

## **Mental Ability – Uni or Multidimensional? An Analysis of Effects**

David Epstein  
Law School  
University of Michigan

Christopher Winship  
Department of Sociology  
Harvard University

### **Supplementary Appendix**

#### **The Armed Services Vocational Aptitude Battery.**

The ASVAB is a mental ability test given to all potential entrants to the Armed Services. It consists of ten subtests: Paragraph Comprehension, Word Knowledge, Arithmetic Reasoning, Mathematical Knowledge, Numerical Operations, Coding Speed, General Science, Automotive and Shop Information, Mechanical Comprehension, and Electronics Information. An important subcomponent of the ASBVAB is what is known as Armed Services Qualifying Test (AFQT), which consists of the first four items above in the ASVAB: Arithmetic Reasoning, Mathematics Knowledge, Paragraph Comprehension and Word Knowledge. The AFQT is generally considered a high quality intelligence test.

In late 1970's, the Department of Defense decided to renorm the ASVAB on a national sample. In 1980 ASVAB was given to the sample of youth, ages 15 to 21 in the Department of Labor's National Longitudinal Survey of Youth (NLSY). The NLSY is described in more detail in the Methods Section. Professor R. Darrell Bock at the University of Chicago was hired to use the NLSY to renorm the ASBAB.

R. Darrell Bock and Elsie G.J. Moore carry out an extensive analysis of the ASVAB in their 1986 book *Advantage and Disadvantage: A Profile of American Youth*. Using exploratory factor analysis, they estimate a maximum likelihood factor solution based on promax rotation. They conclude that four factors are needed to explain performance on the ten ASVAB subtests.

“Factor 1 is clearly the ever-present verbal attainment factor with large loadings for the Word Knowledge and Paragraph Comprehension tests, some loading of the General Science test, and a still smaller loading on Electronics Information. Factor 2 is the familiar fluent production factor typically seen in such speeded tests as Numerical Operations and Coding Speed.... Factor 3 is clearly a quantitative attainment factor with dominant loadings on Arithmetic Reasoning and Mathematics Knowledge. Mechanical Comprehension also makes a small contribution to this factor. Factor 4 represents special technical knowledge covered by the General Science, Mechanical Comprehension, Electronics Information, and Auto and Shop Information” (Bock and Moore 200).

Bock and Moore note that verbal ability and fluent production are two of the three factors found in most cognitive tests (Bock and Moore 200). Spatial visualizing ability, the third factor commonly found in cognitive tests, is not present in the ASVAB, though Bock and Moore note that it “may be reflected to some extent in the Mechanical Comprehension and Arithmetic Reasoning tests” (Bock and Moore 200). It is not altogether surprising

that the ASVAB does not directly mirror other cognitive tests, as it is designed as a vocational aptitude battery and not simply a cognitive battery.

### **Total Effects of Different Components of Mental Ability**

In this appendix we examine on the decomposition of total effects for different components of mental ability for our three economic outcomes. We have chosen not to examine other factors because the effects of the different components of mental are generally small and in many cases inconsistent.

The effects in the models in Tables 10.4 through 10.6 are decomposed into direct, indirect, and total effects in Tables S4 through S6 here. We discuss Table S4 first, which provides the decomposition for log wage. In the AFQT model 87.4% of the total effect of g on log wage is direct. In the Bock and Moore model the picture is more complicated. The effect of Quantitative ability is approximately half direct and half indirect. Fluent Production's effect is totally direct as is the case for Technical Knowledge. For Fluent Production, Verbal Ability, and Technical Knowledge, the direct effect is over 100 percent because the direct and indirect effects are of opposite sign. In the New Model results are quite similar, except for the technical knowledge factors. Here General Science's effect is approximately two-thirds direct and one-third indirect. For the other three factors the total effect is either entirely or nearly due to their direct effect.

Table S5 provides an analogous set of decompositions for log income. In the AFQT model, as for log wage, the effect of g is overwhelming direct. In the Bock and Moore and New Models the effect of Quantitative ability is even more disproportionately indirect and Fluent Production's effect is totally direct. As with log wage, in the Bock and Moore model, the effect of Technical Knowledge is entirely direct, but in the New Model the effect of General Science is approximately half direct and half indirect and the effect of Auto and Shop Information and Electronics Information are entirely direct.

The decompositions for poverty found in Table S6 are similar for those for log wage and log income. As before, the effect of g in the AFQT model is almost entirely direct. The effect of Quantitative Ability in this case, however, is totally direct. Caution is appropriate here, though, since both the direct and indirect effects are quite small.

Table S1. Means and Standard Deviations

---



---

Type of Variable	Variable	Obs	Mean	Std. Dev.
Individual Tests	zgs	2156	0.599	0.900
	zar	2156	0.544	0.999
	zwk	2156	0.393	0.834
	zpc	2156	0.279	0.894
	zno	2156	0.216	0.890
	zcs	2156	0.071	0.890
	zas	2156	0.898	0.876
	zmk	2156	0.426	1.053
	zmc	2156	0.778	0.940
	zei	2156	0.732	0.896
Educational Outcomes	ed80	1642	0.003	0.984
	pses	2156	0.218	0.893
	ed90	2022	0.072	1.029
	badeg	1996	0.247	0.432
	dropout	1844	0.117	0.321
Labor/Economic Outcomes	hsGED	1169	0.130	0.336
	loginc	1682	10.396	0.709
	logwage	1302	10.170	0.600
	pov	1688	0.052	0.222
	olf	1763	0.100	0.300
	unemp	1466	0.072	0.259
Social Outcomes	jail	2037	0.028	0.165
	wedby30	811	0.736	0.441
	div5	860	0.179	0.384
	lgspin90	817	9.320	1.001

---

Appendix Table S2. Pairwise Correlation Matrix

	zar	zmk	zcs	zno	zpc	zwk	zgs	zas	zei	zmc	zses	zed1980	ed90	pov	logwage	loginc	olf	unemp	jail	wedby30	div5	lgspin90	
zar	1.00																						
zmk	0.82	1.00																					
zcs	0.58	0.59	1.00																				
zno	0.66	0.63	0.69	1.00																			
zpc	0.70	0.66	0.55	0.60	1.00																		
zwk	0.70	0.67	0.53	0.59	0.79	1.00																	
zgs	0.70	0.68	0.49	0.53	0.70	0.80	1.00																
zas	0.47	0.35	0.33	0.34	0.49	0.56	0.59	1.00															
zei	0.63	0.58	0.44	0.47	0.64	0.73	0.74	0.69	1.00														
zmc	0.65	0.57	0.44	0.45	0.60	0.63	0.67	0.69	0.72	1.00													
zses	0.42	0.48	0.34	0.38	0.41	0.46	0.42	0.22	0.34	0.33	1.00												
zed1980	0.44	0.44	0.42	0.39	0.40	0.46	0.44	0.38	0.44	0.37	0.28	1.00											
ed90	0.58	0.67	0.47	0.50	0.54	0.55	0.54	0.17	0.40	0.37	0.54	0.47	1.00										
pov	-0.18	-0.17	-0.16	-0.22	-0.20	-0.20	-0.18	-0.13	-0.16	-0.15	-0.14	-0.11	-0.18	1.00									
logwage	0.31	0.32	0.30	0.33	0.26	0.27	0.26	0.20	0.25	0.23	0.24	0.31	0.29	-0.40	1.00								
loginc	0.31	0.30	0.29	0.32	0.25	0.27	0.26	0.17	0.23	0.22	0.24	0.28	0.30	-0.54	0.77	1.00							
olf	-0.10	-0.08	-0.09	-0.09	-0.07	-0.06	-0.07	-0.09	-0.06	-0.08	0.00	-0.08	-0.04	0.24	.	-0.17	1.00						
unemp	-0.13	-0.12	-0.10	-0.11	-0.09	-0.12	-0.10	-0.04	-0.11	-0.08	-0.07	-0.09	-0.10	0.20	.	-0.21	.	1.00					
jail	-0.15	-0.15	-0.12	-0.15	-0.15	-0.15	-0.14	-0.10	-0.11	-0.12	-0.10	-0.14	-0.14	0.20	-0.08	-0.16	0.18	0.04	1.00				
wedby30	0.02	-0.06	0.08	0.09	0.03	-0.04	0.01	0.20	0.08	0.06	-0.06	0.04	-0.13	-0.08	0.19	0.23	-0.15	-0.05	-0.06	1.00			
div5	-0.11	-0.10	-0.11	-0.10	-0.07	-0.07	-0.13	-0.06	-0.09	-0.08	-0.06	-0.12	-0.12	0.06	-0.16	-0.18	0.06	0.08	0.11	.	1.00		
lgspin90	0.11	0.15	0.14	0.12	0.07	0.12	0.08	-0.01	0.04	0.07	0.17	0.09	0.17	-0.23	0.22	0.60	0.00	-0.01	0.02	-0.14	0.06	1.00	

Table S3. Factor Correlations

			Bock & Moore		New Model	
			Correlation	S.E.	Correlation	S.E.
Fluent Production	<-->	Verbal	0.75	(0.013)	0.756	(0.013)
Fluent Production	<-->	Quantitative	0.808	(0.012)	0.811	(0.012)
Quantitative	<-->	Verbal	0.859	(0.008)	0.845	(0.009)
Fluent Production	<-->	Technical Knowledge	0.443	(0.023)		
Quantitative	<-->	Technical Knowledge	0.565	(0.02)		
Verbal	<-->	Technical Knowledge	0.686	(0.017)		
Fluent Production	<-->	GS Factor			0.607	(0.016)
Fluent Production	<-->	AS Factor			0.397	(0.02)
Fluent Production	<-->	EI Factor			0.545	(.017)
Fluent Production	<-->	MC Factor			0.523	(0.018)
Quantitative	<-->	GS Factor			0.761	(0.01)
Quantitative	<-->	AS Factor			0.461	(0.018)
Quantitative	<-->	EI Factor			0.67	(0.013)
Quantitative	<-->	MC Factor			0.677	(0.013)
Verbal	<-->	GS Factor			0.852	(0.008)
Verbal	<-->	AS Factor			0.594	(0.015)
Verbal	<-->	EI Factor			0.777	(0.01)
Verbal	<-->	MC Factor			0.686	(0.013)
GS Factor	<-->	AS Factor			0.589	(0.014)
GS Factor	<-->	EI Factor			0.744	(0.01)
GS Factor	<-->	MC Factor			0.674	(0.012)
AS Factor	<-->	EI Factor			0.689	(0.011)
AS Factor	<-->	MC Factor			0.689	(0.011)
EI Fctor	<-->	MC Factor			0.721	(0.01)

Table S4. Decomposition of logwage

---



---

Model	Predictor	Direct	Indirect	Total	% Direct	% Indirect	% Total
AQFT	zed1980	0	0.081	0.081	0.00	100.00	100.00
	zsas	<b>0.048</b>	0.097	0.145	33.10	66.90	100.00
	g	<b>0.125</b>	0.018	0.143	87.41	12.59	100.00
Bock & Moore	zed1980	0	0.099	0.099	0.00	100.00	100.00
	zsas	<b>0.052</b>	0.0865	0.138	37.68	62.68	100.00
	Quant.	0.033	0.029	0.062	53.23	46.77	100.00
	Fluent	<b>0.155</b>	-0.0041	0.151	102.65	-2.72	100.00
	Verbal	<b>-0.095</b>	0.0168	-0.078	121.79	-21.54	100.00
	Technical	<b>0.078</b>	-0.0234	0.055	141.82	-42.55	100.00
New Model	zed1980	0	0.098	0.098	0.00	100.00	100.00
	zsas	<b>0.053</b>	0.0862	0.139	38.13	62.01	100.00
	Quant.	0.048	0.0252	0.073	65.75	34.52	100.00
	Fluent	<b>0.15</b>	-0.0014	0.149	100.67	-0.94	100.00
	Verbal	<b>-0.094</b>	0.0053	-0.089	105.62	-5.96	100.00
	GS Factor	0.009	0.0046	0.014	64.29	32.86	100.00
	AS Factor	<b>0.059</b>	-0.0121	0.047	125.53	-25.74	100.00
	EI Factor	0.028	-0.0032	0.025	112.00	-12.80	100.00
MC Factor	-0.024	-0.0028	-0.027	88.89	10.37	100.00	

---

Table S5. Decomposition of loginc

Model	Predictor	Direct	Indirect	Total	% Direct	% Indirect	% Total
AFQT	zed1980	0	0.092	0.092	0.00	100.00	100.00
	zses	<b>0.057</b>	0.112	0.169	33.73	66.27	100.00
	g	<b>0.13</b>	0.027	0.157	82.80	17.20	100.00
Bock & Moore Model	zed1980	0	0.111	0.111	0.00	100.00	100.00
	zses	<b>0.059</b>	0.1029	0.162	36.42	63.52	100.00
	Quant.	0.02	0.0372	0.057	35.09	65.26	100.00
	Fluent	<b>0.171</b>	-0.0053	0.166	103.01	-3.19	100.00
	Verbal	-0.08	0.0215	-0.058	137.93	-37.07	100.00
	Technical	<b>0.065</b>	-0.0299	0.035	185.71	-85.43	100.00
New Model	zed1980	0	0.108	0.108	0.00	100.00	100.00
	zses	<b>0.06</b>	0.1033	0.163	36.81	63.37	100.00
	Quant.	0.02	0.035	0.055	36.36	63.64	100.00
	Fluent	<b>0.17</b>	-0.0019	0.168	101.19	-1.13	100.00
	Verbal	-0.073	0.0073	-0.066	110.61	-11.06	100.00
	GS Factor	0.007	0.0064	0.013	53.85	49.23	100.00
	AS Factor	0.034	-0.0168	0.018	188.89	-93.33	100.00
	EI Factor	0.021	-0.0044	0.017	123.53	-25.88	100.00
	MC Factor	0.000	-0.0039	-0.004	0.00	97.50	100.00

Table S6. Decomposition of pov

Model	Predictor	Direct	Indirect	Total	% Direct	% Indirect	% Total
AFQT	zed1980	0	-0.019	-0.019	0.00	100.00	100.00
	zsas	-0.008	-0.0226	-0.0306	26.14	73.86	100.00
	g	<b>-0.0321</b>	-0.0027	-0.0348	92.24	7.76	100.00
Bock & Moore	zed1980	0	-0.024	-0.024	0.00	100.00	100.00
	zsas	-0.007	-0.0227	-0.029	24.14	78.28	100.00
	Quant.	0.025	-0.0048	0.02	125.00	-24.00	100.00
	Fluent	<b>-0.036</b>	0.0006	-0.036	100.00	-1.67	100.00
	Verbal	-0.024	-0.0028	-0.027	88.89	10.37	100.00
	Technical	-0.005	0.0038	-0.001	500.00	-380.00	100.00
New Model	zed1980	0	-0.023	-0.023	0.00	100.00	100.00
	zsas	-0.006	-0.0238	-0.03	20.00	79.33	100.00
	Quant.	0.025	-0.0055	0.02	125.00	-27.50	100.00
	Fluent	<b>-0.034</b>	0.0003	-0.033	103.03	-0.91	100.00
	Verbal	<b>-0.032</b>	-0.0011	-0.033	96.97	3.33	100.00
	GS Factor	0.003	-0.001	0.002	150.00	-50.00	100.00
	AS Factor	-0.006	0.0027	-0.003	200.00	-90.00	100.00
	EI Factor	0.008	0.0007	0.009	88.89	7.78	100.00
	MC Factor	-0.006	0.0006	-0.005	120.00	-12.00	100.00

Table S7. Bock & Moore with Verbal Effect Constrained

	OUTCOMES		
	logwage	loginc	olf
ed90	0.062 (0.024)	0.082 (0.025)	0.004 (0.011)
zsas	0.045 (0.022)	0.054 (0.022)	0.021 (0.010)
Quantitative	-0.015 (0.036)	-0.018 (0.037)	-0.01 (0.016)
Fluent Production	0.145 (0.030)	0.16 (0.031)	-0.021 (0.014)
Verbal	0	0	0
Technical Knowledge	0.04 (0.021)	0.032 (0.021)	-0.012 (0.009)
n	2297	2297	2297
DF	52	52	52
R2	0.167	0.154	0.016
Chi2	511.492	506.045	501.134
IFI	0.987	0.987	0.983
TLI	0.973	0.975	0.967
RMSEA	0.062	0.062	0.061

Table S8. New Model with Verbal Effect Constrained

	OUTCOMES			
	logwage	loginc	olf	unemp
ed90	0.058 (0.024)	0.079 (0.025)	0.004 (0.011)	0.001 (0.010)
zses	0.046 (0.021)	0.055 (0.022)	0.021 (0.010)	0.000 (0.009)
Quantitative	0.024 (0.042)	0.003 (0.044)	-0.02 (0.019)	-0.012 (0.018)
Fluent Production	0.128 (0.031)	0.152 (0.032)	-0.018 (0.014)	-0.014 (0.013)
Verbal	0	0	0	0
GS Factor	-0.023 (0.025)	-0.019 (0.026)	0.003 (0.012)	-0.002 (0.011)
AS Factor	0.052 (0.023)	0.029 (0.024)	-0.023 (0.011)	0.019 (0.010)
EI Factor	0.008 (0.008)	0.005 (0.026)	0.018 (0.011)	-0.02 (0.011)
MC Factor	-0.021 (0.025)	0.002 (0.026)	-0.003 (0.012)	0.001 (0.011)
n	2297	2297	2297	2297
DF	32	32	32	32
R2	0.167	0.153	0.019	0.024
Chi2	359.505	356.820	347.202	348.578
IFI	0.991	0.991	0.988	0.988
TLI	0.969	0.971	0.962	0.962
RMSEA	0.067	0.066	0.065	0.066