

# THE STATISTICAL ANALYSIS OF THE ROSVOLD AND MISHKIN DATA

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## SUMMARY

IN the *Canadian Journal of Psychology*, September, 1950, Rosvold and Mishkin discuss the effects of prefrontal lobotomy on the Intelligence Quotient. Test scores from five patients were analyzed, and certain conclusions derived and compared with results obtained by other investigators. In the paper presented herewith a method of statistical analysis, preferred by the present authors, is put forward and compared with the Rosvold and Mishkin method.

## THE ROSVOLD AND MISHKIN ANALYSIS

Six values of "t" were obtained based on the six possible differences between the four types of score, designated A, B, C, and D. Although six pairs can be selected from these four, only three of these yield independent comparisons among the four scores; it is misleading to imply that six hypotheses can be tested without indicating the connection between them. For example, any two of the following three hypotheses clearly imply the third one:

"Score A—score B has a mean value of zero,"

"Score B—score C has a mean value of zero,"

"Score C—score A has a mean value of zero."

To avoid this difficulty, attention must be confined to at most three comparisons. It would also be advantageous to have these comparisons orthogonal; consequently the analysis of variance is indicated.

In the calculation of the standard deviation to be used in the "t" tests in Rosvold and Mishkin's problem (2), four or three degrees of freedom should be used, depending on whether the missing value does or does not occur in the particular comparison. Consequently, the respective 5 per cent "t" values determining the rejection level should be 2.776 and 3.182 rather than the values given, which are the 5 per cent values for three and two degrees of freedom respectively.

## PROPOSED ANALYSIS

In place of the four or three degrees of freedom used in the "t" test, an estimate of error having 11 degrees of freedom is available from an analysis of variance, and should be used, provided there is no *a priori* reason to expect a lack of homogeneity in the error variance as we move from one type of score to another.

The analysis of variance presented is based on the assumption that each observed score is the sum of the following:

- (i) A personal number which varies from patient to patient.
- (ii) An effect varying from one type of score to another. (It is these "column" effects we wish to study.)
- (iii) Superimposed on the "patient" effect + "column" effect, an observational error which we assume is independent of the particular patient and the particular column.

A possible further refinement could be made by allowing for a personal I.Q. change between the pre-morbid and morbid states, its magnitude depending on the individual patient. However, before applying this refinement, more data from the pre-morbid state would be preferable.

TABLE I  
PRE- AND POST-LOBOTOMY SCORES ON "M" AND WECHSLER  
INTELLIGENCE TEST

Patient	Pre-Morbid Score "M" I.Q.	Pre-Lobotomy Wechsler I.Q.	Post-Lobotomy "M" I.Q.	Post-Lobotomy Wechsler I.Q.
	(A)	(B)	(C)	(D)
A.M.	120	109	110	114
A.L.	105	71	85	86
W.C.	94	90	75	87
B.P.	100	..	65	54
H.S.	102	110	95	95

Since there are three degrees of freedom in the differences among column averages, we can make exactly three independent comparisons, each with one degree of freedom. The following three comparisons are suggested by the nature of the problem. The first is between C and D and is used to test the hypothesis that these two types of score have the same mean. This test is necessary since the next two comparisons will be confounded with the mean difference between C and D unless this mean difference is zero. The resulting F ratio will be tested at the 5 per cent level. The second comparison is the excess of B over the average of C and D, and is used to test whether there is significant lowering of the I.Q. after the operation. We shall use a 10 per cent region with the F test and shall reject only if the comparison is positive, thus obtaining a 5 per cent level on the Null hypothesis. The third comparison is the excess of A over the average of B, C, and D, and measures the deteriorating effect of morbidity on intelligence. For this test we shall also use a 10 per cent F and shall reject only when the comparison is positive.

Table I gives the data of Rosvold and Mishkin (2), and Table II records the analysis of variance. The method described by Fisher (1, pp. 175-7) is used to take account of the non-orthogonality due to the missing observation. The numerical analysis assumes that the tests will be made in the order given above and that each test will be made only

TABLE II  
ANALYSIS OF VARIANCE

Variance	d.f.	S.S.	M.S.	F	Sign	Critical F	Hypothesis
(C-D)	1	3.60	3.60	.04		4.84	Accepted
2B-(C+D)	1	34.05	34.05	.34	+	3.23	Accepted
3A-(B+C+D)	1	1014.82	1014.82	10.01	+	3.23	Rejected
Residue	11	1115.03	101.37				

if the preceding tests are insignificant. However, with only the one observation missing, the non-orthogonality is not serious and the tests could be considered as reasonably independent.

Although with the present data our conclusions are essentially unchanged, the use of the proposed analysis will, in the long-run application to similar data, give more correct decisions.

#### REFERENCES

1. FISHER, R. A. *The Design of Experiments* (Edinburgh and London: Oliver and Boyd, 1949).
2. ROSVOLD, H. ENGER, and MISHKIN, MORTIMER. "Evaluation of the Effects of Prefrontal Lobotomy on Intelligence" (*Canadian Journal of Psychology*, 4, 1950, 122-6).