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A FACTORIAL INVESTIGATION OF SCORES ON THE PORTEUS MAZE[1]

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Summary.—A group form of the Porteus Maze was given to 180 freshman students. Each part was treated as a separate test and intercorrelated with all other parts. The intercorrelations were relatively low and a factor analysis revealed four interpretable factors underlying the test. It is suggested that investigation determine which subscore is most valid for the prediction of delinquency.

The history of the Porteus Maze Test begins in the period between 1913 and 1915 when it was first proposed as a measure to extend the score obtainable with the early Binet test of intelligence (Porteus, 1959). Porteus uses the analogy of a worked-out mine to point out that, as a measure of intellect, the use of a single score, thin, 15-min. mental ability scale has had its day. He feels that maze performance is indicative not only of mental age but also of the ability to plan ahead. In 1942 a "reprieve" was given to the maze test with the discovery that relatively simple qualitative (Q) measures could differentiate between delinquents and normals. Porteus noted the lack of interest in this dimension and put forth "A simple book, devoid of scholarly virtue" (1959, p. vi) which was intended to interest psychologists in what might be payable metal. This book makes reference to several studies which indicate that Q can differentiate between delinquents and normals; the most readily available of these are by Wright (1944) and Docter and Winder (1954). Present interest in work with delinquents is given added importance by PL 89-176, known as the work release program, so a new look at the maze test with modern psychometric techniques is in order.

The qualitative (Q) score was apparently intuitively derived by Porteus and is concerned with errors in execution rather than in planning the maze performance. Porteus states that the Q measure does not correlate with the intellectual score (TQ) as determined from maze performance. According to him, the main purpose of the score is "to reveal any haphazard, impulsive, or overconfident habits of action, or a tendency to become absorbed in the task of finding the way through the maze as to neglect other considerations." A Σ_Q score is derived by examining maze performance for 8 types of error: (1) Errors in performance in the first third of the maze; (2) Errors in the last third of the maze; (3) Cut corners, which is line crossing at or in the corners; (4) Crossing or touching a line other than in turning a corner; (5) Lifting the pencil; (6) Wavey lines; (7) Changing direction, which in reality is just about, but not quite

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making an error; (8) Errors occurring in Year VII. The first seven types of error are summed with weights as shown in table below, while all errors in Year VII are weighted further and added to produce the total *Q* score.

Pilot work with college *S*s revealed that most of them could solve the mazes but many made *Q* errors while doing so. Capitalizing on this, a group form of the Maze Test was devised, using conventional Vineland Revision Maze blanks. The 8 mazes from Year VII to Adult were clipped together under a cover sheet containing the identification information. Porteus' instructions were modified to allow one trial for each maze and retracing from the point of error. The low number of *TQ* errors made by the sample makes this procedure feasible. This changes the conditions of the original *Q* but extends its usefulness to group work as a personality measure. This change would have a large effect on *TQ* scores, in which 2 trials are given for all mazes through Year XI and 4 trials in Years XII, XIV, and Adult 1. In the original situation, the maze is removed after the first error, but in the group situation *S* corrects his error and goes on. This reduces the information available for evaluation; however, the amount needed does not appear to be great. According to Porteus, the first and second maze performances can be matched and "it has been proved possible to establish an individual pattern of behavior in 80 per cent of individuals on the first and last half to three-quarters of an inch they draw in tracing each Maze" (1959, p. 127). It seems that the signs in maze performance are robust and show up almost independently of the conditions of the administration.

The major question in this study was, are the 8 parts of *Q* suitable for combination into a single score or are there factors underlying this score that may eventually prove even more useful in defining such deviations as delinquency. It is to be recognized that the answer obtained is in terms of a group-administered test and as such does not necessarily generalize to the individually administered performance.

METHOD

The Maze Test was given in the modified form to 5 groups, each composed of 50 freshman and sophomore students in introductory psychology. In all, 90 males and 90 females took both the test and the corollary tests necessary to establish the relationships between verbal ability and *Q*. The total *Q* score was correlated with a verbal ability factor, Educational Testing Service V3 (ETS V3) (French, Ekstrom, & Price, 1963), and the reliability determined for *Q*. The 8 parts of *Q*, dropping out the total score, were intercorrelated, factored and rotated, using the U.C.L.A. Biomedical Varimax procedure. It is recognized that good factorial trait identification requires many more than the 8 scores available with the Porteus *Q*. It should be noted that in this case the major emphasis is within the population defined by the test rather than in the sample universe of traits. Can *Q* be treated as a unifactor rather than multifactor test? A unifactor answer would be conclusive; a multifactor answer suggestive.

Results and Discussion

The total Q scores derived from odd and even mazes were correlated, yielding a split-half r of .82. Diligent search failed to reveal comparable correlations for tests given individually although Fooks and Thomas (1957) report interrater r of .98 with individual administration. The .82 reliability though impressive indicates that there may be room for improvement through the judicious recombining of subscores.

TABLE 1
DESCRIPTION OF THE PORTEUS Q PARTS ($n = 180$)

Score	M	SD	$r_{ETS\ V3}$	Scoring weight
Errors in first third	1.14	1.75	−.05	2
Errors in last third	.29	.59	−.15	1
Cut corners	3.67	4.37	−.13	1
Crossed lines	4.64	5.34	−.02	2
Pencil lifts	8.88	9.36	.04	3
Wavey lines	6.27	4.97	−.19*	2
Changed direction	.97	1.20	−.06	1
Errors in Maze VII	.43	.81	−.02	1
Total Q	26.25	16.89	−.08	

*$p = .05$.

Table 1 shows the Pearson product-moment correlations between the Q subparts and ETS V3 with the associated means and standard deviations. The —.08 correlation between ETS V3, a pure factor verbal test, and Q total score confirms Porteus's contention that Q is not an intellectual function. Only errors in the last third of the maze and wavey lines show significant correlations with ETS V3.

TABLE 2
INTERCORRELATIONS AMONG PORTEUS Q SUBPARTS, WITH PART-WHOLE CORRELATION INCLUDED ($n = 180$)

	1	2	3	4	5	6	7	8
1 Errors in first third	*							
2 Errors in last third	.21							
3 Cut corners	.20	.16						
4 Crossed lines	.11	.08	.51					
5 Pencil lifts	.09	.16	.14	.20				
6 Wavey lines	.02	−.13	.21	.28	.07			
7 Changed direction	.41	.21	.04	.14	.13	.08		
8 Errors in Maze VII	.21	.08	.41	.31	.39	.40	.03	
9 Total	.29	.18	.61	.69	.71	.50	.27	.61
10 Part-whole r corrected	.19	.14	.41	.46	.22	.23	.20	.58

Note.—$r = .16$ at $p_{.05}$; $r = .21$ at $p_{.01}$.
*Unity in the diagonal.

Table 2 shows the Pearsonian intercorrelations among the Maze part scores and the correlation of each part score with the total Q score. The part-whole corrections, following McNemar (1949), are also shown. The major variance in the total test is contributed by the cut-corner and crossed-line dimensions. The category, errors in the last third, yielded an insignificant r with Total score and a negative r with one subpart, indicating that reliability could be improved by elimination of that subpart.

TABLE 3

ROTATED FACTOR MATRIX ($n = 180$)

Subpart	I	II	III	IV	V	h_2
First third	.12	.61	.06	−.01	−.21	.44
Last third	.14	.29	.19	−.29	−.06	.23
Cut corner	.70	.10	.13	.07	−.21	.56
Crossed lines	.67	.10	.15	.18	.15	.54
Pencil lifts	.11	.09	.63	.02	.12	.42
Wavey lines	.22	.02	.10	.62	−.10	.44
Wrong direction	.02	.64	.07	.04	.16	.45
No. VII	.34	.09	.44	.35	−.24	.50
%	.32	.25	.19	.18	.06	

The varimax rotated factor matrix shown in Table 3 represents the structure of Q.

Factor I is a line-crossing factor identified by cut corners and crossed lines. The r between cut corners and crossed lines of .51 and their loading on the same factor probably arises from the arbitrary scoring rule which calls a crossed line occurring at a corner a cut corner. It is suggested that all line crossing without regard to location be called crossed lines. Further, the independence of this factor from other subtests suggests that a weighted subscore made up of these line-crossing characteristics be taken as a separate subscore and so treated.

Factor II is identified by wrong direction and error in the first third of the maze. Since wrong direction is defined as an almost error, it follows that errors and almost errors should be correlated. It is again suggested that errors in the first third and changed direction in the whole test be combined into one subpart and treated separately.

Factor III is identified most clearly by pencil lifts, with a lesser identification with wrong direction. This may be an artifact of the group adminstration because many *S*s seem to make pencil lifts to correct a wrong direction. Experience has shown that in scoring a maze, pencil lifts and pauses are hard to differentiate. It is suggested that pencil lifts and pauses be combined into one category called non-continuous performance, which could be more reliably scored.

Factor IV explains a low 18% of the total variance and can be identified as a wavey-line factor. This dimension is not highly related to the total score and

may be one needing separate analysis. This factor is of theoretical interest because the wavey-line dimension is the only single score found to differentiate between matched groups of delinquents and non-delinquents.

Factor V is a residual, accounting for less than 7% of the variance.

The action of two of the subparts is worthy of consideration. Errors in the last third do not correlate with any factor, show an r of .14 with Total score and show an r of —.13 with errors in the first third. All evidence, including the .23 communality, indicates that this dimension could be eliminated from the Total score. The curious r of —.13 between first and last third errors has implications for the Test Quotient score derived in the other use of the Maze.

The variable, error in Year VII, is designed to reveal those who are so impulsive that they make speed errors on the easy maze. Because it amounts to a penalty point added for any Q error on this maze, it could be expected to correlate with all other types of Q error. The moderate loading of this variable on all factors is a result of the procedure for obtaining Year VII scores.

The structure of the test invites further research with the instrument. It has been shown capable of making distinctions between delinquents and normals. It has been used in drug studies and in research on psycho-surgery (Porteus, 1959). The fact that there is no high part-whole correlation and that no more than two subtests load on one factor leads to testable hypotheses about the efficiency of various subparts in making comparisons between groups.

Further, the present study supports Docter and Winder (1954) and Fooks and Thomas (1957) in their suggestion that the weights used in deriving the Q score add nothing to the Total. The present analysis indicates that the weights may not only be unnecessary but also in the wrong order since they do not equalize the contribution of the part scores to the Total.

The factor structure suggests that combinations of subparts be examined separately, with special attention to the following: (1) line crossing, defined as any point at which S crosses a line—this is a combination of the present line crossing and cut corners; (2) pencil lifting; (3) wavey lines; and (4) a category in which all errors in the first third are scored and summed with the category of changed direction.

The importance of continued investigation of tests like the Porteus Q and the IES Arrow-Dot subtest (Dombrose & Slobin), also used to differentiate delinquents from normals, extends beyond the current use of these measures. These measures base the evaluation of the individual upon more than his interpretation of questions and his insight into the methods of psychologists. The instructions for these instruments elicit maximum performance from the individual while avoiding the distortion of performance into the socially desirable direction. Offshoots from this class of instrument may help refine personality measurement, with performance based measures sampling behavior domains as the intelligence tests sample actual behavioral performance.

Research is continuing in an attempt to determine whether the suggested part scores are more efficient in discriminating between reformatory inmates and outside groups than are the present Total Q scores.

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