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Appendix E: Ability Scores

by Albert E. Beaton

The members of the NBER-TH sample were tested in 1943 on a battery of 18 tests: Reading Comprehension, Mechanical Principles, Dial and Table Reading, Spatial Orientation I, Spatial Orientation II, Numerical Operations, Speed of Identification, General Information—Navigator, General Information—Pilot, Mathematics A, Mathematics B, Rotary Pursuit, Divided Attention, Two-Hand Coordination, Complex Coordination, Aiming Stress, Discrimination Reaction Time, and Finger Dexterity. For a description of the tests see Thorndike & Hagen (1959). These tests constitute a battery of the type of tests usually used for measuring aptitude for college admission plus other tests more specific to the role of Air Force pilot or navigator.

We wished to form a single measure of ability that would include as much information as possible from these tests. This is not to argue that ability is a single trait, but merely to devise a general index which is a composite of a number of different abilities. Any such composite obviously loses some of the information captured by the test scores.

To form the composite, we first computed a correlation matrix of the 18 tests and factor-analyzed the matrix using principal-components analysis with varimax rotation. The factor analysis indicated that the scholastic-type tests form one large factor, whereas the other tests fragmented into several small factors.

We then performed a principal-components analysis of the scholastic-type tests to form a single ability factor. The tests included were Reading Comprehension, Dial and Table Reading, Spatial Orientation I, Spatial Orientation II, Numerical Operations, Speed of Identification, and the Mathematics A and B tests. Because the Reading Comprehension test had a low floor—i.e., very low scores were impossible—a dummy variable was added

TABLE E-1
Factor analysis
and ability
measures*

Panel A: Means and standard deviations

<i>Variable</i>	<i>Mean</i>	<i>Standard deviations</i>
<i>Reading Comprehension</i>	22.6404	11.7236
<i>Reading dummy</i>	0.9841	0.1250
<i>Dial and Table Reading</i>	35.7257	8.8158
<i>Spatial Orientation I</i>	21.0812	6.4968
<i>Spatial Orientation II</i>	28.2426	5.5544
<i>Numerical Operations</i>	72.4753	22.1561
<i>Speed of Identification</i>	33.6293	7.0941
<i>Mathematics B</i>	16.2734	9.8541
<i>Mathematics A</i>	25.1058	17.0936

Panel C: Correlation coefficients

	<i>Reading Comprehension</i>	<i>Reading dummy</i>	<i>Dial and Table Reading</i>	<i>Spatial Orientation I</i>
<i>Reading Comprehension</i>	1.0000	0.2452	0.2962	0.2506
<i>Reading dummy</i>	0.2452	1.0000	0.0750	0.0580
<i>Dial and Table Reading</i>	0.2962	0.0750	1.0000	0.2758
<i>Spatial Orientation I</i>	0.2506	0.0580	0.2758	1.0000
<i>Spatial Orientation II</i>	0.1334	0.0400	0.3732	0.4006
<i>Numerical Operations</i>	0.1365	0.0200	0.5293	0.0451
<i>Speed of Identification</i>	0.1154	0.0512	0.2670	0.3523
<i>Mathematics B</i>	0.4999	0.1017	0.4492	0.1699
<i>Mathematics A</i>	0.4343	0.0994	0.4366	0.1916

Panel D: Factor loadings for first three factors

<i>Principal components</i>	<i>I</i>	<i>II</i>	<i>III</i>
<i>Reading Comprehension</i>	0.6011	0.2642	-0.4947
<i>Reading dummy</i>	0.2040	0.1188	-0.7088
<i>Dial and Table Reading</i>	0.7578	-0.0042	0.2585
<i>Spatial Orientation I</i>	0.4847	-0.5263	-0.2562
<i>Spatial Orientation II</i>	0.5424	-0.5960	0.0879
<i>Numerical Operations</i>	0.6152	0.2255	0.5051
<i>Speed of Identification</i>	0.4377	-0.6504	-0.0161
<i>Mathematics B</i>	0.7263	0.4359	0.0090
<i>Mathematics A</i>	0.7268	0.3135	0.0169

*The number of observations is 4,349.

Panel B: Latent roots

<i>Index</i>	<i>Root</i>	<i>Percent</i>
1	3.1319	34.80
2	1.4783	51.22
3	1.1430	63.92
4	0.8529	73.40
5	0.6041	80.11
6	0.5190	85.88
7	0.4872	91.29
8	0.4225	95.99
9	0.3611	100.00

<i>Spatial Orientation II</i>	<i>Numerical Opera- tions</i>	<i>Speed of Identi- fication</i>	<i>Mathe- matics B</i>	<i>Mathe- matics A</i>
0.1334	0.1365	0.1154	0.4999	0.4343
0.0400	0.0200	0.0512	0.1017	0.0994
0.3732	0.5293	0.2670	0.4492	0.4366
0.4006	0.0451	0.3523	0.1699	0.1916
1.0000	0.2285	0.4474	0.1380	0.2124
0.2285	1.0000	0.1386	0.4500	0.4005
0.4474	0.1386	1.0000	0.0701	0.1395
0.1380	0.4500	0.0701	1.0000	0.5806
0.2124	0.4005	0.1395	0.5806	1.0000

such that a value of 1 was given to each person who did not score at the lowest possible level, and a score of 0 was attributed otherwise.

The results of this analysis are shown in Table E-1. The first panel of the table shows the means and standard deviations; the next presents the latent roots to indicate the relative size of the factors; and the third section contains the correlation coefficients. The factor loadings for the first three factors are shown in the remainder of the table.

The first factor accounts for nearly 35 percent of the variance of these tests. The factor loadings are high (>0.4) for all variables except the reading dummy variable. These loadings were used to compute the general-ability score.

The second factor is also interpretable as a contrast between the two mathematics tests against the spatial tests and the speed of identification test. The third factor is a contrast between the Numerical Operations and the Reading Comprehension tests.

Reference

Thorndike, Robert L., and Elizabeth P. Hagen: *Ten Thousand Careers*, John Wiley & Sons, Inc., New York, 1959.