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# *Appendix B: Mental- Ability Tests and Factors*

*by Paul Taubman and Terence Wales*

The 17 tests used in obtaining the four factors discussed in the text are listed in Table B-1. A brief description of the tests appears in Thorndike and Hagen (1959, pp. 9-11), and a detailed discussion can be found through the entire book. From the titles and descriptions, it is clear that many of the tests measure different facets of the same ability. Rather than use all the tests or any arbitrary

**TABLE B-1** *Factor loadings*

<i>Ability test</i>	<i>Factor loading</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>Reading Comprehension</i>	0.4123	0.0700	0.7186	0.0136
<i>Mechanical Principles</i>	0.0149	0.3522	0.7210	0.0247
<i>Dial and Table Reading</i>	0.6990	0.2566	-0.0129	0.3260
<i>Spatial Orientation II</i>	0.0658	0.1042	0.3117	0.6420
<i>Spatial Orientation I</i>	0.2217	0.1379	0.0311	0.7642
<i>Numerical Operations I &amp; II</i>	0.7822	0.0597	-0.2183	0.1030
<i>Speed of Identification</i>	0.0500	0.1008	0.0643	0.7831
<i>General Information—Navigator</i>	0.4842	-0.1199	0.5605	0.1495
<i>General Information—Pilot</i>	-0.0811	0.0329	0.5874	0.3567
<i>Mathematics B</i>	0.7444	-0.0104	0.3514	-0.0717
<i>Mathematics A</i>	0.7464	-0.0469	0.3060	0.0571
<i>Rotary Pursuit</i>	-0.0304	0.6772	0.0453	0.0396
<i>Two-Hand Coordination</i>	-0.0385	0.6870	0.2703	0.0572
<i>Complex Coordination</i>	0.1251	0.7026	0.1877	0.2028
<i>Aiming Stress</i>	-0.0111	0.4128	0.0009	0.0093
<i>Discrimination Reaction Time</i>	0.3891	0.3800	0.0940	0.2636
<i>Finger Dexterity</i>	0.1974	0.5438	-0.1664	0.1253

SOURCE: All data in this table are from NBER-Thorndike sample.

subset, we used factor analysis to obtain measures of a few types of ability.

The basic idea in factor analysis is that any test contains information on one or more general abilities and on test-specific components. That is:

$$F = SC + u$$

where  $S$  is the set of scores,  $F$  represents the set of general abilities, and  $u$  is the test-specific components. Using the scores in each of the tests, it is possible to estimate  $C$  by imposing certain conditions on  $u$ . Estimates of the  $F$  can then be found from  $SC$  where the  $C$  are known as the factor loadings. Each  $F$  is, of course, just a weighted average of the test scores.<sup>1</sup> In some instances, however, the major weights in each average are attached to items that measure one type of attribute. The factor is then labeled by this attribute.

For the test scores in the NBER-TH data, the factor loadings for the four factors are given in Table B-1. Consider, first, the second factor, in which Rotary Pursuit, Two-Hand Coordination, and Complex Coordination all have loadings in excess of 0.65. In addition, Finger Dexterity, Aiming Stress, Discrimination Reaction, and Mechanical Principles have weights in the range of 0.35 to 0.54. The common element in all tests is coordination; consequently, we refer to this as the *complex coordination factor*. For the fourth factor the only important tests are Speed of Identification and Spatial Orientation I and II. Given the description of the Speed of Identification test, it seems clear that the fourth factor measures spatial perception and perhaps abstract reasoning.

Both these factors are easy to interpret or identify, whereas the first and third are somewhat more difficult. In the first factor the most important items with loadings of at least 0.69 are Numerical Operations, Mathematics A and B, and Dial and Table Reading, all of which are concerned with mathematics and quantitative skills. Unfortunately, secondary but still important weights (0.49 to 0.39) are accorded to Navigator—General Information, Reading Comprehension, and Discrimination Reaction Time. Although the navigator test emphasizes mathematical material, the other two

<sup>1</sup> Because the original test scores are standardized and then manipulated as correlation, all weights have to lie between plus and minus 1. The importance of each test in a factor is indicated by the absolute size of its loading coefficient.

**TABLE B-2**  
**Regression**  
**coefficients and**  
**t-values**  
**(Entire sample)**

Variable	1955		1969	
	Coefficient	t-value	Coefficient	t-value
<i>Intercept</i>	229	3.6	1356	4.4
<i>Some college</i>	54	4.1	193	4.3
<i>B.A.</i>	58	4.4	341	7.5
<i>Some graduate</i>	75	3.4	287	3.9
<i>M.A.</i>	51	2.5	351	5.1
<i>Ph.D.</i>	61	2.6	670	9.6
<i>M.D.</i>	300	6.9	494	3.8
<i>Teacher</i>	-162	7.3	-496	6.1
<i>Age (years)</i>	8	4.1	-2	.3
<i>Ability 2</i>	23	1.5	69	1.3
<i>Ability 3</i>	33	2.2	107	2.1
<i>Ability 4</i>	50	3.4	144	2.9
<i>Ability 5</i>	84	5.7	279	5.5
<i>Health</i>	-33	4.4	-205	7.8
<i>Single</i>	-122	3.7	-237	2.2
<i>Father, high school</i>	26	2.5	108	3.1
<i>Father, college</i>	21	1.7	97	2.2
<i>Biography 2</i>	0.7	0.1	119	2.4
<i>Biography 3</i>	30	2.0	92	1.8
<i>Biography 4</i>	63	4.3	167	3.4
<i>Biography 5</i>	81	5.6	206	4.2
$R^2$	.10		.11	
<i>Observations</i>	3,500		3,700	

NOTE: The dependent variable is monthly earnings in dollars. Education variables are zero-one dummies.

Ability  $i$  = value of 1 if individual is in  $i$ th mental-ability fifth and 0 otherwise.

Health = 1 if excellent, 2 if good, 3 if fair, and 4 if poor.

Single = value of 1 if individual is single and 0 otherwise.

Father, h.s. = value of 1 if father attended high school and 0 otherwise.

Father, college = value of 1 if father attended college and 0 otherwise.

Biography  $i$  = value of 1 if individual is in  $i$ th biography fifth and 0 otherwise.

SOURCE: NBER-Thorndike sample.

items do not; nevertheless, we treat this as a mathematical-ability test.

In the third factor, Reading Comprehension and Mechanical Principles have loadings in excess of 0.7; General Information—Pilot and General Information—Navigator have loadings of about

TABLE B-3 Regression coefficients and t-values by occupation, 1969

Variable	Professional, sales, and technical		Managers and owners		Blue-collar, white- collar, and service	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	877	2.0	1781	3.6	866	4.6
Some college	86	1.1	95	1.2	32	1.5
B.A.	245	3.0	203	2.6	94	2.6
Some graduate	77	.7	180	1.5	158	1.8
M.A.	128	1.3	259	2.3		
Ph.D.	446	4.0	347	1.6		
M.D.	904	7.8				
LL.B.	584	5.8	66	2.0		
Teacher	-198	2.4				
Age (years)	6	.6	-2	.2	-3	.1
Ability 2	103	1.5	30	.3	19	.7
Ability 3	110	1.6	23	.3	5	.2
Ability 4	130	1.9	90	1.0	55	2.0
Ability 5	30	4.4	225	2.6	30	.1
Health	-157	4.6	-257	5.6	-23	1.5
Single	-259	2.1	118	.5	-98	1.5
Father, high school	88	1.9	92	1.6	20	.9
Father, college	-84	1.5	157	2.2	-2	.1
Biography 2	105	1.6	91	1.1	-6	.2
Biography 3	48	.7	54	.6	43	1.4
Biography 4	40	.6	204	2.4	31	1.0
Biography 5	145	2.2	200	2.3	3	.1
Technical	82	1.1				
Sales	71	1.1				
Service					-46	1.9
White collar					-103	3.4
R <sup>2</sup>	.21		.05		.04	
Observations	728		1085		208	

NOTE: See Table B-2 for an explanation of terms.

0.5; mathematics B and mathematics A have loadings of 0.35 and 0.30, respectively; and Spatial Orientation II has a loading of 0.31. In general, these tests encompass verbal ability, mathematical skills, reasoning, and mechanical principles. Since the first three items would be found in standard IQ tests, we have chosen to call

this third factor *IQ*. However, it is important to note that Professor Thorndike believes that the first factor would correlate much more closely with *IQ* and should be named as such, while the third tends toward mechanical principles. The reader should keep this caveat in mind when examining our remarks about the importance of the different types of ability and when comparing the NBER-TH results with those of Wolfle-Smith.

*Reference*

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

