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Comparison of Performance on the Shipley Institute of Living Scale, Air Traffic Control Specialist Selection Test, and FAA Academy Screen

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NOTICE

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Current research to evaluate the effects of stressors for Air Traffic Control Specialists (ATCSs) on performance, physiological, biochemical, and subjective responses requires use of non-ATCS subjects in the laboratory. This prompted efforts to find screening measures for selecting non-ATCS research subjects with characteristics similar to the ATCS population. The present study was conducted to establish normative data for ATCSs on a measure of general intelligence using the Shipley Institute of Living Scale (SILS) to supplement screening criteria regarding health, educational level, and work history.

While a broad body of literature exists on selection of ATCSs, limited data have been reported concerning the average IQ of this population. Brokaw (1957) reported data from the California Testing Board Test of Mental Maturity; however, he only reported correlations of the sub-test scores with other aptitude tests. Karson and O'Dell reported data from the intelligence factor on the 16 Personality Factor Test (16PF) for 20,933 ATCSs in 1974. This ATCS group was found to have scores on this measure of intelligence nearly one standard deviation above the general population, or comparable to a Wechsler IQ score of about 115. The 16PF scores on the intelligence factor (B) from a more recent ATCS applicant group (Schroeder and Dollar, 1989) were identical to those of Karson and O'Dell (1974).

For purposes of this study, a relatively short, easily administered global measure of intelligence was required. The Shipley Institute of Living Scale (SILS) was selected because it 1) provides both verbal (vocabulary) and cognitive performance (abstraction) measures of general intelligence functioning; 2) can be administered in a short amount of time to a large group; 3) provides estimated Wechsler Adult Intelligence Scale-Revised (WAIS-R) Full Scale Intelligence scores; 4) has reasonable test-retest reliabilities and validity (Martin, Friedmeyer, Sterne, and Brittain, 1977; Goodman, Streiner, and Woodward, 1974; and Zachary, 1986); 5) has been widely used (Martin, Blair, and Vickers, 1979; Young and Rearden, 1979; and Guilberstadt, Lushene and Buegel, 1976); and 6) has been used previously for subject selection in aviation-related research (Mertens and Collins, 1986). However, no data had been collected on the ATCS population.

Normative data on the SILS was collected on a sample of ATCS students entering the FAA Academy for future reference in selecting non-ATCS research subjects for air traffic control related research. In addition, this provided an opportunity to investigate the relationship between general intelligence, as measured by the SILS, and ATCS selection measures which include the Office of Personnel Management (OPM) Air Traffic Control test battery and the FAA Academy nonradar screen program (NSP).

METHOD

Subjects

Three groups of students (N=563) entering the FAA Academy in September 1990 and in August and October 1991 were used for this study. At that time, ATCS applicants underwent a two stage selection process, (a) administration of the Office of Personnel Management (OPM) Air Traffic Control Specialist Test Battery and (b) participation in the nonradar screen program (NSP), a nine week performance-based screening course at the FAA Academy in Oklahoma City. Students from this sample who withdrew prior to completing the NSP, those who had previously participated in the NSP, and those for whom OPM data were not available, were excluded from the sample. There were 414 of the total 563 students who were included in the final sample. Twenty-nine percent (121) of the final sample were women and 79% (328) were non-minorities. Fifty-nine percent (243) of the final sample reported having completed some college, while 31% (128) reported completing a college degree. The remaining 10% (43) completed high school. The average age of this final sample was 26.1 (age range from 19 to 34). All students in the final sample had successfully completed the first stage of the selection process; that is, they had received a score of 70 or better on the OPM battery.

Thorndike, 1949). To correct for restriction in range, population OPM scores and variance were calculated from data supplied to the Civil Aeromedical Institute by the Office of Personnel Management for persons reporting a date of availability between January 1988 and December 1989 (N=3,484).

RESULTS

Of the 414 ATCS students in final sample, 233 (56.3%) passed the Academy NSP, 181 (43.7%) failed. The average estimated WAIS-R for the group of 414 Academy entrants was 109.8 (sd=5.9). The average Shipley scores for the sample were as follows: Vocabulary 31.4 (sd=3.7); Abstraction 35.7 (sd=3.5); and Total 67.0 (sd=5.9).

TABLE 1. Mean Scores on the SILS by Academy Status

	ACADEMY STATUS			
	Passed (N=233)		Failed (N=181)	
SILS SCORES	**AVE.**	**SD**	**AVE.**	**SD**
Vocabulary	31.9	3.8	31.0	3.5
Abstraction	36.2	3.1	34.9	3.9
Total	68.0	5.8	65.8	5.8
WAIS-R (estimated)	110.8	5.8	108.6	5.7

The first analysis conducted for this study compared the performance of those who passed the Academy and those who failed. Table 1 presents descriptive statistics for scores on the SILS by final Academy Status.

Results of a Multivariate Analysis of Variance comparing SILS scores of passing students to those who failed were significant ($F(4,409)=5.15$, $p<.001$). Analysis of Variance for each measure (df=1,412) revealed that students who passed the Academy scored significantly higher on all SILS measures (Vocabulary $F=6.64$, $p<.01$; Abstraction $F=15.11$, $p<.001$; Total $F=14.17$, $p<.001$; WAIS-R $F=14.58$, $p<.001$).

The second analysis calculated Pearson correlations between SILS and both sets of ATCS selection measures—OPM and NSP. Table 2 presents correlations between OPM and SILS measures. Both unadjusted correlations and correlations adjusted for the restriction in range due to prior selection of subjects by the OPM exam are presented.

TABLE 2. Correlations between SILS and OPM Scores

Unadjusted for Restriction in Range by OPM

	SILS Scores			
OPM TEST MEASURES	**Vocabulary**	**Abstraction**	**Total**	**WAIS-R**
Multiplex Controller Aptitude Test (MCAT)	.13**	.10*	.14**	.13**
Abstract Reasoning (ABSR)	.09	.18**	.17**	.17**
Occupational Knowledge Test (OKT)	.08	.01	.05	.03
OPM Rating	.11*	.08	.12*	.08

Adjusted for Restriction in Range by OPM

	SILS Scores			
OPM TEST MEASURES	**Vocabulary**	**Abstraction**	**Total**	**WAIS-R**
Multiplex Controller Aptitude Test (MCAT)	.33	.26	.36	.33
Abstract Reasoning (ABSR)	.10	.19	.18	.18
Occupational Knowledge Test (OKT)	.07	.01	.04	.03
OPM Rating	.34	.26	.37	.26

*p<.05 **p<.01

TABLE 3. Correlations Between SILS and NSP Performance Measures

Unadjusted for Restriction in Range by OPM

NSP	SILS Scores Vocabulary	Abstraction	Total	WAIS-R
Block Average (BA)	.14**	.19**	.20**	.18**
Comprehensive Course Test (CCT)	.16**	.18**	.21**	.18**
Average 5 of 6 Labs (AVL5)	.09	.23**	.20**	.20**
Controller Skills Test (CST)	.21**	.30**	.30**	.30**
Final Comprehensive Score (COMP)	.14**	.27**	.24**	.24**

** p<.01

Adjusted for Restriction in Range by OPM

NSP	SILS Scores Vocabulary	Abstraction	Total	WAIS-R
Block Average (BA)	.30	.29	.36	.28
Comprehensive Course Test (CCT)	.28	.27	.33	.27
Average 5 of 6 Labs (AVL5)	.27	.33	.36	.30
Controller Skills Test (CST)	.35	.38	.43	.38
Final Comprehensive Score (COMP)	.34	.38	.43	.38

The correlation between scores from SILS Abstraction and the OPM Abstract Reasoning, although statistically significant, was notably low (.18), suggesting the possibility of differences in what each test measures. The highest adjusted correlations were found between all SILS scores and MCAT and OPM Rating.

Table 3 presents correlations between NSP performance measures and SILS scores. Correlations were adjusted for restriction in range of SILS scores due to prior OPM selection utilizing Thorndike's three variable case formula (Thorndike, 1949).

These correlations revealed that the Abstraction scores were somewhat better than the Vocabulary at predicting NSP performance. This was particularly true for the skill-based performance measures, specifically the graded laboratory problems and the Controller Skills Test. Among the SILS measures, the adjusted SILS Total score was the best predictor of NSP performance. Table 4 presents correlations between OPM and NSP scores.

Review of Table 4 reveals that correlations between the SILS Abstraction and NSP measures from Table 3 were notably higher than the correlations between OPM Abstract Reasoning (ABSR) and NSP measures. OPM Rating had the highest adjusted correlations with the skill-based NSP measures. The OKT correlations with NSP performance measures are unusually high in this sample when compared to previous reports (Della Rocco, et al., 1991).

DISCUSSION

The purpose of this study was to administer a relatively short, global measure of intelligence to ATCSs in order to collect normative data and assess the relationship between SILS measures and well-investigated ATCS selection measures. Few studies had reported IQ data for this population and none had been reported for the SILS.

Data were collected from a sample of 414 ATCSs prior to entering the second stage of the ATCS selection process, the Nonradar Screen Program. Of the people who passed, the average estimated WAIS-R scores were found to be 110.8 (sd=6). Thus, as a group, ATCSs tend

TABLE 4. Correlations between OPM Scores and NSP Performance Measures

Unadjusted for Restriction in Range by OPM

NSP	OPM Scores MCAT	ABSR	OKT	Rating
Block Average (BA)	.11*	.12*	.31**	.22**
Comprehensive Course Test (CCT)	.10*	.04	.29**	.16**
Average 5 of 6 Labs (AVL5)	.16**	.14**	.25**	.24**
Controller Skills Test (CST)	.19**	.10*	.23**	.22**
Final Comprehensive Score	.18**	.14**	.28**	.25**

** p<.01

Adjusted for Restriction in Range by OPM

NSP	OPM Scores MCAT	ABSR	OKT	Rating
MCAT ABSR OKT Rating				
Block Average (BA)	.29	.13	.28	.60
Comprehensive Course Test (CCT)	.26	.04	.26	.47
Average 5 of 6 Labs (AVL5)	.40	.15	.22	.63
Controller Skills Test (CST)	.46	.11	.21	.60
Final Comprehensive Score	.44	.15	.25	.55

to be above average in intelligence. This finding is similar to the findings of Karson and O'Dell (1974). The students who passed the NSP were found to have scored significantly higher than unsuccessful students on each of the SILS measures. Correlations between the SILS and ATCS selection measures, OPM and NSP scores respectively, were found to be low to moderate, but similar to correlations found in early work on ATCS selection (Brokaw, 1984). Because of the research leading to the use of an abstract reasoning test in the OPM battery (Collins, Boone, and VanDeventer, 1984), it was anticipated that the Abstraction would be a better predictor of NSP performance than the Vocabulary. This was found to be the case.

Specifically, the Abstraction scores were found to correlate better than Vocabulary scores with the performance-based NSP measures (i.e., the laboratory grades and the Controller Skills Test). Comparison of the adjusted correlations from OPM and NSP scores in Table 4 with those of the SILS and NSP scores from Table 3 suggests that the MCAT and SILS Total were comparable predictors of NSP performance. The OPM Rating was the best predictor of NSP performance. Although MCAT and OPM Rating would be desirable for use in selection of subjects in our ATCS stressor studies, they are controlled tests and not available outside the ATCS selection process.

The correlation between SILS Abstraction and the abstract reasoning test on the OPM battery was found to be only .18. Even though this was significant, it would suggest that the tests measured different aptitudes or abilities. A closer examination of the OPM test reveals that it measures nonverbal reasoning, while the SILS is more of a verbal reasoning measure.

The average age of the sample was relatively young (26) because of the maximum age restriction of age 30 for initial entry into the ATCS occupation. Research indicates that age is positively related to vocabulary scores and negatively related to abstraction (Zachary, 1986). Zachary also reports that abstract thinking declines in older adults while vocabulary scores generally increase during the formative adult years and remain virtually unchanged into old age. For purposes of matching non-ATCS research subjects to ATCSs on intelligence, caution is advised when generalizing these findings to older subjects because of the restricted range of age of participants in this study.

The data derived from this study provided normative data for use of the SILS as a screening tool for non-ATCS subjects in air traffic related research. Because of the prior selection of this sample on the OPM and the restricted age range, generalization of these data to the ATCS population, to selecting older subjects, and to selecting subjects from different cultural groups requires additional research.

REFERENCES

Boone, J.O. and Lewis, M.A. (1978). The Development of the ATC Selection Battery: A New Procedure to Make Maximum use of Available Information when Correcting Correlations for Restriction in Range due to Selection. Federal Aviation Administration, Office of Aviation Medicine, Washington, DC: DOT/FAA/AM-78-36.

Brokaw, L.D. (1957). Selection Measures for Air Traffic Control Training. Lackland Air Force Base, Air Force Personnel and Training Research Center: Technical Memorandum PL-TM-57-14.

Brokaw, L.D. (1984). Early Research on Controller Selection 1941-1963, in Sells, S.B., Ed. Selection of Air Traffic Controllers, Federal Aviation Administration, Office of Aviation Medicine, Washington, DC: DOT/FAA/AM-84-2.

Collins, W.E., Boone, J.O., and VanDeventer, A.D. (1984). The Selection of Air Traffic Control Specialists: Contributions by the Civil Aeromedical Institute in Sells, S.B.(Ed.) Selection of Air Traffic Controllers, Federal Aviation Administration, Office of Aviation Medicine, Washington, DC: DOT/FAA/AM-84-2.

Della Rocco, P.S., Manning, C.A., and Wing, H. (1991). Selection of Air Traffic Controllers for Automated Systems: Applications from Today's Research in J.A. Wise, V.D. Hopkin, and M.L. Smith (Eds) Automation and Systems Issues in Air Traffic Control NATO ASI Series, Series F: *Computer and Systems Sciences*, Vol. 73. Berlin: Springer-Verlag.

Gilberstadt, H., Lushene, R., and Buegel, B. (1976). Automated Assessment of Intelligence: The TAPAC Test Battery and Computerized Report Writing. *Perceptual and Motor Skills*, 43(2), 627-35.

Goodman, J.T., Streiner, D.L., and Woodward, C.A. (1974). Test-Retest Reliability of the Shipley Institute of Living Scale: Practice Effects on Random Variation. *Psychological Reports*, 35, 351-4.

Karson, S. and O'Dell, J.W. (1974). Personality Makeup of the Air Traffic Controller. *Aerospace Medicine*, 45, 1001-7.

Manning, C.A., Kegg, P.S., and Collins, W.E. (1988). Studies of Poststrike Air Traffic Control Specialist Trainees: II. Selection and Screening. Federal Aviation Administration, Office of Aviation Medicine, Washington, DC: DOT/FAA/AM-88-3.

Martin, P.J., Friedmeyer, M.H., Sterne, A.L. and Brittain, H.M. (1977). I.Q. Deficit in Schizophrenia: A test of competing theories. *Journal of Clinical Psychology*, 33, 667-72.

Martin, J.D., Blair, G.E., and Vickers, D.M. (1979a). Correlation of the Slosson Intelligence Test with the California Short-Form Test of Mental Maturity and the Shipley Institute of Living Scale. *Educational and Psychological Measurement*, 39, 193-6.

Martin, J.D. (1979b). Correlation of the Quick Word Test and the Wide Range Vocabulary Test with the Shipley Institute of Living Scale. *Educational and Psychological Measurement*, 39, 935-7.

Mertens, H.W. and Collins, W.E. (1986). The effects of Age, Sleep Deprivation, and Altitude on Complex Performance. *Human Factors*, 28(5), 541-51.

Norusis, M.J. (1990). SPSS Advanced Statistics: User's Guide. Chicago, SPSS, Inc.

Schroeder, D.J. and Dollar, C.S. (1989). Personality Characteristics of Pre/Post-Strike Air Traffic Control Applicants. Presented at the 60th Annual Scientific Meeting of the Aerospace Medical Association, Washington, DC.

Thorndike, R.L. (1949). Personnel Selection: Test and Measurement Techniques. New York: John Wiley and Sons.

Young, A. and Rearden, J.J. (1979). Black Intelligence Test of Cultural Homogeneity and Shipley Institute of Living Scale scores for black Chicago Youths. *Psychological Reports*, 45, 457-8.

Zachary, R.A. (1986) Shipley Institute of Living Scale Revised Manual. Los Angles: Western Psychological Services.

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