuse likely group (33%), and, finally, the not psychosis-prone/substance abuse not likely group

(18%). Given these data, one might argue that simply inquiring as to a subject's lifestyle allows for relatively accurate classification regarding tendencies toward psychosis and significant substance abuse. To a certain extent, we would agree with this argument, and we encourage researchers to include questions regarding homelessness in their screening of "normal" comparison subjects. It is a rather obvious, but often overlooked, premise that when reimbursement is provided, individuals will tend to conceal facts (e.g., psychiatric, medical, or neurological conditions) that might preclude participation. We also suspect that many normal volunteers are somewhat "research sophisticated" and have been involved in more than one study. On the other hand, almost 20% of the not psychosis-prone/substance abuse not likely group admitted to being homeless, and this group was generally quite high in their level of functioning. Our findings emphasize the importance of a complete and thorough evaluation of all putative normal control subjects. Investigators may wish to use detailed structured interviews such as the SADS, the Structured Clinical Interview for DSM-III-R Personality Disorders (30), or detailed objective self-report measures, such as the MMPI. Although this involves a considerable time commitment for all parties, it also ensures accurate group membership and thus allows the researcher maximal methodological and statistical analytic power.

Finally, our study has an intrinsic philosophical component that, while not directly answerable, deserves comment. The issue involves the definition of normality. Is normality the virtual or absolute absence of psychopathology? We believe that most clinical researchers would allow for some level of psychopathological symptoms in their definitions of normality, but at what point does one make a demarcation? Melville wrote in the novel *Billy Budd*, "Who in the rainbow can show the line where the violet tint ends and the orange begins? Distinctly, we see the difference of the colors, but when exactly does the one first blindingly enter into the other? So with sanity and insanity." In the current study, our criteria cutoff values were guided by clinical studies that are necessarily somewhat arbitrary in nature. Are they the "correct" cutoff points in the sense of defining "normality"? We do not know the answer to this question but hope that continued efforts at clinical data collection and examination of data distributions in nonpsychiatric populations will increase our understanding of the relevant parameters.

REFERENCES

1. Kazdin AE: Research Design in Clinical Psychology. New York, Harper & Row, 1980
2. Braff DL, Grillon C, Geyer MA: Gating and habituation of the startle reflex in schizophrenic patients. *Arch Gen Psychiatry* 1992; 49:206-215
3. Robins LN, Helzer JE, Weissman MM, Orvaschel H, Gruenberg E, Burke JD Jr, Regier DA: Lifetime prevalence of specific psychiatric disorders in three sites. *Arch Gen Psychiatry* 1984; 41: 949-958
4. Regier DA, Boyd TH, Burke JD, Rae DS, Myers JK, Kramer M,

- Robins LN, George LK, Karno M, Locke BZ: One month prevalence of mental disorders in the United States. *Arch Gen Psychiatry* 1988; 45:977-986
5. Zimmerman M, Coryell W: DSM-III personality disorder diagnoses in a nonpatient sample: demographic correlates and comorbidity. *Arch Gen Psychiatry* 1989; 46:682-689
 6. Pollin W, Perlin S: Psychiatric evaluation of "normal control" volunteers. *Am J Psychiatry* 1958; 115:129-133
 7. Perlin S, Pollin W, Butler RN: The experimental subject: the psychiatric evaluation and selection of a volunteer population, in *Clinical Investigation in Medicine: Legal, Ethical, and Moral Aspects*. Edited by Newman R, Ladimer I. Boston, Boston University, 1963
 8. Halbreich U, Bakhai Y, Bacon KB, Goldstein S, Asnis GM, Endicott J, Lesser J: The normalcy of self-proclaimed "normal volunteers." *Am J Psychiatry* 1989; 146:1052-1055
 9. Spitzer RL, Endicott J: Schedule for Affective Disorders and Schizophrenia (SADS). New York, New York State Psychiatric Institute, Biometrics Research, 1975
 10. Chapman LI, Chapman JP: The measurement of differential deficit. *J Psychiatr Res* 1978; 14:303-311
 11. Caldwell AB, O'Hare C: A Handbook of MMPI Personality Types. Santa Monica, Calif, Clinical Psychological Services, 1975
 12. Graham JR: The MMPI: A Practical Guide, 2nd ed. New York, Oxford University Press, 1987
 13. Andreasen NC: Scale for the Assessment of Positive Symptoms (SAPS). Iowa City, University of Iowa, 1983
 14. Andreasen NC: Scale for the Assessment of Negative Symptoms (SANS). Iowa City, University of Iowa, 1983
 15. Overall JE, Gorham DR: The Brief Psychiatric Rating Scale. *Psychol Rep* 1962; 10:799-812
 16. Hamilton M: Development of a rating scale for primary depressive illness. *Br J Soc Clin Psychol* 1967; 6:278-296
 17. Derogatis LR, Lipman RS, Covi L: SCL-90: an outpatient psychiatric rating scale—preliminary report. *Psychopharmacol Bull* 1973; 9:13-28
 18. Eckblad M, Chapman LJ: Magical ideation as an indicator of schizotypy. *J Consult Clin Psychol* 1983; 51:215-225
 19. Westermeyer J, Neider J: Social networks and psychopathology among substance abusers. *Am J Psychiatry* 1988; 145:1265-1269
 20. Wechsler D: Wechsler Adult Intelligence Scale, Revised. New York, Psychological Corp, 1981
 21. Heaton RK: The Wisconsin Card Sorting Test Manual. Odessa, Fla, Psychological Assessment Resources, 1981
 22. Borkowski JG, Benton AL, Spreen O: Word fluency and brain damage. *Neuropsychologia* 1967; 5:135-140
 23. Jones-Gotman M, Milner B: Design fluency: the invention of nonsense drawings after focal cortical lesions. *Neuropsychologia* 1977; 15:653-674
 24. Feldman MJ, Drasgow J: The Visual-Verbal Test. Los Angeles, Western Psychological Services, 1976
 25. Siegel SM: Discrimination among mental defective, normal, schizophrenic, and brain damaged subjects on the Visual-Verbal Concept Formation Test. *Am J Ment Defic* 1957; 62:338-343
 26. Hollingshead AB: Two-Factor Index of Social Position. New Haven, Conn, Yale University, 1965
 27. Siever LJ: Biological markers in schizotypal personality disorder. *Schizophr Bull* 1985; 11:564-575
 28. Neale JM, Oltmanns TF: Schizophrenia. New York, John Wiley & Sons, 1980
 29. Loberg T: Neuropsychological findings in the early and middle phases of alcoholism, in *Neuropsychological Assessment of Neuropsychiatric Disorders*. Edited by Grant I, Adams KM. New York, Oxford University Press, 1986
 30. Spitzer RL, Williams JBW, Gibbon M: Structured Clinical Interview for DSM-III-R Personality Disorders (SCID-II). New York, New York State Psychiatric Institute, Biometrics Research, 1987

APPENDIX 1. MMPI Classification Criteria for "Normal" Subject Group Membership

MMPI criteria for "normal" subject groups:

1. Not psychosis prone/substance abuse not likely: F Scale T score less than 70 and Wiggins Psychoticism T score less than 60; Goldberg Index less than 60; MacAndrew Scale T score less than 70.
2. Not psychosis prone/substance abuse likely: F Scale T score less than 70 and Wiggins Psychoticism T score less than 60; Goldberg Index less than 60; MacAndrew Scale T score of 70 or more.
3. Psychosis prone/substance abuse not likely: F Scale T score of 70 or more and/or Wiggins Psychoticism T score of 60 or more; Goldberg Index of 60 or more; MacAndrew Scale T score less than 70.
4. Psychosis prone/substance abuse likely: F Scale T score of 70 or more and/or Wiggins Psychoticism T score of 60 or more; Goldberg Index of 60 or more; MacAndrew Scale T score of 70 or more.