Multivariate Experimental Clinical Research, Volume 5, No. 2, 1981, 41-51

A DISCRIMINANT FUNCTION FOR DIAGNOSING DEPRESSIVES WITH SELECTED SOURCE TRAIT FACTOR MEASURES FROM THE O-A KIT

S.V. Patrick, R.B. Cattell, P.L. Price, and J.F. Campbell
University of Hawaii

ABSTRACT

Thirty-one depressives and 30 normals were administered the subtests of the O-A battery used for measuring the objective source traits of Independence (U.I. 19), Evasiveness (U.I. 20), Realism (U.I. 25), and Somindence (U.I. 30). The covariance matrices for the two respective groups were found to be significantly different, X = 22.048, $p \leq .015$. The sample variances for the source traits were all greater in the depressives than in the normals, especially Evasiveness (U.I. 20), but none were significantly greater. A subsequent analysis of the correlation matrices, however, indicated that whereas all pairs of source traits were significantly correlated in the normals except Evasiveness (U.I. 20) and Realism (U.I. 25), only two pairs of source traits were significantly correlated in the depressives: Independence (U.I. 19) and Realism (U.I. 25) were positively correlated, and Realism (U.I. 25) and Somindence (U.I. 30) were negatively correlated. The data were then subjected to a discriminant analysis for the purpose of determining the direction and degree to which each of the four source traits contributes to the discrimination of depressives when the source traits are considered simultaneously. The obtained discriminant function was highly significant, X (4) = 26.296, $p \leq .001$. Depressives were found to be lower in Independence (U.I. 19) and higher in Evasiveness (U.I. 20) and Somindence (U.I. 30). The contribution of Realism (U.I. 25) to the discriminant function was too small to be considered significant. Following the discriminant analysis, the overall ability of the four source traits to discriminate normals and depressives was assessed by the Mahalanobis (1936) generalized distance function to classify subjects as normal or depressed. The classification procedure, which did not assume equivalent covariance matrices for the two groups, correctly classified 78.68% of the subjects. The relatively high percentage of correct classifications attest to the diagnostic and theoretical relevance of objectively derived source traits, especially when one considers that three of the four measures chosen were more theoretically obscure and less related to depression than other objective source traits which could have been selected for investigation. The discriminatory power of all the relevant objective source traits should be even higher.

INTRODUCTION

Improving the accuracy of psychiatric diagnosis has been sought by incorporating tests in the diagnostic process. Such tests have typically been questionnaires such as the Sixteen Personality Factor Questionnaire (16PF)

(Cattell, Eber, & Tatsuoka, 1970), Clinical Analysis Questionnaire (CAQ) (Cattell & Kameoka, 1974, 1981), and Minnesota Multiphasic Personality Inventory (MMPI) (Hathaway & McKinley, 1967) or miscellaneous tests thought to be useful such as the Rorschach (Rorschach, 1942) and the Bender-Gestalt (Bender, 1938). Some of the questionnaires, in contrast to the other questionnaires and the miscellaneous tests, have the theoretical importance of being strategically constructed to measure empirically derived constructs relevant to a general theory of personality. The 16PF, for example, measures source traits which are the factor analytically derived dimensions underlying the inter-individual variation on a stratified sample of variables representative of the personality sphere. The CAQ provides another example in that it measures the same source traits as the 16PF but also measures a number of pathological source traits found only in an abnormal population. In spite of the theoretical relevance and the ease in administration of carefully constructed questionnaires as the 16PF and CAQ, they are, however, commonly known to be subject to various distortions due to their subjectivity.

Recently, objective measures of importance to a general theory of personality have been made available in the Objective-Analytic (O-A) Personality Battery Kit (Cattell & Schuerger, 1978). As in the 16PF and the CAQ, the O-A battery was factor analytically developed; however, the measures of the O-A battery are objective in that they are based on the observable behaviors of people in numerous and diverse miniature-test situations. The measures are the dimensions (factors) underlying the inter-individual variation and are referred to as source traits.

Subsequent investigations have indicated that the source traits from the objective-test medium are in general alignment with the more general second-order factors of the questionnaire medium (Cattell, Note 1: Birkett & Cattell, 1978; Cattell & Schuerger, 1978; Wardell & Yeudall, 1976). That is, most of the source traits from the objective-test medium have been found to correspond qualitatively with the more general second-order factors of the questionnaire medium such as Exvia (QI), Anxiety (QII), Cortertia (QIII), and Control (QVIII) derived from factor analyzing the questionnaire primary source traits.

Although the source traits of the objective-test medium are of general theoretical importance and much less subject to distortions such as social desirability and poor self-insight which plague measures from questionnaires —the objective tests upon which they are based require greater skill and a longer time in administration. The O-A battery requires about 4 hours of testing although portions of it may be administered separately, such objective measures require greater skill and time. However, their greater reliabiity and validity are such that it behooves reseachers and clinicians to investigate the information they are capable of yielding.

Although there have been many investigations of depression in relation to questionnaire scales, there have been only a few investigations relating depression to the source traits of the newly developed O-A battery. Table 1 lists those O-A source traits which are expected to be related to depression based on a review of the literature. With the limited patient time usually available, the decision was made to select only four of the O-A source traits for investigation and to

investigate the other source traits at a later time with a different sample of subjects. Of the source traits listed in Table 1, source traits Independence (U.I. 19), Mobilization (U.I. 23), and Anxiety (U.I. 24) are comparatively well understood and are expected to be highly related to depression. Source traits Ego Assertion (U.I. 16), Asthenia (U.I. 28), and Discouragement (U.I. 33) are also reasonably understood though not expected to be a highly related to depression. Source traits Evasiveness (U.I. 20), Realism (U.I. 25), and Somindence (U.I. 30) are well defined factors analytically (Note 3) but indirect evidence suggests they are only moderately related to depression. These latter three source traits — Evasiveness (U.I. 20), Realism (U.I. 25), and Somindence (U.I. 30) — were therefore chosen initially for investigation because of their incomplete theoretical status and their less obvious though expected relation to depression. Additionally, Independence (U.I. 19) was included in the investigation for the purpose of comparing the other source traits with its expected higher relation to depression. (For a more detailed description of the source traits see Cattell, 1979.)

The purpose of the research reported in this article was two-fold: 1) to determine the direction and degree to which each of four source traits selected from the O-A battery contribute to the discrimination of depressives and normals when the source traits are considered simultaneously, and 2) to determine the overall ability of the four source traits to discriminate normals and depressives.

METHOD

Thirty-one depressives and 30 normals were administered the subtest of the O-A battery used for measuring the four source traits of Independence (U.I. 19), Evasiveness (U.I. 20), Realism (U.I. 25), and Somindence (U.I. 30). Fifteen of the depressives were more specifically diagnosed neurotic depressive with suicidal indications, three were diagnosed manic-depressive in a depressed stage, two were diagnosed as depressive reaction, two were diagnosed as agitated-hysterical depression, and one as schizo-affective type depression.

RESULTS

The equivalence of the two covariance matrices for the two respective groups was tested prior to conducting a discriminant analysis. The two covariance matrices, shown in Table 2, were found to be significantly different, X (10) = 22.048, $p \leq$ (Kendall & Stuart, 1966, pp. 266-282). An inspection of the covariance matrices in Table 2 indicates that the sample variances for the source traits were all greater in the depressives than in the normals, especially Evasiveness (U.I. 20) which was nearly twice as great. None of the corresponding comparisons between the two groups, however, were found to be statistically significant when Hartley's test was applied (Winer, 1971, p. 207).

Table 3 shows the correlation matrices for the two groups — which are, of course, standardized covariance matrices — for the purpose of meaningful comparing the directional differences in covariation among the source traits between the two groups. As Table 3 illustrates, only two pairs of source traits were significantly correlated in the depressives: Independence (U.I. 19) and Realism

Table 1

PERSONALITY FACTORS HAVING PREVIOUS EVIDENCE OF SEPARATING DEPRESSIVES FROM NORMALS

Source Trait	Magnitude of Association[1]	Director of Depressive Association[2]	Source[3]
Ego Assertion (UI16)	S	Lower (largely in neurotic and involutional)	2 4
Independence (UI19)	L	Lower (less clearly in involutional)	1 2 3 4
Evasiveness (UI20)	M	Higher (less in involutional)	1 2 3
Exuberance (UI21)	L	Lower (in all depressives)	1 2 3
Mobilization (UI23)	L	Lower (in all depressives)	1 2 4
Anxiety (UI24)	S	Higher (largely neurotics, not in involutionals)	2
Reality Contact (UI25)	M	Lower (scarcely in involutionals)	1 2 3
Asthenia (UI28)	S	Higher (in all depressives)	1 2
Somindence (UI30)	S	Higher (except in involutionals)	3
Discouragement (UI33)	S	Higher (but slight compared to schizophrenics with neurotic depressives	2
IN NEUROTIC DEPRESSIVES ONLY			
Cortertia (UI22)	L	Lower	4
Responsive Will (UI29)	L	Lower (not in psychotic but only in neurotic depressives	1 4

[1]L = large, M = moderate, and S = slight. The magnitude is assessed both by correlations and amount of replication.

[2]In certain studies — notably Cattell, Schmidt, and Bjersted (1972) — these factors have behaved differently for involutional depressives on the one hand and neurotic and general psychotic depressives on the other. This fact is noted when found.

[3]The sources as numbered on the right are as follows:

1 Cattell, Schmidt, and Bjersted (1972, p. 59)
2 Cattell and Schuerger (1978, p. 256)
3 Cattell, Price, and Patrick (Note 2)
4 Cattell and Scheier (1961, p.. 67) for neurotic depressives only. Some weight has also been given to Cattell (1964) and Mahrer (1970).

Table 2

COVARIANCE MATRICES FOR DEPRESSIVES AND NORMALS

Depressives

	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	18.536			
U.I. 20	-0.064	46.304		
U.I. 25	10.343	-1.431	12.471	
U.I. 30	-3.687	-2.065	-3.333	6.547

Normals

	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	14.301			
U.I. 20	-10.743	23.678		
U.I. 25	5.443	-2.954	7.492	
U.I. 30	-3.939	5.712	-3.654	5.996

Table 3

CORRELATION MATRICES FOR DEPRESSIVES AND NORMALS

Depressives

	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	1.000			
U.I. 20	-0.002	1.000		
U.I. 25	0.680***	-0.056	1.000	
U.I. 30	-0.335	-0.119	-0.369*	1.000

Normals

	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	1.000			
U.I. 20	-0.584***	1.000		
U.I. 25	0.526**	-0.222	1.000	
U.I. 30	-0.425*	0.479	-0.545**	1.000

*p .05.
**p .01.
***p .001.

(U.I. 25) were positively related and Realism (U.I. 25) and Somindence (U.I. 30) were negatively related. In the normals, the same two pairs were correlated in the same directions, but, in addition, all the other pairs of source traits except one were significantly correlated.

With the assumption of equivalent covariance matrices necessary for a discriminant analysis violated, the discriminant function derived from the subsequent discriminant analysis may be considered invalid. The robustness of discriminant analysis when the assumption is violated may be great enough, however, for the generated discriminant function to be adequately valid. With this consideration in mind, the discriminant function is cautiously presented to the reader rather than omitted so that he or she may decide upon its worth.

The obtained discriminant function, which is the best linear combination of the source traits for discriminating depressives and normals, was found to have a canonical correlation coefficient of .608 and to be highly statistically significant, $X = 26.296$, $p \leq .0001$. The mean standardized discriminant function score of the normals was -.765. Equation 1 below presents the standardized discriminant function, scoring high in the direction of depression.

$$Y = -.740\,(U.I\ 19) + .401\,(U.I.\ 20) - .334\,(U.I.\ 25) + .467\,(U.I.\ 30) \qquad \text{(Eq. 1)}$$

In equation 1 depressives whose mean score was higher on the discriminant function, were, as expected, generally lower in Independence (U.I. 19) which provided the greatest weight in the equation. They were also higher in both Evasiveness (U.I. 20) and Somindence (U.I. 30) as expected. The relation of Realism (U.I. 25) to depression was not interpreted in accordance with convention because its weight (.334) was less than half that of the largest weight in the equation and therefore not considered significant, although it is interesting that its direction is opposite of that expected. Table 4 provides the correlation coefficients for the combined sample.

Table 4

CORRELATION MATRIX OF COMBINED GROUPS

	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	1.000			
U.I. 20	-0.384**	1.000		
U.I. 25	0.650***	-0.212	1.000	
U.I. 30	-0.517***	0.277*	-0.501***	1.000

*p .05.
**p .01.
***p .001.

The overall ability of the four source traits to discriminate depressives and normals was analyzed by using the generalized distance function of Mahalanobis (1936). The discriminant function could have been used for that purpose by calculating each person's score on the discriminant function and then classifying each person to the group (depressive or normal) whose mean discriminant score was closer. Using the discriminant function for that purpose, however, would

again require the assumption of equivalent dispersion matrices of the discriminating variables for the two groups. Fortunately, the same purpose can be served by using the generalized distance function of Mahalanobis which does not require that the dispersion matrices be equal and is a better classification method (Tatsuoka, 1971; Tatsuoka, 1974).

In using the Mahalanobis generalized distance function in classification, the profile of each person is projected as a point into a k-dimensional hyperspace where the dimensions are the discriminating variables. The generalized distances of each person's profile point to the mean profile of each group is then calculated, and each person is classified in that group which is closest. The distances are generalized in that for each respective group, each distance is based on variables that have been standardized and weighted inversely to the degree to which they are inter-correlated within each group.[1] [In matrix algebra notation, the formula used in the calculations is $d_{ig} = x'_{ig(d)} C_g^{-1} x_{ig(d)}$ where x is a row vector for the raw-score profile between the profile for person *i* and the mean profile of group *g* and where C is the covariance matrix of the source traits within group *g*.]

Table 5 shows the overall ability of the four source traits to discriminate depressives from normals when the subjects are classified using the generalized distance function. The overall percentage of correct classification was 78.68%. The means of the two groups standardized for normals and the respective within-group standardized covariance (correlation) matrices necessary for diagnostic application are presented in Table 6.

Table 5

CLASSIFICATION OF SUBJECTS BY FOUR OBJECTIVE SOURCE TRAITS

As Scored on O-A

As Psychiatrically Classified	Depressives	Normals	Total
Depressives	23(74.19)	8(25.81)	31(100.0)
Normals	5(16.67)	25(83.33)	30(100.0)

NOTE: Percentages are in parentheses. Percentage of correct classifications is 78.68%.

DISCUSSION

The fact that the covariance matrices for the depressives and normals were significantly different is in itself useful information. Although the corresponding variances for the two groups were not significantly different, variances of the source traits obtained in the depressives were consistently larger than the corresponding variances obtained in the normals, especially Evasiveness (U.I. 20). Also, considering the off-diagonal elements of the standardized covariance matrix (see Table 2), it is most interesting that the source traits were more linearly

Table 6

MEAN PROFILES AND INVERSES OF THE WITHIN-CORRELATION MATRICES FOR DEPRESSIVES AND NORMALS

	Depressives			
	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	1.892			
U.I. 20	-0.043	1.027		
U.I. 25	-1.224	0.146	1.963	
U.I. 30	0.176	1.068	-0.652	0.994
Means (Z_D)	-1.288	1.068	-0.652	0.994

	Normals			
	U.I. 19	U.I. 20	U.I. 25	U.I. 30
U.I. 19	2.035			
U.I. 20	1.050	1.844		
U.I. 25	-1.910	-0.543	1.834	
U.I. 30	-0.134	-0.733	0.873	1.771
Means (Z_N)	0.0	0.0	0.0	0.0

dependent in the normals as would be expected but were unexpectedly less linearly related in the depressives. One would expect, for example, that a person who was high in Evasiveness (U.I. 20) would also likely be high in Somindence (U.I. 30) but low in Independence (U.I. 19) as was found in the normals. But, such an expectation was not substantiated in the depressives: Evasiveness (U.I. 20) was not shown to be related to both Somindence (U.I. 30) and Independence (U.I. 19). This unexpected result should not be too surprising, however, if we consider that some combinations of trait scores (profiles) would be expected more frequently in a better adjusted population and the traits therefore more inter-correlated (Cattell, 1979). Besides expecting depressives to be higher or lower on certain traits, one would not expect profiles of depressives to be adaptive and occur more frequently because depressives are maladaptive by definition. The fact that the traits are less inter-related in depressives may be indicative of possessing less integrated personalities.

The results of the discriminant function, though equivocal because of violating the assumption of equivalent covariance matrices for the two groups, were consistent with our expectations. As in an earlier report in which each trait when considered separately was found to be significantly related to depression (Note 2), when considered simultaneously in the discriminant analysis, each trait was found to be related to depression with one possible exception. Realism (U.I. 25) had an obtained relation too small to be confidently accepted. The obtained relation was, however, in the opposite direction than expected, thus posing the possibility that realism may be positively related to depression when its

covariation with other factors is controlled. The depressive might profit from taking a somewhat less realistic view of the world!

The ability of the four source traits collectively to discriminate between depression and controls is quite impressive. Only one of the traits was expected to be highly related to depression, yet, in conjunction with the other traits, 78.68% of the subjects were correctly classified as depressed or normal. One would expect that even greater discrimination would be obtained if measures such as Ego Assertion (U.I. 16), Exuberance (U.I. 21), Mobilization (U.I. 23), Anxiety (U.I. 24), and the other traits listed in Table 1 had been used. The ultimate limit of the discriminatory power of the objective measures in the O-A battery and hence their joint relation to depression may be constrained by little more than the accuracy of clinicians in diagnosing depression. Objective source traits, however, should not be used to supplant the diagnostic process but rather to supplement and reinforce it. To such an end, the use of the objective source traits as measured by the O-A battery is an auspicious development.

FOOTNOTE

[1]The Mahalanobis squared generalized distance for calculating the squared generalized distance of any individual profile from the mean of a group is $d_{ig}^2 = x'_{ig(d)} C_g^{-1} x_{ig(d)}$ where $x'_{ig(d)}$ is the difference profile of individual *i*'s raw-score profile a group *g*'s mean raw-score profile and where C_g-1 is the inverse of the covariance matrix of group *g*. An alternative formula is $d_{ig(d)} R_g^{-1} z_{ig(d)}$ where $z_{ig(d)}$ is a difference profile of the standardized-score profile of individual *i* and the standardized-score mean profile of group *g* (the standardization is across all groups) and where R_g^{-1} is the inverse of the correlation of the factors within group *g*. Because factor scores may be calculated exactly or estimated closely by different weighting rationales using unit weightings which cause the variances and covariances to vary in sizes, the alternative formula based upon standardized variables is more practical [i.e., $d_{ig}^2 = z'_{ig(d)}{}^{-1} z_{ig(d)}$]. To assist clinicians and researchers in the diagnosis of depression, the mean profile, z_g, and inverse of the within-correlation matrix, R_g^{-1}, for each group is presented in Table 6. The means have been based on standardized source traits according to normals. Subtracting and multiplying matrices is a simple process which can be easily learned by consulting Tatsuoka (1971, pp. 7-20).

REFERENCE NOTES

1. Cattell, R. B. *Psychiatric screening of flying personnel: Personality structure in objective tests — a study of 1,000 Air Force Students in basic pilot training* (Report No. 21-0202-007). Randolph Field, Texas: US.A.F. School of Aviation Medicine, 1955.

2. Cattell, R. B., Price, P. L., & Patrick, S. V. Diagnosis of clinical depression on four source trait dimensions. *Journal of Clinical Psychology,* (In press 1981).

3. Price, P.L., Patrick, S.V., & Cattell, R.B. A check on the factor analytic structure of four Objective Analytic (O-A) Kit source traits: Independence, Evasiveness, Realism and Dissofrustance, found diagnostic of depression. (In press *Multivariate Exper. Clin. Res.*, 1981).

REFERENCES

Bender, L. A visual Gestalt test and its clinical use. *American Orthopsychiatric Association, Research Monograph,* 1938, No. 3.

Birkett, H., & Cattell, R. B. Diagnosis of the dynamic roots of a clinical symptom by P-technique: A case of episodic alcoholism. *Multivariate Experimental Clinical Psychology,* 1978, *3,* 173-194.

Cattell, R. B. The parental early repressivenes hypothesis for the asthenia factor, U.I. 28. *Journal of Genetic Psychology,* 1964, *106,* 333-349.

Cattell, R. B. *Personality and learning theory (Vol. 1): The structure of personality in its environment.* New York: Springer Publishing Co., 1979.

Cattell, R. B., Eber, H. W., & Tatsuoka, M. M. *Handbook for the Sixteen Personality Factor Questionnaire.* Champaign, Illinois: Institute of Personality and Ability Testing, 1970.

Cattell, R. B., & Scheier, I. H. *The meaning and measurement of neuroticism and anxiety.* New York: Ronald, 1961.

Cattell, R. B., Schmidt, L. R., & Bjersted, A. Clinical diagnosis by the objective analytic personality batteries. *Journal of Clinical Psychology Monographs, 1972, No. 34, Brandon, Vermont.*

Cattell, R. B., & Schuerger, J. M. Personality theory in action: Handbook for the Objective-Analytic (O-A) Test Kit. Champaign, Illinois: Institute of Personality and Ability Testing, 1978.

Cattell, R. B., & Kameoka, V. *The Clinical Analysis Questionnaire (CAQ).* Champaign, Illinois: Institute of Personality and Ability Testing, 1974, 1981.

Hathaway, S. R., & McKinley, J. C. *The Manual of the Minnesota Multiphasic Personality Inventory (Rev.).* New York: Psychological Corporation, 1967.

Kendall, M. G., & Stuart, A. S. *The advanced theory of statistics (Vol. 3).* London: Charles Griffin & Company Limited, 1966.

Mahalanobis, P. C. On the generalized distance in statistics. *Proceedings of the National Institute of Science, India,* 1936, *12,* 49-55.

Mahrer, A. H. *New approaches to personality classification.* New York: Columbia University Press, 1970.

Rorschach, H. *Psychodiagnostics: A diagnostic test based on perception.* Translated by P. Lemkan & Kroneburg (1st German ed., 1921). New York: Grune & Stratton, 1942.

Tatsuoka, M. M. *Multivariate analysis: Techniques for educational and psychological research.* New York: John Wiley & Sons, Inc., 1971.

Tatsuoka, M. M. *Selected topics in advanced statistics: An elementary approach (No. 3).* Champaign, Illinois: Institute of Personality and Ability Testing, 1974.

Wardell, P., & Yeudall, L. T. A multidimensional approach to criminal disorders. I. The factor analysis of impulsivity. *Journal of Clinical Psychology,* 1976, *32,* 12-31.

Winer, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill Book Company, 1971.