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An investigation into educational and occupational differences in test performance on a battery of adaptability tests for Africans

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respects, and occasionally one may wish to make an unanticipated comparison which does not seem justifiable in the light of known differences between groups.

Experimental control is the ideal, but, if this cannot be attained, one may resort to statistical allowances and thereby arrive at valid conclusions.

Covariance Analysis is a precise method for making allowance for uncontrolled variables by setting forth the sampling error adjustment which is needed in testing the statistical significance of the difference between "corrected" means.

The method is applicable whenever it seems desirable to correct a difference on a dependent variable for a known difference on another variable, which for some reason could not be controlled by matching or by random sampling procedures.

Such a test provides an adjustment for, and a test of significance of, the difference between two or more groups.

The Covariance formulaes used for the adjustment or correction of the various variables in the present experiment, are set forth in detail in Appendix: I.

A Covariance Analysis was undertaken on the Industrial Sample to:

a) Test for the existence of a Regression of Test Scores on Education

and b) Test for the significance of differences between group means of test scores after they have been corrected for the regression of test scores on education.

TABLE : 7

RESULTS OF

ANALYSIS OF COVARIANCE

TO TEST FOR THE EXISTENCE OF A REGRESSION OF TEST SCORES OF EDUCATION.		
	(see NOTE below)	1%
SCREWS	8.7935	+
SORTING I	73.6916	+
SORTING 2	308.3047	+
CUBE CONSTR.	132.2418	+
TRIPOD	32.4676	+
FORMBOARDS	111.2205	+
PEGBOARD	50.5494	+
WIGGLY BLKS.	81.9756	+
KOHS BLKS.	243.2622	+

+ DENOTES SIGNIFICANCE WITH 1 AND 991 DEGREES OF FREEDOM.

NOTE:

THE RATIO BETWEEN THE MEAN SQUARE ACCOUNTED FOR BY THE REGRESSION COEFFICIENT TO THE RESIDUAL MEAN SQUARE.

TABLE : 8

RESULTS OF
ANALYSIS OF COVARIANCE

TO TEST FOR THE SIGNIFICANCE OF DIFFERENCES BETWEEN GROUP MEANS OF TEST SCORES AFTER THEY HAVE BEEN CORRECTED FOR THE REGRESSION OF TEST SCORES ON EDUCATION:

	(see NOTE below)	1%	5%
SCREWS	5.6165	-	+
SORTING I	25.9116	+	+
SORTING 2	2.4651	-	-
CUBE CONSTR.	8.1956	+	+
TRIPOD	15.7497	+	+
FORMBOARDS	4.2826	-	+
PEGBOARD	5.0375	-	+
WIGGLY BLKS.	.4913	-	-
KOHS BLKS.	12.7271	+	+

\+ DENOTES SIGNIFICANCE
\- DENOTES NON-SIGNIFICANCE
WITH 1 AND 991 DEGREES OF FREEDOM.

NOTE:

THE RATIO OF THE "BETWEEN GROUPS" MEAN SQUARE TO THE RESIDUAL MEAN SQUARE AFTER ELIMINATING THE INFLUENCE OF EDUCATION.

An inspection of the Covariance Analysis tables reveals the following:

a significant regression at the 1% level between Test Scores and Education exists on all nine tests of the General Adaptability Battery.

However, when the group means of the Mechanical Group and of the Non-Mechanical Group have been corrected for this regression of Test Scores on Education, seven of the nine tests still serve to differentiate between the Mechanical and Non-Mechanical Groups at the 5% level, and four of them at the 1% level. At the 5% level the Sorting II Test (a test highly weighted on education) and the Wiggly Blocks Test (a test which is considered too difficult to be of any value) are the only two tests which do not differentiate between the two groups.

Consequently, seven of the nine tests will differentiate at the 5% level between Mechanical and Non-Mechanical Groups when the effect of education is held constant.

These tests are:

TABLE : 9

CONFIDENCE LEVELS

SCREWS		5%
SORTING I	1%	5%
CUBES	1%	5%
TRIPOD	1%	5%
FORMBOARDS		5%
PEGBOARD		5%
KOHS BLKS.	1%	5%

3. Does age affect African secondary industrial selection on the General Adaptability Battery?

from the following correlations computed from School Sample data it is apparent that the relationship between age and test performance is fairly high:

TABLE : 10

	r's
SCREWS	.43354
SORTING I	.56604
SORTING 2	.61505
CUBES	.61742
TRIPOD	.51044
FORMBOARDS	.61882
PEGBOARD	.58300
WIGGLY BLKS.	.45825
KOHS BLKS.	.65810

In considering the effect of age upon the test intercorrelations, the test Partial Intercorrelations holding the influence of age and education constant, were calculated on the School Sample. The influence of age being indicated by the difference between the Partial Intercorrelation Table holding the influence of Education constant (r 12.3) and the table of Partial Intercorrelations given on the next page, holding the influence of both Education and Age constant (r 12.34):

TABLE : 11

TEST PARTIAL INTERCORRELATIONS (SCHOOL SAMPLE): THE INFLUENCE OF EDUCTION AND AGE HELD CONSTANT

		1.	2.	3.	4.	5.	6.	7.	8.
1.	SCREWS								
2.	SORTING I	.10681							
3.	SORTING 2	.06995	.29848						
4.	CUBES	.08016	.21539	.19195					
5.	TRIPOD	.14484	.06507	.19508	.34492				
6.	FORMBOARDS	.09964	.24595	.24628	.36182	.20528			
7.	PEGBOARD	.09410	.25375	.22783	.32875	.22583	.36878		
8.	WIGGLY BLKS.	.08929	.19007	.08292	.34226	.19597	.32757	.27647	
9.	KOHS BLKS,	.07425	.22140	.25242	.36873	.30526	.38635	.30259	.22499

Comparing this table with the table of Partial Intercorrelations holding the influence of Education constant, we note a further drop in test correlations, although considerably less than before. Age exerting some influence on test performance.

The influence of Age on secondary industrial selection is shown in the Covariance Analysis tables given on the following page.

These tables show the existence of a significant regression at the 1% level of Test Scores on Age for eight of the tests, the Screws Test being the only exception.

However, all the Group Means of the Mechanical and Non-Mechanical Groups remain significantly different after they have been corrected for this regression i.e: the tests continue to differentiate between the Mechanical and Non-Mechanical Groups when the influence of age is controlled.

TABLE : 12

RESULTS OF

ANALYSIS OF COVARIANCE

TO TEST FOR THE EXISTENCE OF REGRESSION OF TEST SCORES ON AGE:		
	(see NOTE below)	1%
SCREWS	1.4117	-
SORTING I	15.3293	+
SORTING 2	82.1902	+
CUBE CONSTR.	9.8757	+
TRIPOD	29.2699	+
FORMBOARDS	25.6671	+
PEGBOARD	33.8560	+
WIGGLY BLKS.	27.8429	+
KOHS BLKS.	18.9293	+

+ DENOTES SIGNIFICANCE

- DENOTES NON-SIGNIFICANCE

WITH 1 AND 991 DEGREES OF FREEDOM.

NOTE:

THE RATIO BETWEEN THE MEAN SQUARE ACCOUNTED FOR BY THE REGRESSION COEFFICIENT TO THE RESIDUAL MEAN SQUARE.

TABLE : 12

RESULTS OF

ANALYSIS OF COVARIANCE

TO TEST FOR THE EXISTENCE OF REGRESSION OF TEST SCORES ON AGE:		
	(see NOTE below)	1%
SCREWS	1.4117	-
SORTING I	16.3293	+
SORTING 2	82.1902	+
CUBE CONSTR.	9.8757	+
TRIPOD	29.2699	+
FORMBOARDS	25.6671	+
PEGBOARD	33.8560	+
WIGGLY BLKS.	27.8429	+
KOHS BLKS.	18.9293	

+ DENOTES SIGNIFICANCE

- DENOTES NON-SIGNIFICANCE

WITH 1 AND 991 DEGREES OF FREEDOM.

NOTE:

THE RATIO BETWEEN THE MEAN SQUARE ACCOUNTED FOR BY THE REGRESSION COEFFICIENT TO THE RESIDUAL MEAN SQUARE.

TABLE : 13

RESULTS OF

ANALYSIS OF COVARIANCE

TO TEST FOR THE SIGNIFICANCE OF DIFFERENCES BETWEEN GROUP MEANS OF TEST SCORES AFTER THEY HAVE BEEN CORRECTED FOR THE REGRESSION OF TEST SCORES ON AGE.

	(see NOTE below)	1%
SCREWS	45.7320	+
SORTING I.	64.3680	+
SORTING 2.	18.2220	+
CUBE CONSTR.	8.0820	+
TRIPOD	55.8821	+
FORMBOARDS	31.9257	+
PEGBOARD	28.7657	+
WIGGLY BLKS.	7.8715	+
KOHS BLKS.	26.0145	+

+ DENOTES SIGNIFICANCE

- DENOTES NON-SIGNIFICANCE

WITH 1 AND 991 DEGREES OF FREEDOM.

NOTE:

THE RATIO OF THE "BETWEEN GROUPS" MEAN SQUARE TO THE RESIDUAL MEAN SQUARE AFTER ELIMINATING THE INFLUENCE OF EDUCATION.

4. Having investigated the influence that Age and Education considered separately, exert upon the General Adaptability Battery's selectivity in secondary industry, we will now consider the combined influence of both these factors on test selectivity:

Does a combined age-education factor affect African secondary industrial selection on the General Adaptability Battery?

A Convariance Analysis on the combined influence of both these factors was undertaken.

This analysis shows that after removing the effects of differences in age and education distributions, the test battery - with the exception of the Wiggly Blocks Test - differentiates at the 1% level of significance between the group means of the Mechanical and Non-Mechanical Groups.

At the 5% level all tests differentiate between the two Groups.

The results of this analysis are shown on the following page.

TABLE : 14

ANALYSIS OF COVARIANCE

THE SIGNIFICANCE OF DIFFERENCES BETWEEN GROUP MEANS AFTER REMOVING THE EFFECTS OF DIFFERENCES IN AGE AND EDUCATION DISTRIBUTIONS:

	†	1% P.	5% P.
SCREWS	23.59717	+	+
SORTING I	46.28849	+	+
SORTING 2	11.008743	+	+
CUBE CONSTR.	6.35669	+	+
TRIPOD	8.46599	+	+
FORMBOARDS	24.29513	+	+
PEGBOARD	23.90229	+	+
WIGGLY BLKS.	4.61328	-	+
KOHS BLKS.	15.63885	+	+

NOTE:

+ DENOTES SIGNIFICANCE

- DENOTES NON-SIGNIFICANCE

† THE RATIO OF THE "BETWEEN GROUPS" MEAN SQUARE TO THE RESIDUAL MEAN SQUARE AFTER ELIMINATING THE INFLUENCES OF AGE AND EDUCATION.

NOTE:

In Tables 8, 13 and 14, where the significance in group means is considered after correcting for the regression on test scores of education, age and age and education respectively, it will be noted that the ratios giving the "between groups" mean square to the residual mean square for the Sorting 2 Test, after each of the above corrections, shows the following pattern:

		1% P.
Corrected for Ed.	2.4651	-
Corrected for Age.	18.2220	+
Corrected for Age & Ed.	11.0087	+

The Non-significant difference between group means when corrected for education and the appearance of a significant difference between group means when corrected for age, and for age and education together, is due to the existence of an inverse relationship (i.e: a negative correlation: - .03544) between age and education, so that the positive effects of the one are counterbalanced by the negative effects of the other.

5. We have now investigated:

1) the effect of education upon test selectivity,

2) the effect of age upon test selectivity,

and 3) the effect of age and education combined upon test selectivity.

Extending this investigation a stage further we will now consider:

<u>The usefulness of including a coefficient for Age after first taking account of Education</u>

i.e: the inclusion of the regression coefficient of age in the equation to indicate how much a term for age reduces the S.D. of the scatter of the observed variables about the predicted variables.

In other words, a consideration of the influence exerted by age in the equation in addition to the effect of education.

By Covariance Analysis it was found that the inclusion of a coefficient for age reduced variability on five of the nine tests at the 1% level of significance, and seven of the nine tests at the 5% level.

Working to the 1% level of significance, the inclusion of a coefficient for age after first taking account of education, reduced variability on the following tests:

Sorting 2

Tripod

Formboards

Pegboard

Wiggly Blocks

The complete results of this analysis are given in the table on the following page.

TABLE : 15

RESULTS OF

ANALYSIS OF COVARIANCE:

TO TEST THE USEFULNESS OF INCLUDING A COEFFICIENT FOR AGE AFTER FIRST TAKING ACCOUNT OF EDUCATION

	(see NOTE below)	1% P.	5% P.
SCREWS	.5707	-	-
SORTING I	6.2857	-	+
SORTING 2	49.9330	+	+
CUBE CONSTR.	2.2162	-	-
TRIPOD	17.1491	+	+
FORMBOARD	13.7367	+	+
PEGBOARD	26.77	+	+
WIGGLY BLKS.	14.3277	+	+
KOHS BLKS.	5.6000	-	+

\+ DENOTES SIGNIFICANCE

\- DENOTES NON-SIGNIFICANCE

NOTE:

THE RATIO OF THE DIFFERENCE BETWEEN THE SUM OF SQUARES ACCOUNTED FOR BY AGE AND EDUCATION, AND EDUCATION ALONE, TO THE RESIDUAL MEAN SQUARE.

6. The African secondary industrial labour force is characterised by its fluidity, because of the high labour turnover amongst this population it is in an almost continual state of flux.

A careful inspection of the occupational histories of these workers - made from their biographical forms - reveals that the vast majority have held four or more jobs over the past seven years.

Unlike the Mine labour force which is drawn mainly from migrant labourers, consisting of either "raw boys" with no industrial experience at all, or migrant labourers returning to the Mines for a further spell of duty, most of the secondary industrial workers who are urbanised men, have considerable experience in a number of different jobs.

The usual position amongst these men is, the longer they have stayed in the urban areas, the longer is their industrial experience.

A factor such as job experience may exert some influence on test scores. We must ask the question:

Does length of job experience affect test performance on the General Adaptability Battery?

Assuming job experience does influence test scores, a difficulty in assessment will arise when a subject who at the time of testing has little present job experience, gets a high score because of the influence of previous industrial experience.

Consequently, when considering the influence of job experience upon test performance, in order to cover these possibilities, the subjects were grouped into the following three categories:

Group I: Subjects with long present job experience and long industrial experience.

Group II: Subjects with short present job experience and long industrial experience.

Group III: Subjects with short present job experience and short industrial experience.

Note:

Long Industrial Experience = a stay of 10 years or more in the Urban Areas.

Long Present Job Experience = a stay of 4 years or more in the present job.

Short Industrial Experience = a stay of less than 4 years in the Urban Areas.

Short Present Job Experience= a stay less than 1 year in the present job.

Now, if Job Experience is a factor increasing test scores, one would expect the scores of the groups to fall in the following order:

Group I (with the longest Job Experience) to have the highest scores.

Group II (with the second longest Job Experience) to have the second highest scores.

Group III (with the least Job Experience) to have the lowest scores.

If on the other hand, length of job experience tended to be a factor decreasing test scores, one would expect the opposite pattern to appear.

To test this hypothesis three tests were selected. Each representing one of the three main "types" of tests used in the battery:

1) A buffer type test - SCREWS
2) A Mech. type test - TRIPOD
3) A Non-Mech. type test - KOHS BLOCKS

The following data was obtained when the scores of the three groups on the above tests was analysed:

TABLE : 16

MEAN TEST SCORES, S.D's AND NUMBER OF CASES FOR EACH TEST IN EACH OF THE GROUPS

GROUP I (long present job and long industrial experience)

BUFFER TEST	MECH. TEST	NON-MECH. TEST
Screws	Tripod	Kohs Blocks
M. 9.55748	M. 34.61235	M. 50.25580
S.D. 4.13460	S.D. 15.33250	S.D. 23.8663
N. 174	N. 178	N. 172

GROUP II (short present job and long industrial experience)

BUFFER TEST	MECH. TEST	NON-MECH. TEST
Screws	Tripod	Kohs Blocks
M. 10.08824	M. 40.51940	M. 60.90880
S.D. 4.11498	S.D. 14.84445	S.D. 27.24030
N. 204	N. 206	N. 181

GROUP III (short present job and short industrial experience)

BUFFER TEST	MECH. TEST	NON-MECH. TEST.
Screws	Tripod	Kohs Blocks
M. 9.61888	M. 35.98650	M. 53.03150
S.D. 4.01140	S.D. 13.85002	S.D. 27.08770
N. 143	N. 148	N. 143

SIGNIFICANCE OF MEAN DIFFERENCES IN TEST SCORES BETWEEN EACH GROUP

BUFFER TEST			MECH. TEST			NON-MECH. TEST		
Screws			Tripod			Kohs Blocks		
	"t"	1%P.		"t"	1%P.		"t"	1%P.
I to III	.076	-	I to III	.907	-	I to III	1.376	-
I to II	.683	-	I to II	3.993	+	I to II	5.447	+
II to III	.593	-	II to III	3.071	+	II to III	3.797	+

As can be seen from the table, the scores of the three job experience groups do not fall into any pattern from which one may interpret a progressive increase or decrease of scores due to length of job experience.

The "t" tests indicate that the scores of the Screws Test are unaffected by length of job experience, while some uncertainty exists with regard to the influence of length of job experience on the Tripod and Kohs Blocks Tests.

To obtain more conclusive results due recognition must be taken of the possible influence exerted by age and education on the test scores of the job experience groupings used in this study.

A regression calculation was undertaken to test the usefulness of including a coefficient for "length of job experience" after first accounting for the influence of age and education. (See Appendix: I for the stages in the calculation and the formulae used).

The results obtained show that the inclusion of a coefficient for "length of job experience", causes reduction in the residual variation on both the Tripod and Kohs Blocks Tests which is significant at the 1% level, while it is not significant on the Screws Test:

	(see NOTE below).	1% P.
SCREWS	.16760	-
TRIPOD	12.9516	+
KOHS BLOCKS	18.7162	+

\+ DENOTES SIGNIFICANCE

\- DENOTES NON-SIGNIFICANCE.

NOTE: The difference between the sum of squares when job experience is included and when job experience is omitted divided by the residual sum of squares.

To test the significance of this influence, a Covariance Analysis was then calculated between the group means of test scores in the three job experience groups after they had been corrected for the regression of test scores on age and education.

(See Appendix: I for the stages in this calculation and the formulae used).

Table: 17 confirms the pattern shown by the "t" tests, namely, that the Screws test scores are unaffected by length of job experience, and it establishes that scores on both the Tripod and Kohs Blocks Tests, are influenced by this factor.

TABLE : 17.

RESULTS OF

ANALYSIS OF COVARIANCE

TO TEST FOR THE SIGNIFICANCE OF DIFFERENCES BETWEEN GROUP MEANS OF TEST SCORES IN THE THREE JOB EXPERIENCE GROUPS AFTER THEY HAVE BEEN CORRECTED FOR THE REGRESSION OF TEST SCORES ON AGE AND EDUCATION.

	(see NOTE below)	1%	5%
SCREWS	.889339	-	-
TRIPOD	6.46381	-	+
KOHS BLOCKS	12.66558	+	+

+ DENOTES SIGNIFICANCE

- DENOTES NON-SIGNIFICANCE

WITH 1 AND 855 DEGREES OF FREEDOM.

NOTE:

THE RATIO OF THE "BETWEEN GROUPS" MEAN SQUARE TO THE RESIDUAL MEAN SQUARE AFTER ELIMINATING THE INFLUENCE OF AGE AND EDUCATION.

As the Covariance Analysis does not show the direction of the significant difference, the test means in the three job experience groups were computed to compare:

1. the direction of increase of the Means without holding any factor constant;

and 2. the direction of increase when age and education are held constant.

Table:18 (on the following page) shows that test scores in the job experience groups increase in opposite directions:

GROUP I
↓
GROUP II
↑
GROUP III

Possible reasons for this increase of means, in opposite directions are:

1. It may be due to a random fluctuation,

or 2. As Groups I and II have "long industrial experience" as a common factor and Groups II and III have "short present job experience" as a common factor, the opposing directions of test score increases in the job experience groups, may be due to the existence of an inverse relationship between these two factors. (i.e: between industrial experience and present job experience). The argument being that individuals with long industrial experience are "industrially educated", urbanised people, who tend to become more frustrated with conditions of service and who, in seeking satisfaction move from one job to another, never staying in any one job for any length of time - giving them on our present classification, a long industrial experience but a short present job experience.

TABLE : 18

		SCREWS:	TRIPOD:	KOHS BLOCKS:
GROUP I	M. without holding any Factor constant	9.557	34.612	50.255
" I	M. holding age and education constant	7.024	32.079	48.722
GROUP II	M. without holding any Factor constant	10.088	40.519	60.908
" II	M. holding age and education constant	9.149	39.580	58.375
GROUP III	M. without holding any Factor constant	9.618	35.986	53.031
" III	M. holding age and education constant	8.386	34.754	51.799

TEST MEANS WITHOUT HOLDING ANY FACTOR CONSTANT AND TEST MEANS HOLDING AGE AND EDUCATION CONSTANT, IN THE THREE JOB EXPERIENCE GROUPS.





SCALE:

= 100 BOYS

= 100 GIRLS

PROPORTION OF MALE TO FEMALE TESTEES

7. The Industrial Sample consists wholly of African males, the School Sample, however, includes both males and females.

Using the School Sample data the following question will be investigated:

Do any sex differences in test performance exist on the General Adaptability Battery?

the sample population under consideration is illustrated in the foregoing diagram showing the "Proportion of Male to Female Testees".

From the table given below it can be seen that little difference in relationship exists between test performance and education for either sex, when compared to the total sample or to one another:

TABLE : 19

	EDUCATION		
	TOTAL SAMPLE	BOYS ONLY	GIRLS ONLY
	r's	r's	r's
SCREWS	.39059	.42416	.32293
SORTING I	.56553	.58568	.52212
SORTING II	.61631	.61988	.62001
CUBE CONSTR.	.67144	.68778	.64170
TRIPOD	.46543	.50926	.47178
FORMBOARDS	.65642	.67608	.61817
PEGBOARD	.59276	.62318	.55695
WIGGLY BLKS.	.52332	.55049	.45039
KOHS BLKS.	.71288	.71057	.73906

Also, as can be seen from the following table, little difference in relationship exists between test performance and age for either sex, when compared to the total sample or to one another:

TABLE : 20

	AGE		
	TOTAL SAMPLE	BOYS ONLY	GIRLS ONLY
	r's	r's	r's
SCREWS	.43354	.46300	.32665
SORTING I	.56604	.58444	.52616
SORTING II	.61505	.62312	.62982
CUBE CONSTR.	.61742	.62674	.58644
TRIPOD	.51044	.55747	.43899
FORMBOARDS	.61882	.63988	.55808
PEGBOARD	.58300	.60929	.51914
WIGGLY BLKS.	.45825	.47141	.40073
KOHS BLKS.	.65810	.66558	.64874

With the exception of three standards, no significant differences exist between the ages of the two sexes. The possibility of differences in test scores between the sexes being due to age variations is consequently negligible. The following "t" tests for the age means of both groups confirms this:

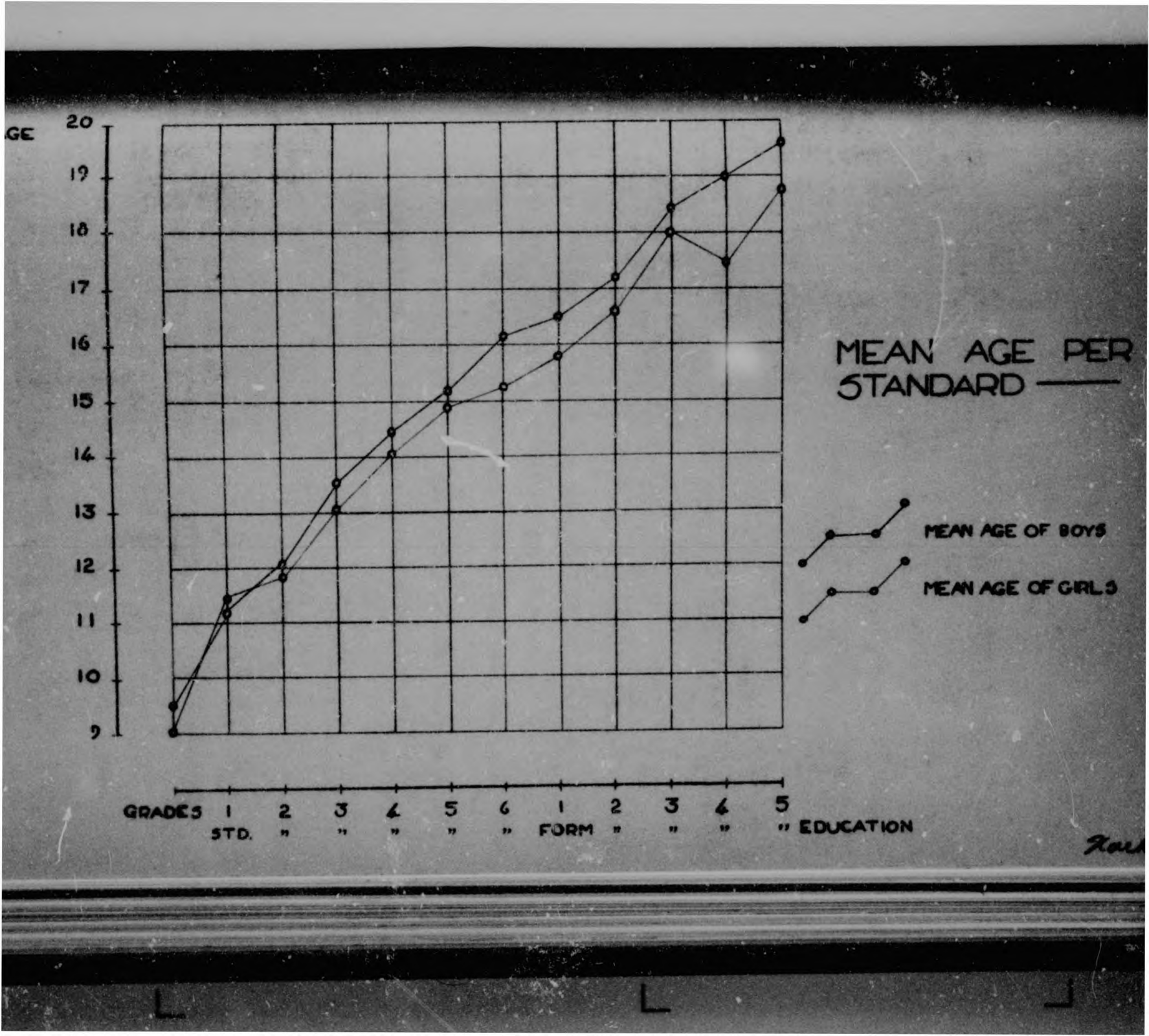
TABLE : 21

	"t"	1% P.
Grades	.92184	-
Std. 1	.55595	-
2	1.3582	-
3	2.22609	-
4	1.621771	-
5	1.11613	-
6	3.76673	+
Form I	3.20294	+
II	2.80252	+
III	1.17761	-
IV	1.57955	-
V	1.32609	-

TABLE : 22

AGE MEANS AND STANDARD DEVIATION PER STANDARD OF EDUCATION OF THE AFRICAN PUPILS.

	GIRLS.			BOYS.		
	N	M	S.D.	N	M	S.D.
GRADES	38	9.15789	2.00694	112	9.50893	2.00443
STD. 1.	34	11.55882	1.64840	115	11.37391	1.81043
2.	43	11.95349	1.52426	107	12.33645	1.56445
3.	58	13.03448	1.36417	92	13.57609	1.55500
4.	64	14.18750	1.22315	85	14.58824	1.77756
5.	46	14.91304	1.19471	68	15.19118	1.42719
6.	75	15.32000	1.21282	74	16.21622	1.63794
FORM 1.	56	15.76786	1.42664	124	16.50806	1.42277
2.	61	16.62295	1.04277	119	17.21008	1.74357
3.	45	18.00000	1.19257	105	18.40000	1.38626
4.	18	17.50000	1.01379	68	19.08824	1.65146
5.	4	18.75000	1.08972	56	19.64286	1.78711


GE
20
19
18
17
16
15
14
13
12
11
10
9
MEAN AGE PER STANDARD
MEAN AGE OF BOYS
MEAN AGE OF GIRLS
GRADES 1 2 3 4 5 6 1 2 3 4 5
STD. " " " " " FORM " " " " EDUCATION

Following on this the mean test score for each test was calculated for both sexes separately. The significance of the mean differences was then computed.

The results given on the following page show that the scores of the sex groups differ significantly on seven of the nine tests.

TABLE : 23

	MALES			FEMALES				
	M.	N.	S.D.	M.	N.	S.D.	t.	1%P.
SCREWS.	6.94978	1125	3.53935	5.19004	542	2.93928	.33795	-
SORTING 1	102.56050	1125	44.59550	98.76200	542	44.63150	1.62746	-
SORTING 2	126.10000	1125	39.76040	131.47420	542	38.46010	2.64218	+
CUBE CONSTRUCTION	31.86665	1125	19.31385	26.99075	542	17.68615	5.11154	+
TRIPOD	34.88000	1125	16.69060	20.40405	542	15.63770	17.30738	+
FORMBOARDS	40.30220	1125	14.37170	36.88005	542	13.55260	4.73195	+
PEGBOARD	40.07110	1125	14.89925	33.47600	542	14.14990	2.78744	+
WIGGLY BLOCKS	9.99156	1125	6.90020	8.33764	542	5.76972	5.13480	+
KOHS BLOCKS	78.37560	1125	29.44180	71.69560	542	30.28930	4.25068	+

MEAN TEST SCORES, NUMBER OF SUBJECTS, STANDARD DEVIATIONS AND THE SIGNIFICANCE OF DIFFERENCES OF MEANS, OF AFRICAN MALES AND FEMALES.

J.

1. Summary of Research Findings:

The following is a summarisation of the research findings based on the statistical analysis of the data undertaken in the preceeding section:

1. With the present haphazard type of African selection for secondary industry a large overlap in ability exists between the individuals employed on Mechanical jobs and those employed on Non-Mechanical jobs.

2. The tests comprising the battery when applied to the present (i.e: unselected) labour force, were each - with the exception of the Wiggly Blocks Test - able to differentiate significantly between the Mechanical Group and the Non-Mechanical Group, but because of the random variations of ability existing within these two groups no assessment could be made of the ability of the various tests to differentiate between individuals in practice.

3. However, when the nine tests are considered as a battery, on a job analysis criterion, the Operating Characteristics for the Discriminant Function show that with the cut-off situated at .020, approximately 39% of the Mechanical Group would fall below it, and 39% of the Non-Mechanical Group would fall above it.

4. Education exerts a significant influence on performance on all tests.

5. The influence of education is most marked in the following tests:

School Sample:

Education vs. Test scores.

	"r"
Sorting 2	.61631
Cube Construction	.67144
Formboards	.65642
Kons Blocks	.71288

Industrial Sample:

		(see below) †
Sorting 2	308.3047	
Cube Construction	132.2418	
Formboards	111.2205	
Kohs Blocks	243.2622	

† The ratio between the Mean Square accounted for by the Regression Coefficient to the Residual Mean Square.

6. There is evidence to believe that the General Adaptability Battery functions to some extent as a test of educational achievement.

7. Regarding the influence of education on test selectivity in secondary industry : after correcting the group means of both the Mechanical and Non-Mechanical Groups for the regression of test scores on education, the following facts emerge:

a) selecting at the 1% level, education effects the selectivity of 5 of the 9 tests,

b) selecting at the 5% level, education effects the selectivity of 2 of the 9 tests.

Summarised, the influence of education upon the tests selectivity between the two groups of workers is as follows:

	CONFIDENCE LEVELS	
	1%	5%
SCREWS	-	+
SORTING 1	+	+
SORTING 2	-	-
CUBE CONSTR.	+	+
TRIPOD	+	+
FORMBOARDS	-	+
PEGBOARD	-	+
WIGGLY BLKS.	-	-
KOHS BLKS.	+	+

NOTE: A positive difference (+) between the two groups indicates that education is not the main differentiating factor in the test performance of Mechanical and Non-Mechanical workers.

8. Age exerts a significant influence on performance on eight of the tests, the Screws Test being the only exception.

9. The influence of age is most marked on the following tests:

School Sample:

	Age vs. Test scores "r"
Sorting 2	.61505
Cube Construction	.61742
Formboards	.61882
Kohs Blocks	.65810

NOTE:

It will be observed that the above tests (School Sample) are also the tests most influenced by education. This is to be expected, the correlation between age and education within the School Sample being .87364.

Industrial Sample:

		(see below)
Sorting 2	82.1902	†
Tripod	29.2699	
Formboards	25.6671	
Pegboard	33.8560	
Wiggly Blocks	27.84299	

† The ratio between the Mean Square accounted for by the Regression Coefficient to the Residual Mean Square.

10. Regarding the influence of age on test selectivity in secondary industry: after correcting the group means of both the Mechanical and Non-Mechanical Groups for the regression of test scores on age, all tests discriminate at the 1% level of significance between the two groups.

Summarised, the influence of age upon the tests selectivity between the two groups of workers is as follows:

	CONFIDENCE LEVEL
	1%
SCREWS	+
SORTING 1	+
SORTING 2	+
CUBE CONSTR.	+
TRIPOD	+
FORMBOARDS	+
PEGBOARD	+
WIGGLY BLKS.	+
KOHS BLKS.	+

NOTE: A positive difference (+) between the two groups indicates that age is not the main differentiating factor in the test performance of Mechanical and Non-Mechanical workers.

11. After removing the effects of differences in both age and education distributions in order to consider the influence exerted upon test selectivity by the combination of age and education as a single factor, it was found that with the exception of the Wiggly Blocks Test, the tests all differentiate at the 1% level of significance between the group means of the Mechanical and Non-Mechanical Groups.

12. Considering the usefulness of including a coefficient for Age after first taking account of Education, it was found that under such conditions, Age influences test selectivity on the following tests:

SORTING 2

TRIPOD

FORMBOARDS

PEGBOARDS

WIGGLY BLOCKS.

13. Length of job experience exerts a significant influence on test performance.

14. Seven of the nine tests were found to differentiate significantly between boys and girls.

K.

1. Concluding Statement:

As a screening device - to differentiate between Mechanical workers and Non-Mechanical workers - the General Adaptability Battery can make a considerable contribution to increasing the efficiency of African secondary industrial labour.

Despite difficulties arising from the haphazard selection with regard to individual aptitudes existing within the sample population considered in this study, the test battery has shown a 61% discriminative ability.

Variations in both age and education have been shown to exist among the present African secondary industrial population.

It has been shown that with the exception of the regression of the Screws Test on Age, there is a significant regression on both these variables with all tests at the 1% level of P.

At first glance these results would seem to justify the inclusion of coefficients for age and education in the initial stages of any secondary industrial selection experiment. The argument being that this procedure would allow one to consider a given tests' ability to select on the basis of the criterion without distortion caused by irrelevant variables.

However, our findings in this research are:

1. that better educated persons do better on the tests - (which may be a possible reason why the tests are valid.) And before one can argue for the inclusion of a coefficient for education in a selection experiment, one must answer the

following question:

Is higher education an asset on the job?

If one considers that higher education is an asset on the job then it is unnecessary to correct for education.

If on the other hand one considers that higher education is not an asset on the job, correction for this factor must take place.

and 2. that old persons do less well on the tests. This may be because they are less well - educated than the younger generation or because they are less testable. And here again before one can argue for the inclusion of a coefficient for age in a selection experiment, one must answer the following question:

Are old persons better or worse on the job?

If they are better on the job then a correction for age is essential.

If they are worse on the job - the tests become more valid and no correction for age is necessary.

We are not in a position at present to answer these two important questions. And until such time that research into the problem of these two questions is undertaken, we will be unable to scientifically justify the inclusion or exclusion of coefficients for age and education in the application of the General Adaptability Battery to secondary industry.

The test battery can make a definite contribution to South African secondary industrial efficiency. Whether it will be able to contribute to any material extent, however, depends upon the development of:

a) firstly, and most important: a systematic Training Programme for test selected applicants,

b) an efficient Manning System to ensure correct job placement,

c) an organised Inspectional System to check on, modify, alter and improve existing practices within the selection programme,

and d) the existence of a close liaison between the testing section and the various section heads and foremen.

Aptitude selection devices are by no means the panacea for all industrial ills. The present battery attempts to measure an individual's natural or innate ability to acquire relatively general types of knowledge or skills. The application of such selection devices does not in any way lessen the need for comprehensive training programmes. Indeed, it is essential if the tests are to be utilised to their fullest advantage that they be coupled with some system of training.

A systematic training programme designed to develop the existing habits, abilities are skills of test selected applicants is absolutely necessary if industry is to reap the full benefit of aptitude test selection. Selection without systematic training is a short-sighted, wasteful policy.

South African secondary industry as a whole, has as yet, paid scant attention to the need for developing systematic training programmes for their African operatives. An untrained operative regardless of innate ability, is usually an inefficient operative, and labour inefficiency is reflected in increase production costs.

Wide scope exists for research into the development of training methods for African secondary industrial

workers. Not only in the field of training for operatives, but also for some type of supervisory selection and training. A selected and trained African supervisory force is almost as essential to the future wellbeing of South African secondary industry as is a selected and trained operative labour force.

Considerable success has been achieved on the Gold Mines with the employment of certain types of Leaderless Group Tests. Yet in secondary industry where European control tends to be less strictly imposed, resulting in the shouldering of greater responsibility by the African supervisors, little or no research into the selection and training of supervisors has been undertaken.

During the course of the present study two leadership tests were devised and applied to the African staff of the Public Utility Transport Corporation - Wynberg. Unfortunately it was not possible in the time at the writers disposal to proceed beyond the experimental stage with these two tests and consequently, no definite conclusions as to their worth can be drawn. However, purely from observation, the tests applied appear to have possibilities.

Photographs and descriptions of the tests and the test situations appear in Appendix H.

Leaderless Group Test assessments are highly subjective assessments. This means that in order to make comparisons among scores every effort should be made to see that the conditions under which testing is done are the best and that they are uniform and remain so.

Secondary industrial workers are for the most fairly well educated, sophisticated, observant people. Every-

Author De Ridder J C
Name of thesis An investigation into educational and occupational differences in test performance on a battery of adaptability tests designed for Africans 1956

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