Factor Analysis of Clerical Aptitude Tests

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This exploratory study of clerical aptitudes was undertaken for the principal purpose of discovering the structure of clerical aptitudes. The clerical field embraces a large group of occupations, and consequently the measurement of clerical aptitudes has received intense study. This is fortunate, since tests to help in the estimation of success in these occupations are among the most necessary aids in employment work.

Although there are many different kinds of clerical jobs, it seems plausible that most of these jobs are related in various ways. Other workers have attempted to describe these relationships in terms of basic or primary abilities (**1, 2, 4, 6**). However, it seems that much remains to be done in the way of describing the dynamic character of clerical aptitudes and in evaluating the tests that measure them.

This present study, then, is concerned with the application of factor analysis techniques to clerical aptitude test data. A carefully planned analysis of representative clerical aptitude tests should be worthwhile both from the standpoint of test evaluation and of test construction.

Procedure

A battery of seventeen clerical aptitude tests, and one general intelligence test were given to a homogeneous group of 194 high school commercial students.

A description of the tests selected and the particular subsections used are given below. The Psychological Corporation has published a report which describes these tests, with the exception of Tests 9 and 18, in more detail (**3**). Some of the tests were not presented in their entirety. Obviously, this may have had some influence on the reliabilities of these particular tests. However, it seemed justifiable to include only specific subsections of particular tests in order to permit the use of a greater variety of tests in the battery.

1. *Number Comparison:* This is Test 1 from the Minnesota Clerical Test. It consists of pairs of numbers which are to be compared for similarities or differences.
2. *Name Comparison:* This is Test 2 from the Minnesota Clerical Test. This test requires the examinee to compare names for similarities or differences.
3. *Number Checking:* This is Test 1 from the Test of Clerical Competence. The examinee is to verify typewritten numbers against handwritten numbers. The numbers are not placed exactly opposite each other as in the Minnesota Clerical Test.
4. *Name and Address Checking:* This is Test 2 from the Test of Clerical Competence. The examinee is to check handwritten names and addresses against others that are typed. Again the pairs do not lie exactly opposite each other.
5. *Number Checking:* This is Part 2, sections 1, 2, and 3, of the Clerical Aptitude Test. The examinee has to check the smallest number in section 1, the second largest in section 2, and second smallest in section 3.
6. *Number Checking:* This is Part 2, section 4 of the Clerical Aptitude Test. The subject checks pairs of numbers that are the same or different. This test seems to be remarkably similar to the Minnesota Number Checking Test.
7. *Speed of Writing:* This is Test 1 from the ERC Stenographic Aptitude Test. The examinee must copy legibly the Gettysburg Address from a printed copy.
8. *Word Discrimination:* This is Test 2 from the ERC Stenographic Aptitude Test. The examinee is required to choose the correct homonym which best completes a sentence.
9. *Copying Numbers:* This is Test 3 from the IER General Clerical Test. The examinee copies numbers from one side of the page to another.
10. *Copying:* This is Test 4 from the NIIP Clerical Test (American Revision). A series of names, initials and numbers are to be copied exactly from one column to another.
11. *Checking Copy:* This is Part I from the General Clerical Test. The examinee is required to check the accuracy of copy at the bottom of a page with the original at the top.
12. *Spelling:* This is Part VI from the General Clerical Test. The examinee is to rewrite incorrectly spelled words.
13. *Alphabetical Filing:* This is Part II from the General Clerical Test. The examinee is

to locate names alphabetically in a pictorial representation of a file drawer.

14. *Filing:* This is Test 6 from the NIIP Clerical Test (American Revision). The examinee files a group of numbers and names. The names are to be arranged alphabetically.

15. *Classification:* This is Test 2 from the NIIP Clerical Test (American Revision). The examinee is to arrange under the proper heading such items as postage stamps, coal, groceries, etc.

16. *Business Classification:* This is Test 3 from the Test of Clerical Competence. The examinee sorts letters for referral to different industrial departments.

17. *Arithmetic:* This is Part 3 from the Detroit Clerical Aptitude Examination. The examinee is to solve simple arithmetical computation problems.

18. *Otis S-A Tests of Mental Ability:* This is the Higher Examination form of this test. The examinee is required to solve general mental ability problems designed for high school and college freshmen students. This test becomes variable 36 in the correlation matrix and in Table 2.

Thirty-six test variables were obtained from this battery, since it was decided to include the "error" scores on the seventeen clerical tests as separate variables in addition to the "correct" answer scores. This was done in order to give some clues to the organization of error scores and to see if they tended to cluster on one factor. *Age* was also included as an original variable. Product moment correlations were then computed from these scores. It was found, however, that the correlations of *age* and *errors in speed of writing* with the other variables were not significant at the 5 per cent level of confidence; therefore, they were dropped from the correlation matrix.

Table 2 presents the correlation matrix of the thirty-six variables.[1] It was subjected to Thurstone's method of centroid or multiple factor analysis (5). Thurstone's method was used because of the greater flexibility and more consistent and psychologically significant factors that could be obtained. Three significant factors were extracted from the original correlation matrix. These three factors then were rotated into a satisfactory approximation of a simple structure. The factor loadings for the variables after rotation are given in Table 2.

[1] To reduce printing costs Table 1 has been deposited with the American Documentation Institute. Order Document 3180 from American Documentation Institute, 1719 N Street, N.W., Washington 6, D. C., remitting $1.00 for microfilm (images 1 inch high on standard 35 mm. motion picture film) or $1.00 for photocopies (6 × 8 inches) readable without optical aid.

Results

Interpretation of the factors in this study seems to have led to a fairly satisfactory identification of all three. A loading of .40 is regarded as significant.

It is evident from Table 2 that factor I has the two highest loadings on clerical tests where accuracy in perceiving comparisons between names and numbers, and not motor speed, pays the premium in good scores. The highest loading is on Test 5 which requires the ability to perceive the smallest, the second largest, and the second smallest numbers in a series. Test 5 also has zero loadings on factors II and III which means it has significance only for factor I. Test 11 has nearly as high a loading as Test 5. It requires the ability to perceive errors in copy at the bottom of a page when comparing it with a corresponding line of the original at the top. Both of the tests include more of a perceptual span in observing and comparing than any of the other tests. Test 10 is very similar to Test 11 in that accuracy is needed in copying names, numbers, and letters in the proper spaces from one side of a page to another. Tests 1, 2, and 3 demand accuracy in the perception of similarities or differences of numbers and names when they appear opposite or nearly opposite each other. Tests 13, 16, and 36 contain items that require ability to make visual discriminations. Since most of the "error" scores have negative loadings on this factor, accuracy in all the above discriminations seems very essential. The "error" score negative loadings were on the same tests that had positive loadings for the "correct" answers. This means that the "error" scores mainly corroborated the speculation as to the factors, rather than revealed any new concepts concerning the structure of "error" scores.

On the other hand, the zero side of the ledger contains the test which consists primarily of motor speed, Test 7. Another test with a fairly low loading is Test 9, copying

Table 2

The Rotated Factor Matrix: F_r

Variable Number and Description	Perceptual Analysis Factor I	Speed Factor II	Comprehension of Verbal Relationships Factor III	Communality h^2
1. Number Comparison	.43	.78	.12	.81
2. Name Comparison	.43	.60	.43	.72
3. Number Checking	.46	.70	.24	.75
4. Name and Address Checking	.34	.62	.44	.64
5. Number Checking (rank order)	.73	.00	.00	.53
6. Number Checking (comparison)	.32	.37	−.05	.24
7. Speed of Writing	.07	.65	.00	.43
8. Word Discrimination	.31	−.05	.67	.55
9. Copying Numbers	.27	.44	.43	.45
10. Copying	.48	.55	.17	.56
11. Checking Copy	.65	.38	.23	.61
12. Spelling	.40	.35	.59	.63
13. Alphabetical Filing	.44	.44	.43	.57
14. Filing	.42	.18	.43	.40
15. Classification	.35	.21	.54	.46
16. Business Classification	.44	.00	.48	.43
17. Arithmetic	.34	.33	.39	.38
18. Errors in Number 1	−.42	.31	.05	.28
19. Errors in Number 2	−.49	.14	.04	.26
20. Errors in Number 3	−.29	.20	.21	.17
21. Errors in Number 4	−.39	.01	.18	.19
22. Errors in Number 5	−.67	.05	−.07	.46
23. Errors in Number 6	−.44	.05	.08	.21
24. Errors in Number 7	Not included in original factor matrix			
25. Errors in Number 8	−.26	.35	−.51	.45
26. Errors in Number 9	−.33	.02	−.26	.18
27. Errors in Number 10	−.26	.04	−.10	.08
28. Errors in Number 11	−.33	.28	.03	.19
29. Errors in Number 12	−.31	.10	−.49	.34
30. Errors in Number 13	−.17	.05	−.22	.08
31. Errors in Number 14	−.24	.24	−.36	.24
32. Errors in Number 15	−.07	.27	−.28	.15
33. Errors in Number 16	−.33	.44	−.25	.36
34. Errors in Number 17	−.53	.11	.01	.29
35. Age	Not included in original factor matrix			
36. Mental Ability (Otis Higher Level)	.44	−.08	.57	.52

numbers, which again requires a great deal of speed for a high score. In light of the foregoing, factor I can be described as *Perceptual Analysis*, with span and accuracy playing major parts, and speed of movement playing an almost vanishing role. Factor I accounts for 17 per cent of the total variance.

As evidenced from Table 2, the six highest loadings for factor II are on tests which appear related to speed. Test 7 seems to be almost a pure test of speed. Tests 1, 2, 3, 4, and 10 can certainly be viewed as tasks in which speed would be a distinct asset.

Variable 33, errors in Business Classification, although it consists of the "error" scores on the test, is positively weighted on this factor. This would seem to indicate that those subjects who indiscriminately rushed through this

test made the better showing on this factor. Further corroboration seems to be furnished by the tests revealing zero loadings. These are 5, 8, 16, and 36. It seems within reason that these tests are ones in which speed per se is not required; and, in fact, would be actually detrimental for subjects who were freshmen and sophomores in high school. That is, the more quickly they would rush through the selection of the answers on these tests, the more prone they would be to overlook clues that would lead to the correct answers. This in turn would lead to either zero or negative loadings. The absence of negative loadings for the "error" variables seems to indicate that accuracy was not important on this factor. We must conclude, then, that factor II seems almost certainly to be one dealing with *Speed*, particularly in making simple discriminations. Factor II accounts for 14 per cent of the total variance.

It appears from Table 2 that factor III is also overdetermined. The two highest factor loadings are on tests that demand a high degree of verbal ability, 8 and 12. Tests 15, 16, and 36 all contain items that require verbal comprehension. Tests 2, 4, and 13 involve verbal material, although they do not require the complexity of interpretation demanded in the above mentioned tests. The only two tests that are not concerned with verbal items are Tests 9 and 14. Both of these seem to include the factor of immediate memory and the grasping of relationships. On the low side of the ledger, Tests 5 and 7 show negligible loadings which indicates that factor III does not require much in the way of speed and perceptual analysis.

The only negative loadings, on variables 25 and 31, seem to point up the verbal aspect of this factor, since these negative loadings resulted from the "error" scores of the word comprehension and the spelling tests. However, the significant loadings on two tests containing number material seem to indicate something in addition to verbal ability. One logical interpretation is that the factor could be tentatively identified as *Comprehension of Relationships*, with verbal ability assuming a more important role. It would seem that the presence of this factor would be increasingly more significant for the performance of more complex clerical job functions. The third factor accounts for 11 per cent of the total variance.

A final comment on the total variance of the three factors seems indicated since they account for only 41 per cent of the total variance. The ability required by this particular battery must be somewhat more in unique rather than in common factor space. Over half of the variance of the battery needs to be explained further on the basis of unique and unrelated components.

Although the inclusion of the "error" scores did not reveal any new factors, they did aid in the identification of the factors found in the present study and therefore probably should be included routinely in the matrices.

Summary and Conclusions

Results of this investigation suggest several considerations.

1. The intercorrelations among the various tests, all of which purport to measure clerical aptitudes, cannot be adequately accounted for by postulating a single general factor of clerical ability. It would seem that there are several different components influencing performance on these seemingly similar kinds of tests.

2. Since only 41 per cent of the total variance was accounted for by these three factors, there may be other factors that would account for scores made on the general clerical aptitude tests. If further tests of types similar to those that have low loadings on all three factors had been added, it is probable that additional identified factors would show up.

3. The Minnesota Clerical Test, which involves checking pairs of numbers and names for similarities and differences, seems to be related positively to more general types of clerical aptitude tests than any other tests included in the battery. This test accounted for more variance than any other and was found to have high loadings on all three factors. This seems to corroborate the results of Andrew (1), who found the Minnesota test to be more significant in measuring clerical aptitudes than any other test used in her battery.

4. The present study was limited to an analysis of the factors present in commonly used clerical aptitude tests. Naturally, factors other than basic aptitudes, such as social effectiveness, interest in the work, co-operativeness, etc., might also enter into actual clerical job success.

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