

The question which now arises is whether these environmental differences bring about changes in the structure of intelligence. Before discussing this problem, it will be necessary to review factor analytical studies which have been carried out on African groups. Though they are few in number they do have an important bearing on the major hypotheses to be tested in this study.

3. Studies on the Structure of African Intelligence

The first factor analytical study of cognitive tests applied to Africans which appeared in the literature was that of MacDonald (1945). His purpose in carrying out this study was to condense a battery of thirteen tests into the smallest yet most effective battery for selection purposes. His tests were applied to a sample of 1,855 African military recruits who were stationed in the middle eastern regions of Africa. Although his intercorrelation matrix was based on unequal sample sizes the correlations were stable as they were based on a thousand cases or more.

A centroid factor analysis was performed on the matrix of intercorrelations and yielded a three-factor structure. Although he did not offer an interpretation of the factors, his results were most interesting. A striking feature was that all the tests had large specificities which would lead one to expect many more factors than the three he obtained. Had he applied a

greater number of reference tests he would probably have obtained more factors.

MacDonald's results were interesting enough for Vernon (1950) to re-analyse his data. Vernon re-calculated the intercorrelations among the tests but his sample size was smaller (It appears that some of the raw scores of the subjects were lost during the course of the war). Again, the correlations were based on samples of varying size, i.e. 308 to 631. Vernon also extracted three factors but decided to discard one of them as it failed to yield a logical grouping of the tests. The first factor was interpreted as general adaptability which he regarded as being unrelated to *g* since the formboards and dexterity tests also loaded on it. The second factor was a bipolar factor, which according to Vernon, divided the tests into cognitive and manipulative/physical aspects. The unrotated matrix obtained by Vernon was subsequently rotated by hand to simple structure by Grant and Schepers (1969) who concluded that there were two clear factors i.e. an intellectual factor involving "education of relations" and a factor describing dexterity.

In none of the studies dealing with the analysis of MacDonald's data is any mention made of the level of formal schooling or the extent of urbanization of the subjects tested. It may be assumed, considering the period when this information was collected, that the sample was largely illiterate and rural-oriented.

In 1946 work began on the construction of the

General Adaptability Battery (G.A.B.) which was designed for the selection and classification of African mine-workers. The tests comprising the battery and the rationale underlying its sub-tests have been described in an article written by Biesheuvel (1952 a). Biesheuvel (1954) has factor analysed the G.A.B. on two occasions; first on a group of mineworkers and then on a group of motor assembly operatives. His aim was " to determine whether the tests do in fact measure general adaptability " (p. 192). In both cases a general factor with substantial loadings on all the tests was obtained. Both analyses produced a doublet for the two sorting tests and no other significant factors. Biesheuvel interpreted the general factor as "practical general intelligence".

This interpretation is consistent with Biesheuvel's conceptualization of African intelligence. He has described it mainly in terms of being "global" or "holistic" and "non-analytical" (Biesheuvel, 1949). He has also expressed a preference for the concept of a general factor over Thurstone's primary mental abilities. He has written: "We agree with Godfrey Thomson's realistic view that 'the real defence of 'g' is that it has proved useful. It still remains to be seen whether Thurstone's primary factors will prove equally useful'" (Biesheuvel, 1952 b, p. 57). This point of view will be discussed more fully at a later stage.

Murray (1956) applied a battery of 19 performance tests to a sample of 119 African industrial workers.

He subjected the matrix of intercorrelations to a factor analysis using Burt's summation technique. Three factors were extracted and the significance of the factor loadings was tested by means of Burt and Banks's chi-squared test. Only one factor was considered significant. Having considered the results at length Murray concludes "..... that so far as the African is concerned the simplicity of the factor structure is determined by a simplicity of mental structure" (p. 63).

In all the studies reviewed thus far, British factor-analytical techniques were used. In none of the studies were the factor matrices rotated to simple structure. It is therefore inevitable that a general factor would be found. Another point for consideration is the composition of the test batteries. In order to determine an hypothesized dimension adequately, three or more tests loading on that dimension are required. If only two tests load on a particular dimension it is impossible to obtain unique estimates of communality. In addition, by definition a common factor cannot exist if only one test loads on an hypothesized dimension. In most of the studies mentioned quite high specificities were obtained for many of the tests. This suggests that had more tests been added to the batteries used, more factors would have been uncovered. There is also the nature of the samples to which the tests were applied to be considered. This aspect will be dealt with more fully at an appropriate point.

A study by Grant and Schepers (1969) takes cognizance of the criticisms mentioned in the above paragraph. Ten cognitive tests, among which were the sub-tests of the G.A.B., were administered to a sample of 90 mine recruits. The tests were intercorrelated and the resultant matrix was subjected to an iterative principal factor analysis. Unlike the studies mentioned above the factor analysis yielded a fairly clear two-factor structure in which both factors were definitely cognitive in nature. The matrix was rotated to simple structure and the factors were labelled perceptual speed and "eduction of relations". The latter term was used in relation to the studies reviewed and should not be confused with Spearman's g . To be more precise it is an ability involving both analysis and synthesis. This point is made by the authors. An appropriate label for this factor would be perceptual analysis. The rotated factor matrix, communalities, uniquenesses and specificities are shown in Table 1. The plot of the factor loadings of the two factors against one another is shown in Figure 1. This information is provided because it will be referred to again in a later chapter.

In addition to the two factors extracted the authors draw attention to the fact that two of the tests in the battery had high specificities, suggesting the presence of another two possible factors. This suggestion has been taken up by the present writer. In chapters IV and V the results of attempts to overdetermine these

TABLE 1

ROTATED FACTOR MATRIX, COMMUNALITIES, UNIQUENESSES AND SPECIFICITIES

Tests	A	B	h^2	u^2	s^2
Kohs	0.75	0.23	0.61	0.39	0.09
Circles	0.77	0.30	0.68	0.32	0.24
Form Perception	0.32	0.39	0.25	0.75	0.55
Fret Repetition	0.79	0.14	0.65	0.35	0.28
Fret Continuation	0.69	0.26	0.54	0.46	0.33
Form Series	0.43	0.20	0.22	0.78	0.63
Sorting I	0.18	0.88	0.80	0.20	0.08
Sorting II	0.42	0.70	0.66	0.34	0.25
Cube	0.42	0.52	0.45	0.55	0.34
Tripod	0.35	0.49	0.37	0.63	0.46

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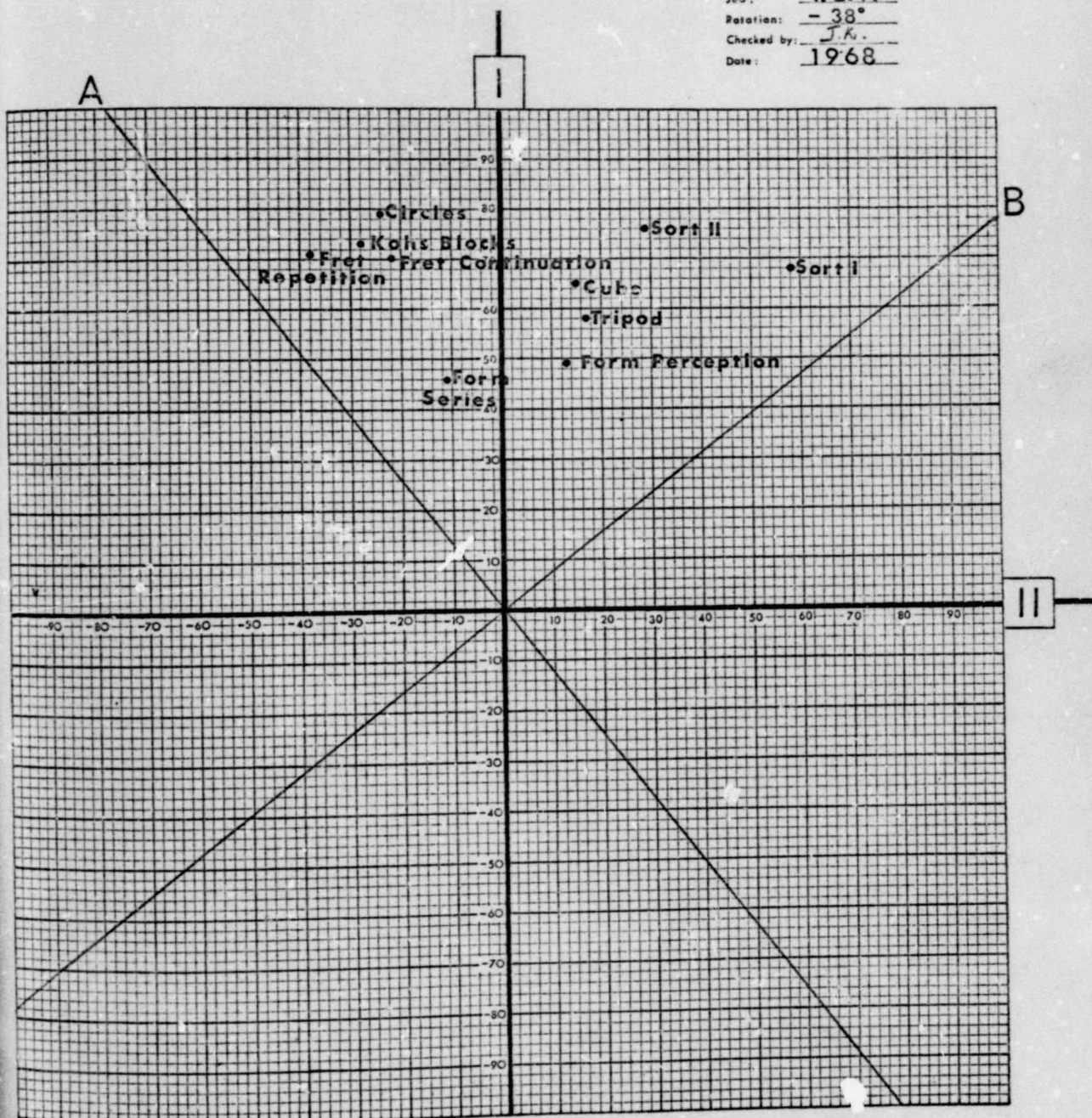
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FIGURE 1

N.L.P.R. 161/62
N.L.P.N.

Perceptual Analysis and Perceptual Speed

Job: I. B. P.
 Rotation: - 38°
 Checked by: J.K.
 Date: 1968



New Factors		
	A	B
I	1.00	.78
II	-.78	1.00

Rotation made

two factors are presented. The analysis of the results obtained are discussed in detail.

In concluding their article Grant and Schepers suggest that the unitary factor structures obtained by other investigators was due mainly to the inadequacy of their test batteries. They also contend that Spearman's one factor structures arose because of a similar shortcoming. They therefore urge investigators in the field of African intelligence to provide batteries of tests which are diverse enough to cover the wider domain of intellect. In addition, they conclude that if rotations to simple structure are performed on the matrices of factor loadings the interpretation of factors becomes clearer and the necessity to resort to blanket concepts such as g and general adaptability disappears.

In the studies reviewed, including Grant and Schepers's, the subjects tested all had either no formal schooling or only a smattering. In addition they uniformly came from rural-tribalized environments. If one inspects the factor plot which arose out of the last study reviewed it will be noticed that an oblique rotation instead of an orthogonal rotation would have yielded a clearer simple structure. On inspection it would seem then that the factors uncovered are correlated. To what extent they are correlated is unknown. Could it be then, that in unacculturated groups, factors tend to be more correlated than for acculturated groups? In those studies where g was found to account for a large

common variance it might well mean that the infra-factors present in a battery were so highly correlated that they emerged as a single factor. What evidence is there for this hypothesis? It has already been shown that members of rural-illiterate-tribalized societies are likely to be at a disadvantage on visual-perceptual intelligence tests. Although it is tempting to suggest that these disadvantages may well affect the structure of intelligence there is no direct proof for such an hypothesis. Indirect information, however, suggests that this might well be the case.

In a study of the discriminative power of the G.A.B. Hudson et al (1962) computed separate correlation coefficients for four samples which differed in terms of scholastic education. The investigators then drew up scatter plots of correlations between test scores for pairs of samples. Altogether 36 pairs of correlation coefficients were plotted. When a best fitting straight line passes through the origin of a scatter plot at 45 degrees it may be expected that the same factor structure would be obtained from an analysis of either set of data. From their data the authors maintain that such a conclusion seemed warranted for the educated samples. For the poorly educated group, however, it seemed that the factor structure differed from those of all the other more highly educated samples. These findings suggest the possibility of differences in factor structure between lowly educated samples on the one hand and better educated samples on

the other. The results do not give any indication, however, as to whether factors may be more highly correlated for the lowly educated group than they are for the better educated groups.

From the studies of Irvine (1969) it would appear that his better educated groups yield more factors than the lowly educated or illiterate groups which were investigated. It should be remembered though, that since his subjects were able to cope with tests of a paper-and-pencil kind Irvine was able to assemble a more diverse test battery. Investigators of lowly educated, unacculturated groups on the other hand are limited to performance tests only.

CHAPTER III

THEORIES ON THE DIFFERENTIATION OF ABILITIES

Theories relating to the differentiation of abilities will now be examined. Attention will be paid, in particular, to the cultural and developmental aspects of differentiation. At the same time the inherent methodological problems will be considered. A number of hypotheses, arising out of the previous chapter and the examination of these differentiation theories, will then be formulated. Ferguson's theory, although it was proposed later than the Burt-Garrett theory, will be discussed first.

1. Ferguson's Theory

Ferguson (1954, 1956) has proposed a theory to account for the development of the various cognitive abilities in terms of learning. His theory is attractive because it is concerned with the process by which differentiation of cognitive abilities takes place and because it is in principle a testable theory. In the light of the findings which emerged from factor analytical studies on the structure of African intelligence, the ensuing discussion will show that Ferguson's theory is particularly relevant.

In his 1956 paper Ferguson elaborates on the various ways in which the term "ability" may be used. In the

first place, it may refer to measures of performance on any task. The observed measures locate the individual on the latent variable within a range of error. Ferguson sees the latent variable as a necessary construct in that it permits a concept of error, which in any situation is a departure from a fixed, true, standard, latent or parametric value. This view of ability is consonant with Thurstone's (1947) operational definition which states that: " an ability is a trait which is defined by what an individual can do."

As a derivative of the meaning just mentioned, ability may be construed as a factor in the methodology of factor analysis. An individual's factor score is a derived measure. It is the weighted additive sum of measures of performance on separate tasks, the weights being obtained by a process of mathematical analysis (cf. formula in Chapter I, pp. 12-13). A factor score also implies a latent factor variable, since both the weights and the separate performance measures which determine it are in practice subject to error. The term factor as distinct from factor score, usually connotes a latent variable. Ferguson regards the concept of ability as a factor score to be essentially operational as it is determined by operationally determined variant values¹.

¹ Ferguson's exposition of the meaning of ability in terms of performance on a task and in terms of factors is given in full as it describes why American psychologists regard factors as causal entities (cf. discussion in Chapter I, p. 26).

The third meaning of the term, to which Ferguson refers, is that ability is an attribute of the state of the organism. This state is subject to modification by environmental and genetic factors. It is presumed that the state of the organism is functionally related to observable performance in particular tasks. A persistent notion is that differences in intelligence are related to differences in the state of the organism.

Ferguson (1954) postulated that:

" in the adult subject in our culture, those more or less stable attributes of behaviour which we ordinarily speak of as abilities, and which are defined in terms of performance on psychological tests refer to performance at a crude limit of learning The hypothesis implies that these abilities are overlearned acquisitions, and that the stability which characterizes them is a result of learning" (pp. 97-98).

Conceiving of abilities as overlearned acquisitions he includes this meaning in the third sense mentioned above. In other words ability refers to the extent to which an acquisition has been overlearned. Ferguson sees no incompatibility among these various meanings of "ability" and even suggests that the use of different words to describe the same construct is perhaps unnecessary.

Ferguson goes on to discuss the importance of learning at different stages of life. He points out that gross individual differences in ability do exist and that these differences are a complex result of the interaction of

the biological propensities of the organism and the learning which occurs at particular stages of life. In this respect he refers to Hebb's (1949) distinction between early and late learning. Hebb has emphasized that the stage in life at which learning occurs will determine how effectively an individual will respond to a task. Ferguson points out that this implies that the stage of development at which learning of a particular class has occurred is one factor in determining the limit of overlearning at the adult stage. It may be concluded then that early learning or its absence may have a permanent and generalized effect on the adult.

Ferguson then goes on to make a statement which is particularly relevant for the study of African intelligence. He writes:

"..... if a child's environment is restricted with respect to certain activities he may function well below the limit of his potentiality in those activities at varying ages, and a permanent impairment at the adult stage may result. Presumably children reared in different environments, which demand different types of learning at different ages, develop different patterns of ability" (Ferguson, 1954, p. 99).

In his 1956 paper Ferguson re-states his observation in more explicit terms:

"Cultural factors prescribe what shall be learned and at what age; consequently different cultural environments lead to the development of different patterns of ability. Those abilities which are culturally valid, and correlate with numerous performances demanded by the

culture, are those that show a marked increment with age" (Ferguson, 1956, p. 121).

In support of this argument Ferguson quotes the work of Burnett (1955) which showed conclusively that the pattern of abilities of children reared in relatively isolated communities differs markedly from that of children reared in urban centres. He observes also, in passing, that a culture-free test is a misconception because the abilities of man are themselves not culture-free. This observation is a negative comment on Cattell's concept of fluid intelligence ("..... the major measurable outcome of the influence of biological factors on intellectual development") which is measured by so-called "culture-free" tests. It is impossible to administer these tests, for instance, to the majority of Africa's African population as the tests are just not understood.

Ferguson's remarks on the relationship between age and ability require further elaboration. He mentions a study carried out by Gordon (1923) in which the I.Q.s of canal boat children were compared with those of gypsy children. The gypsy children performed appreciably better than the canal boat children on the Stanford Binet. Ferguson points out that the canal boat children received only a limited education and were relatively isolated while the gypsy children received a higher education and were presumably less isolated. Of importance in this study was the fact that the correlation between I.Q. and age for the canal boat children was $-.76$,

while for the gypsy children it was $-.43$. Ferguson provides information from other sources to show that the increment of score with age is less for under-privileged groups than for privileged groups. He argues that:

" those abilities that are of importance in a particular cultural environment, and that may be expected to correlate with performance in the important activities which the culture demands, are those which show a pronounced increment with age"
(Ferguson, 1954, p. 107).

He also points out that in one culture the increment of test performance with age may be substantial while in another it might be negligible. This is seen as being due to the demands of the cultural environment which dictates what shall be learned and at what age. Ferguson suggests that tests which have high positive correlations with age should be retained as they are of the kind which measure abilities that are likely to prove useful in a particular cultural environment.

Ferguson maintains that for isolated, under-privileged and restricted cultural communities the initial problem is one of developing tests for describing adequately the abilities for members of such communities. The tests so created should conform to the usual criteria of reliability, discriminatory capacity and the like.

For purposes of the present investigation this problem was recognized at the outset. In Grant and Schepers's study one of the major aims was to provide additional

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