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THE ORGANIZATION OF MENTAL ABILITIES OF A VENDA GROUP IN CULTURAL TRANSITION

This report forms part of South Africa's contribution to the International Biological Programme

NATIONAL INSTITUTE FOR PERSONNEL RESEARCH
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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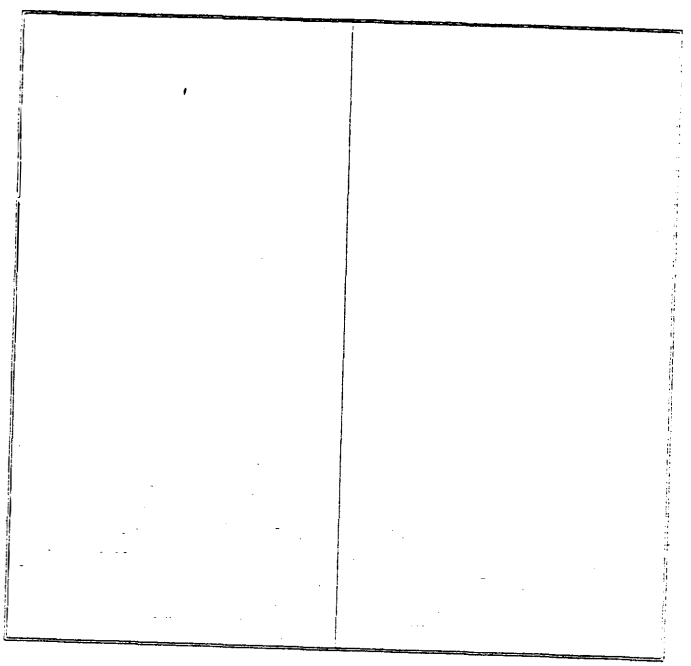

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ABSTRACT

This study is concerned with the organization of mental abilities of an African ethnic group in cultural transition from a rural-illiterate to an urban-literate state. It was undertaken in order to determine what effects literacy and urbanization have on: a) the structure of intelligence and b) level of performance on cognitive tests. Samples of 199 rural and 218 urban adult Venda males were tested on a battery of 16 cognitive tests. The analysis involved comparing mean levels of performance of the groups on these tests and comparisons of intellectual structure by a) traditional factor analytic means and b) an inter-group factor analysis procedure. The results showed that both scholastic education and urbanization improve levels of performance on the tests and that scholastic education, but not urbanization, brings about a change in the organization of mental abilities. The results are discussed in terms of two theories on the differentiation of abilities.

OPSOMMING

Hierdie studie is gemoeid met die organisasie van verstandelike vermoëns van 'n Bantoe etniese groep in kulture oorgang vanaf 'n platteland - ongeletterde na 'n stedelik-geletterde toestand. Die studie is onderneem ten einde vas te stel watter gevolge geletterdheid en verstedeliking op die volgende het: a) intelligensie-struktuur en b) prestasievlak op kognitiewe toetse. Steekproewe bestaande uit 199 stedelike en 218 landelike volwasse Venda-mans is aan 'n battery van 16 kognitiewe toetse onderwerp. Die ontleding het die vergelyking van die gemiddelde prestasievlakke van hierdie groepe op die toetse behels, sowel as vergelykings van intellektuele struktuur deur a) tradisionele faktorontledingstegnieke en b) 'n inter-groep faktorontledingsprosedure. Die resultate dui daarop dat beide skoolopleiding en verstedeliking prestasievlakke op die toetse verhoog en dat skolastiese opleiding, maar nie verstedeliking nie, 'n verandering ten opsigte van die organisasie van verstandelike vermoëns teweegbring. Die resultate word aan die hand van twee teorieë ten opsigte van die differensiasie van vermoëns bespreek.

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INTRODUCTION

The International Biological Programme (I.B.P.) is a world-wide plan of research concerned with the biological basis of productivity and human welfare. Discussions leading to the I.B.P. started in 1959 and were stimulated by the success of the International Geophysical Year. A planning committee was formed in 1962, but the programme was not formalized until July, 1964. The operational programme started formally on 1st July, 1967 and is destined to run for five years.

In order to provide an operating framework for its research, the I.B.P. was divided into seven sections. In the section Human Adaptability (H.A.) which covers subjects such as tolerance to heat, cold and high altitudes, among others, it was decided that cultural aspects of human adaptability should be included. The South African contribution to this section was of a multi-disciplinary kind, involving nutrition status surveys, psychological and sociological investigations as well as studies on the physical characteristics and disease patterns of a population. It was decided that the adult males of the Venda tribe would be studied from the point of view of changing from a rural peasant to an urban industrialized life. Urbanization as a process of human adaptation was a logical area of investigation in a country like South Africa.

The study is presented in three chapters. The first two chapters are concerned with theoretical issues. In the first chapter the nature of African intelligence and its assessment is outlined in the light of current investigations. Factors which are known to influence African intelligence are commented on. In the second chapter two theories on the differentiation of abilities, which differ in terms of methodology, are presented and an assessment of each is made. At the end of this chapter three hypotheses are postulated.

The final study is presented in detail in the last chapter. It deals with the organization of mental abilities of a Venda group in cultural transition from a rural-illiterate to an urban-literate state. The results are discussed in the light of the wo theories on the differentiation of abilities outlined in chapter two.

SUMMARY

In the literature, two of the most frequently recurring variables which have been shown to influence the level of performance of Africans on cognitive tasks are scholastic education and urbanization. To date, there has been no systematic investigation which has attempted to show how a change from a pre-literate, rural culture to a literate, urban culture affects the intellect of individuals in terms of level of abilities, patterning of abilities and structure of abilities. This study was undertaken in order to investigate these problems.

The study is presented in three chapters. The first two chapters are concerned with theoretical issues. In the first chapter events leading up to the measurement of the intelligence of Africans are described and objectives of psychological research in Africa are put forward. It is suggested that many of these objectives could be realised by studying individuals who were in the process of undergoing cultural changes. It was felt that cultural changes were accompanied by intellectual changes.

Special attention is paid to factors which are regarded as influencing African intelligence. The following factors are discussed: climate, nutrition, socioeconomic status, domestic environment, material environment and scholastic education. These aspects are reviewed within the context of the development of intelligence and discussed in relation to the change from a rural-illiterate-tribalized state to an urban-literate-detribalized state. It is shown that the former state is impoverished and the latter, by comparison, enriched. Differences between these two states were expected to be reflected in performances on cognitive tasks.

Studies on the structure of African intelligence are reviewed. It is shown that most investigators interpreted their results from the point of view of the British factor analytic school of thought. These studies tended to suggest that the structure of African intelligence could be described only in terms of a single unitary ability i.e. g or general adaptability. The only study in which more than one cognitive factor was found was that conducted by Grant and Schepers, who analysed their results from the American point of view. They showed in their article that unitary factors had been obtained by other investigators because their test batteries were not diverse enough and because rotations to simple structure were not carried out. Apart from the two factors which emerged from their study, Grant and Schepers indicated the possibility of obtaining a further two factors with a larger battery of tests. Thus it appeared from this study that the structure of African

intellect was not as simple as other investigators believed.

Two studies are cited which suggest that the structure of intellect of illiterate Africans differs from that of literate Africans. It is suggested that urbanization might also result in changes in the structure of intellect.

In the second chapter theories on the differentiation of abilities are discussed. Attention is paid, in particular, to cultural and developmental aspects of differentiation and at the same time methodological problems are outlined. Ferguson's theory is discussed in detail and is shown to be close to the American school of thought. His definition of ability is presented at some length in order to show why American psychologists regard factors as causal entities and not as statistical abstractions as British psychologists have contended. Ferguson's emphasis on learning and his conception of abilities as overlearned acquisitions is mentioned. His assertion that different cultures lead to the development of different patterns of ability is given prominence. The age at which learning occurs, an aspect emphasized by Hebb, is shown to feature prominently in Ferguson's theory. His conception of transfer is also discussed. His conclusion that the positive correlation between abilities (factors) may be accounted for by the operation of positive transfer is mentioned and his explanation of the differentiation of abilities in terms of learning is given prominence. It is shown that his theory is particularly important within the scope of the overall study. Ferguson's theory is regarded as both attractive and tenable.

In the same chapter the Burt-Garrett differentiation hypothesis is presented and studies carried out to test it are reviewed. It is shown that the hypothesis is more appropriate for hierarchical models of intellectual factors. Criticisms of the hypothesis and of the studies designed to test it are given. Methodological problems associated with the hypothesis are discussed in detail and it is shown that many of these problems arise out of approaching the problem by insisting on a g factor. The overall impression gained by examining the evidence for this hypothesis is that as long as hierarchical models are used in explaining results, no definitive support for it can be obtained. Most of the studies reviewed dealt with the changing composition of intelligence as a function of age. They were chosen because they reflected the more important methodological problems encountered when testing the hypothesis.

At the end of this chapter three hypotheses are put forward. Briefly, they were:

that literacy and urbanization lead to better performances on cognitive tests;

that, as cultures prescribe what shall be learned and at what age, a change in culture (in terms of literacy and urbanization) leads to a change in the pattern of abilities of those who have undergone this change;

that an enriched environment (in terms of literacy and urbanization) leads to a greater differentiation of abilities.

The meaning of differentiation is left an open question as it was decided that the results would be examined in terms of both the theories under review. By contrasting how well the results could be explained in terms of either of these theories, it was felt that the validities of the theories could be examined simultaneously.

Chapter three is devoted to a description of the final study. The aim of the study was to test the three hypotheses stated earlier. Literacy and urbanization are regarded as two specific aspects of culture. The sample and the manner in which it was selected is described. Difficulties associated with the selection of the sample are outlined. Samples of 199 rural and 218 urban adult Venda males were selected for investigation. The Urban-Rural Scale, a measure of individual urbanization, was applied to both samples. The results obtained are discussed and it is shown that both samples are essentially rural-oriented. The selection of the final test battery from earlier pilot studies is described and it is postulated that the battery measures five abilities. These abilities are defined. It is emphasized that the pilot studies were of an exploratory nature. The results obtained were therefore regarded as tentative. The administration of the final battery and the testing procedure are described. Sixteen cognitive tests were administered to both the urban and rural samples. For purposes of the analysis these two groups were subdivided into illiterate and literate groups.

A comparison of the mean levels of performance on all the tests revealed that a continuum could be discerned i.e. Rural Illiterate, Urban Illiterate, Rural Literate and Urban Literate. The first group had the lowest level of performance and the last group the highest. This result was

interpreted as supporting the first hypothesis.

The matrices of test intercorrelations for the four groups were factor analysed by means of the principal factor analysis technique. The results yielded by these factor analyses are interpreted in terms of the methodology typically used to explain the Burt-Garrett hypothesis. It is shown that the results are contrary to all expectations and that a number of important questions are left unanswered.

Covariance matrices were computed for each of the four groups and a number of likelihood ratio tests were carried out to test their equality. It was found that significant differences existed between the literate and illiterate groups but not between the urban and rural groups. This agreed with the results reported in another study.

The four intercorrelation matrices were also analysed by means of an inter-group factor analysis procedure. This method was expressly chosen with Ferguson's theory in mind. A factor matrix common to all four groups was extracted and rotated obliquely to simple structure. This matrix contained five factors which largely confirmed those that had been obtained in the pilot studies. Factor correlation matrices were then obtained for each group. In comparing the magnitude of correlations between factors in each group it was noticed that for the two illiterate groups there was only one intercorrelation of .60 or more in each group. All other intercorrelations were lower. In the two literate groups six and four intercorrelations of above this magnitude were obtained for the rural and urban groups respectively. It was shown that literates bring fewer abilities than illiterates into play when solving an apparently "diverse" array of tests. Thus the second hypothesis that a change in culture leads to a change in the pattern of abilities of those who have undergone this change was supported in terms of literacy but not in terms of urbanization.

The differences in degree of differentiation is discussed and explained in terms of Ferguson's theory. The high correlations between factors are explained by the process of positive transfer. For positive transfer to occur however, it is necessary for subjects to have overlearned abilities to a state of invariance. The distinctive abilities which emerge in an adult in any culture are those that tend to facilitate rather than inhibit each other. Thus, the abilities measured by the battery of tests had attained a state of invariance for the literate groups but not for the illiterate groups. In other words the literate groups had developed the

abilities measured by the battery more fully than the illiterate groups. Learning is regarded as the process whereby the abilities of individuals become differentiated. This process is facilitated by the abilities already possessed by the individual. It is concluded that since the two literate groups have attained certain abilities, as measured by tests in the battery, they are likely to be more differentiated than their illiterate counterparts. Thus, the third hypothesis that an enriched environment leads to greater differentiation of abilities was supported in terms of literacy but not in terms of urbanization.

Some of the larger differences between factor intercorrelations among the four groups are interpreted. Differences in levels of performance among the four groups are also explained in terms of differences in factor intercorrelations.

It is concluded that both literacy and urbanization are important factors in helping Africans to adapt to the demands of a western-technological culture.

CHAPTER I

AFRICAN INTELLIGENCE AND ITS ASSESSMENT

1. Introduction

Psychological research in Africa is relatively recent in origin. Prior to the second world war little of scientific value was published on the psychology of the indigenous inhabitants of the continent. Much of what was available came from the pens of travellers, missionaries, civil servants and anthropologists. Many of the written accounts were highly coloured by preconceived ideas and a firm belief in the inferiority of African peoples (cf. Carothers, 1953, p.87). After the war scientific interest in the mental capacities of Africans quickened. This came about largely as a result of an expanding industry which required some means of assessing the occupational suitability of a technologically unsophisticated labour force. In the realm of education the demand for scientific measuring devices also grew. A number of investigations, conducted mainly in South Africa and the Belgian Congo, led to the construction of a number of cognitive tests (usually adapted from Western ones) and the field of research took on a distinct empirical bias. In later years, as Doob (1965) and Andor's (1966) literature surveys show, the focus of attention broadened to include the study of perception, motivation, attitudes and personality. Throughout the development of psychology in Africa, however, the study of cognitive abilities, with all its attendant problems has occupied a position of central importance.

Since the early work of Biesheuvel (1952[a], 1954) and Ombredane (1952), in which the performance of illiterate and semi-literate Africans on cognitive tests was studied most investigations in recent times have been confined to the study of school-going subjects. In the last decade, extensive surveys have been carried out in which either locally constructed or specially adapted paper-and-pencil tests have been applied to literate subjects in west, central and east Africa (cf. Schwarz, 1961, 1963; Irvine et al, 1964 and Silvey, 1964). In all these studies the subjects had a reasonable understanding of English which simplified the administration of tests greatly. Similarly, in francophone Africa, psychologists have worked mainly with literate schoolchildren and have been able to administer their tests in French. (Much of this work is discussed by Faverge and Falmagne, 1962). In contrast, the investigation of the mental abilities of illiterate and semi-literate Africans have sharply declined during the

same period. In South Africa where most of the pioneering work on such groups was carried out, research has been largely of an applied kind. Well-established tests such as the General Adaptability Battery (Biesheuvel, 1952[a]) and the Form Series Test (Grant, 1965) have been installed in numerous industrial firms. Basic research into the nature of the mental abilities of illiterates and semi-literates, on the other hand, has declined alarmingly. It may be argued that this situation is the natural outcome of an upsurge of education in Africa which has led to an overall increase in the level of schooling. This is true only to a limited extent. The fact remains that the majority of Africans are either illiterate or semi-literate.

The objectives of psychological research in Africa were set down clearly by Biesheuvel (1958) when he wrote:

> "It is to provide a means of testing the general validity of psychological hypothesis concerning human behaviour. Western culture, within which scientific psychology originated, has inevitably served as a reference for the formulation of these hypothesis. As a result psychological laws may lack universality. For example, are human abilities uniquely defined by such factors as Spearman's g or Thurstone's primaries, or are these concepts merely artefacts of the kind of intellectual functions fostered by Western culture? Are the dynamics of volitional behaviour those postulated by psychoanalysis, or do comparative studies show that this kind of development is only found in societies that have the family structure and moral codes indigenous to the West?
>
> Such studies can be of the utmost theoretical significance to psychology as a science and may well involve a re-formulation of its concepts, particularly those concerning thought, motivation, personality and character" (pp. 161 - 162).

From his work on literate Africans, Irvine (1969), has found it necessary to redefine intelligence as "..... that which is learned, socially valued, purposeful and commendable" (p. 230). He has also gone on to make a distinction between primary and secondary modes of thinking. He regards initial learning within the parental value system and language code as primary and learning in school, when it takes place largely through a second language, as secondary. In tests of a verbal kind he finds that ideas learnt in school are easily over-ruled by those of the primary system.

Many of the objectives of psychological research in Africa may be realised best of all in a study of Africans in transition from a rural-

illiterate-tribalized state to an urban-literate-detribalized state. Adaptation of a high order is demanded of individuals who are expected to make this change. Yet, although this situation is a reality of Africa, relatively little work connected with this problem has been carried out. An examination of the proposed dichotomy will show how these two aspects of African life differ and how they are likely to influence the intellect of individuals who happen to live in one or the other.

2. Factors Influencing African Intelligence

A useful point of departure, in discussing factors which influence African intelligence, would be to examine Biesheuvel's definition of intelligence. His definition arose out of first hand experience associated with assessing the "capacity" of Africans at all levels of development. He has defined intelligence as:

> "..... the capacity to gain insight into the nature of things and events, to grasp causal relations, to profit by experience and so to acquire a number of skills whereby the adjustment between individual and environment is mediated" (Biesheuvel, 1956b, p.447).

He goes on to state that "capacity" can be looked upon as the "power of the mind"; that it is innate and genetically determined and that the degree to which it can be effectively applied will depend on how well its growth is stimulated during the years from birth to maturity. This definition shows the influence of concepts which are to be found in the thinking of Spearman, Burt and Piaget. "Power of the mind" is similar to Spearman's (1927) "mental energy", the genetic basis of intelligence is also in Burt's (1955) definition and the developmental aspects of the interaction between the individual and the environment are attributable to Piaget. (cf. Hunt, 1961 and Flavell, 1963).

Through Biesheuvel (1943, 1956b) environmental factors affecting African intelligence have received the attention that they deserved. At the time of his writing factual evidence supporting his observations was sparse, but later studies have shown many of them to be correct. Some of these factors will be dealt with in relation to rural and urban environments. It will be shown that a rural environment is impoverished and that an urban environment by comparison is enriched.

One of the most controversial factors that Biesheuvel (1956a) has raised is the debilitating effects of the climate in tropical regions. He maintains that humid heat all the year round is hostile to energetic action

and that: "Climate is a permanently limiting factor in the amount of effort, mental and physical, that can be expected from most African populations" (p. 386) He points out that in the tropics there are hardly any seasonal variations in the daily temperature range and that as a consequence work tempo will be stabilized at a comparatively low level. He also alludes to tropical diseases which by causing debility are likely to affect the liveliness of the mind No conclusive evidence for the effect of climate on intelligence has been established (Inter-African Labour Institute, 1960), nor for that matter has a link been established between tropical diseases and intelligence. Although the question remains an open one it is likely that both aspects do have a detrimental effect on intelligence. Africans living in tropical rural areas are likely to be more prone to the adverse effects of climate and disease. In the urban areas of South Africa tropical diseases are now rare, and it is also true that most urban areas are situated in the cooler parts of the country. Hypothetically speaking, climate and disease might have an effect on "experience producing drives" (Hayes, 1962) which in turn affect level of intelligence.

Nutrition is an important factor affecting intelligence. Kwashiorkor or infantile protein malnutrition has been shown to result, in some cases, in permanent brain damage (Nelson, 1959; Nelson and Dean, 1959). Pellagra, which occurs among adults as a result of a protein deficient diet, is known to be associated with a wide range of electroencephalograph abnormalities (Nelson, 1963). Cowley and Griesel (1959) were able to demonstrate marked effects of dietry deficiencies, especially in proteins, on the learning in rats. A startling aspect of this investigation was the fact that these deficiencies were carried over into successive generations. The effects of inadequate nutrition on children have been demonstrated by Stoch (1967). He followed up coloured children severely malnourished in the first two years of life for over five years and compared them with an adequately nourished control group of similar socioeconomic level. The experimental group scored 15.7 IQ points lower than the control group on the S.A. version of the WISC scale. The profiles of the experimental group also resembled those of brain-damaged children. In a number of studies (Geber, 1958, 1961, Bardet et al, 1960 and Falade, 1960) the effects of abrupt weaning on psychomotor development in African babies have been shown to be severe. This is probably due to a change in diet. After weaning most African babies are put onto a largely carbohydrate diet.

These studies have an important bearing on African intelligence for it is a well-known fact that the diets of Africans, especially those in

rural areas, consist mainly of carbohydrates and little protein. Urban Africans, on the other hand, being better informed are likely to be more aware of the connection between diet and health and will thus supplement their diets with protein-rich foodstuffs. It is also true though that dietry habits die hard.

Socioeconomic status is yet another factor which has a bearing on intelligence and in the African context it is particularly important. Africans residing in rural areas have a subsistence economy which meets their immediate needs. Should a drought threaten their crops then the prospect of starvation becomes a very real danger with which to contend. Rural Africans belong, in general, to a peasant class and poverty is the rule rather than the exception. The domestic environment does not provide the kind of stimulation that is necessary for the adequate deployment of intelligence. For the infant and the growing child there are grave disadvantages in growing up in a rural environment. The material environment offers little scope for the development of manipulative and perceptual skills. Because of poverty parents cannot afford toys, furniture, household utensils etc. Whatever materials are present are constructed by members of the society and on the whole are relatively scarce. Urban Africans, on the other hand, at least have a steady income, which although limited, far exceeds what rural Africans can earn. The opportunity is therefore present to be able to provide their children with a wider material environment. Because of a higher income and the availability of foodstuffs the prospect of starvation in an urban area becomes a remote possibility. The effects of socioeconomic status and urbanization on the intelligence of members of Western societies have been reviewed by Anastasi (1958, pp. 505 - 535). From the results of the studies reviewed one would expect urban Africans to surpass the intellectual capabilities of their rural counterparts.

Another factor which has a bearing on intelligence is the general cultural, as distinct from familial, environment. In recent years a number of studies carried out in the perceptual realm have high-lighted the importance of culture. Cowley and Murray (1962), for instance, compared the spatial development of groups of Zulu and European school children who were matched for sex and age. The Zulu children came from families in the upper socioeconomic levels and the European children from a wide range of economic levels. The subjects were matched in terms of educational range. Whilst the sequence of development was the same for both groups the rate of development of the Zulus was far below that of the Europeans. The work of Hudson (1960, 1962 and 1967) on 3-D perception has shown that the earlier children

are exposed to pictorial material, the sooner and better they learned to obtain a depth impression from two-dimensional data. It would appear from his results that even advanced education could not compensate for early deprivation.

In an interesting study Berry (1966) applied perceptual and conceptual tests to members of the Temne tribe and to Eskimos in an attempt to demonstrate a relationship between the cultural and ecological characteristics of their societies and the perceptual skills developed by the respective members of these societies. The results obtained were compared with Scottish subjects who represented a western control group. He also divided his groups into rural and urban sub-groups. His results showed Scots and urbanised Eskimos to perform best and rural Temne to perform worst. In explaining his data he points out that the groups differed in terms of culture and child upbringing. The Eskimos emphasised independent individuality and resourcefulness while the Temne were dependant and conformistic. He also showed that the more acculturated, urbanized Eskimos and Temne were closer to the Scots control group than they were to their unacculturated, rural counterparts. In a related study (Dawson 1967[a]) the effects of socialization processes on spatial-perceptual abilities was demonstrated. It was found that Temne, who are subjected to severe socialization processes tended to manifest a more field-dependent (cf. Witkin et al, 1962) perceptual style as contrasted with the Mende whose socialization processes were less severe. In the same study it was also shown that perceptual skills (as measured by Hudson's materials) were limited by the field-dependence variable. Thus, the results indicate, in general, that a strict, conformist environment has a negative effect on the perceptual abilities of members of societies which foster a restrictive style of life.

In a recent book (Segall, Campbell and Herskovits, 1966) the influence of culture on visual perception has been dealt with in detail. The authors' results showed significant differences across cultures in susceptibility to several geometric or optical illusions. Their findings consistently showed that the more acculturated an individual is the more susceptible he is to these illusions. These findings suggest that acculturation leads to greater flexibility.

It may be concluded from these studies that Africans living in a conformistic tribal state are likely to be at a distinct disadvantage when subjected to intelligence tests which have a visual-perceptual basis. In societies governed by custom and conformity there is inevitably little to stimulate and much to inhibit thought. Curiosity will not be encouraged

as there are traditional answers for most questions and where something is not understood magic is invoked to provide an answer. Africans are likely to lead a fuller intellectual life by breaking their tribal bonds. As was demonstrated by Grant (1969) urbanization as a process leads, at least, to a loosening of these bonds.

Scholastic education is one of the strongest factors influencing African intelligence. In nearly every investigation of African intelligence strong positive correlations between formal schooling and test performance will be found. Though educational facilities for Africans are increasing they affect only a minority. Those who do attend school will usually go only as far as standard six and then drop out. A bare minimum go beyond, not because of a lack of motivation but rather because of a lack of financial means or proper facilities. On the whole schooling facilities are better in urban areas. Of course in those rural areas where schools have been estiablished by missionaries, facilities are likely to be equivalent.

Biesheuvel (1956) has commented on the importance of scholastic education for the growth of intelligence. He has written:

> "Scholastic education is the mechanism which establishes the mental skills through which intelligence can best make itself effective, and whereby the mind is raised to higher adaptive levels" (p. 448).

Confirmation for these views is provided by Bruner (1966) who draws a distinction between pre-literate and literate societies. In pre-literate societies most instruction occurs by <u>showing in context.</u> He points out that there is no practice or drill as such, save in the form of play modeled directly on adult models. In the end every man in the culture knows nearly all there is to know about how to get on with life. Each person in the society has his place and if he does not conform to his established role he is reprimanded and brought back into line. In literate societies there is knowledge and skill in the culture far in excess of what any one individual knows. And so, increasingly, there develops an economical technique of instructing the young based heavily on <u>telling out of context.</u> In literate societies this practice is institutionalized in the school or teacher and both promote this abstract way of instruction which in turn leads to the ability to manipulate symbolic information.

Through adequate exposure to scholastic training it has been shown that African subjects can improve their performance on intelligence tests. McFie (1961) applied six WISC tests, including Kohs Blocks, together with a memory for Designs and Weigl Sorting test to a group of

boys at a technical training school. The subjects then received training in perceptual and memory skills during the course of their studies. He re-tested the group two years later and found most improvement in Kohs Blocks and Memory for Designs. He attributed these improvements to the experience the subjects had obtained in studying physical objects, in accurate spatial orientation and working at speed. Ombredane (1952 and 1957) has shown that the performance of Africans on the coloured version of the progressive matrices test, with age held constant, increased regularly with educational level.

It would seem then that scholastic education leads to improvement in performance on most visual-performance tests. It is no wonder then that differences in perception, reasoning, spatial abilities etc. have repeatedly been found between literates and illiterates.

As a final point of comparison between acculturated and unacculturated groups there appear to be other differences in their general environments which are worth noting. In cities, where acculturated groups are most likely to be found, the tempo of life is much faster than in rural areas. There is a greater diversity of ideas to which city-dwellers are exposed, there is greater contact with members of other social groups, more ambiguous situations are encountered and life, in general, is more stimulating. In the work situation urban dwellers learn new skills, have greater contact with Europeans and their lives are regulated by the importance of time.

It may be concluded, from this review of the major environmental factors influencing intelligence, that a rural-illiterate-tribalized environment is impoverished and that its antithesis i.e. an urban-literate-detribalized environment is, in comparison, enriched. It is expected, therefore, that most cognitive tests will reflect the effects of these differences.

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 specifities 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 recalculated 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 <u>general adaptability</u> which he regarded as being unrelated to <u>g</u> 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 mineworkers. 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, 1952b, 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 simple 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 a 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 a 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 subject 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 specifities are shown in Table 1.

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	0.18
Fret Continuation	0.69	0.26	0.54	0.46	0.33
Form Series	0.43	0.20	0.22	0.78	0.68
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

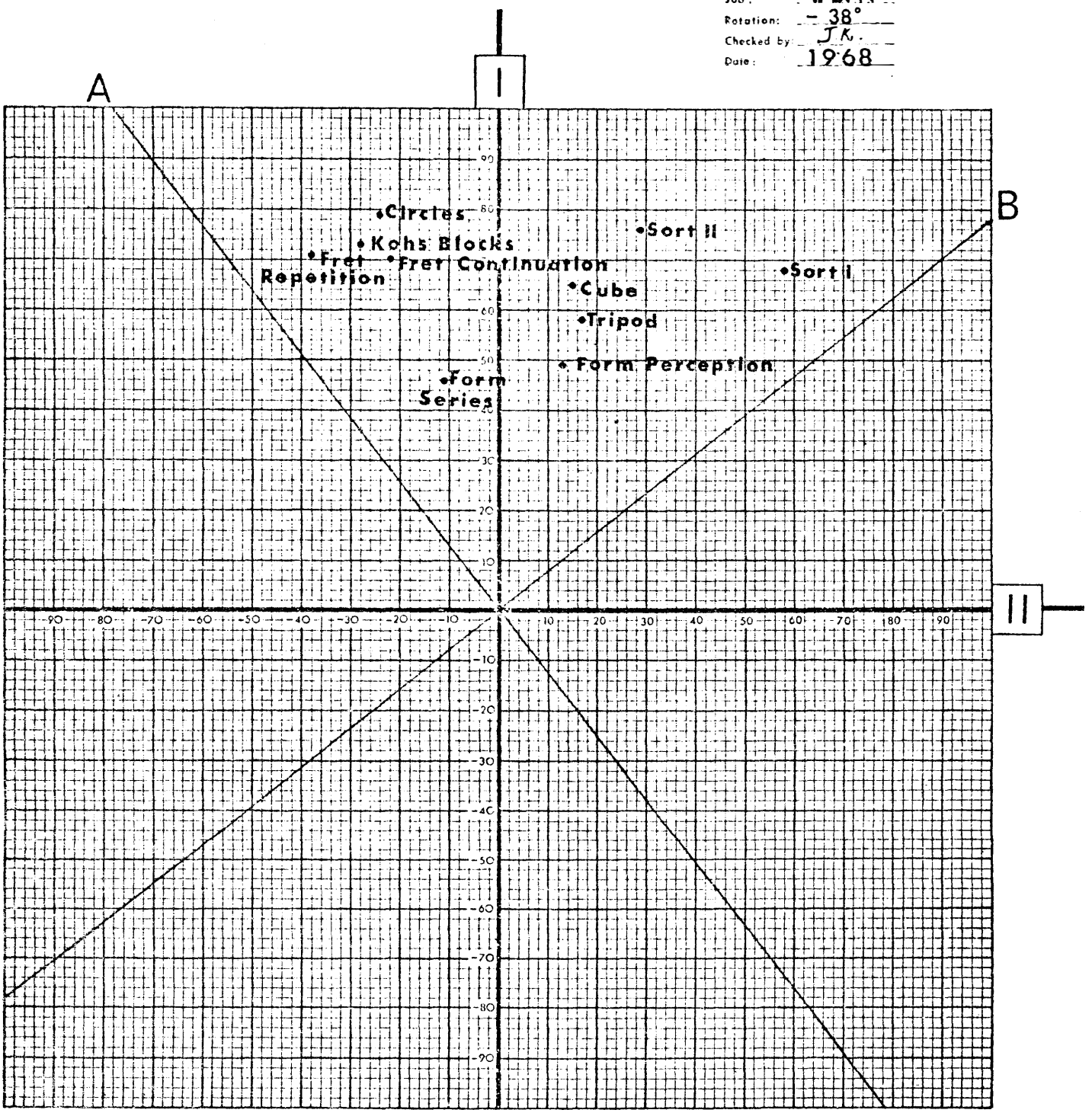
The plot of the factor loadings of the two factors against one another is shown in Figure 1.

N.I.P.R.
N.I.P.N. 161/62

Figure 1.

Perceptual Analysis and Perceptual Speed

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



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

Rotation made

This information is provided because it will be referred to again in this chapter and 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 specifities, suggesting the presence of another two possible factors. This suggestion has been taken up by the present writer. Two pilot studies were carried out to over-determine these two factors. In the first a "spatial thinking" dimension was identified and in the second a "conceptual reasoning" dimension was identified.

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-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 suggests 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 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 II.

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. On 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. 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 values.[1]

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 over learned 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 to 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. On 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

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[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.

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 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 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 it is reasonable to conclude from these studies 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 tests for measuring the realm of African intellect. In later pilot studies attention was paid to over-determining two more abilities (three, in fact, were found). Throughout these studies, the reliabilities and discriminatory powers of the tests were always kept in mind. In addition the requirements for testing uneducated, under-privileged, non-Western groups were carefully noted. In this connection the cautionary remarks of Biesheuvel (1949), Reuning (cited in Reader, 1962 - 1963), Schwarz (1961), Grant (1965), Wober (1967) and Vernon (1969) were accommodated wherever they were feasible. The pilot studies offered an opportunity to refine the measuring devices and also provided valuable information which enabled the present investigator to select a battery of tests postulated as covering a wide range of abilities. The rationale underlying the selection of these tests will be discussed in detail at the appropriate point.

Another aspect of Ferguson's theory is the concept of transfer which he regards as being crucial in his attempt to relate learning to human ability. He neither attempts to explain the psychological nature of transfer nor does he explain why or how it occurs. The term is merely restricted to provide a conceptual framework within which existing experimental data can be re-interpreted.

Transfer, according to Ferguson, is the effect of repetition on tasks different from the one practiced. Learning is a special case of transfer in which change as a result of repetition occurs from tasks similar to the one practised. Transfer is thus the more general phenomenon. Overlearned acquisitions, or abilities, have transfer effects on subsequent learning and the effects are differential i.e. different abilities have

different effects at different stages of learning. Ferguson quotes the work of Fleishman et al (1954) to support his contention. The work of Schepers (1962) gives additional weight to the argument.

As Ferguson sees the situation, at any given point in time an organism may be said to be in a particular state. This state undergoes continuous change because of a large number of circumstances both within and outside the organism. One of the factors which leads to a change in this state is the behaviour of the organism in response to specific environmental circumstances e.g. performance on a task. Any change of state leads, theoretically, to changes in an indefinitely large number of other possible forms of performance, so any covariation which can be identified between any two or more forms of performance is seen as occurring as a function of transfer. (The "environmental circumstances" to which Ferguson refers would also include, presumably, literacy and acculturation).

Certain aspects of the organism, however, attain a crude stability or invariance and are thus less susceptible than others to modification through other factors over limited ranges of time. What are conventionally regarded as the abilities of man are among these invariants. The whole process of growth and development, according to Ferguson, is directed towards the reduction of uncertainty in the behaviour of the organism, and to the establishment of invariants. Thus, behaviour becomes organized or structured and to some extent predictable.

Ferguson's remarks on transfer are relevant in the methodology of factor analysis. He argues that all learning, except some which occurs early in life, occurs in the context of prior experience. This means that an individual will learn more readily activities which are facilitated by prior acquisitions and less readily those activities which are not facilitated or inhibited by prior learning. Since in the adult many abilities are overlearned acquisitions it follows that in the development of distinctive abilities, those abilities will tend to develop which are facilitated and not inhibited by one another. This line of reasoning leads Ferguson to conclude that the positive correlation between abilities may be accounted for by the operation of positive transfer.

On the problem of how abilities are differentiated Ferguson has written:

> "Learning is clearly a process by which the abilities of man are differentiated from one another, but the process of differentiation is aided and abetted by the abilities which the individual already possesses." (1954, p. 110).

He points out that in the learning of a particular task transfer effects are probably greater at the earlier than at the later stages of learning. Thus, as learning continues the ability to perform that particular task gradually becomes differentiated from, though not independent of other variables which facilitate its differentiation. It may be concluded that the differentiation of abilities occurs, therefore, as a function of the learning process itself.

Ferguson's theory is distinctive because of its emphasis on environmental factors in the formation of ability. Although he concedes that biological factors fix certain boundaries, the evidence seems to suggest that the range of variation that results from learning is very great. Since the present study is concerned with the effects of cultural and educational factors (both of which are learned) on the structure of African intellect, Ferguson's theory is particularly important. His work has been dealt with in some detail. This was considered necessary as it will be contrasted with the Burt-Garrett differentiation hypothesis.

2. The Differentiation Hypothesis

As early as 1927, Spearman called attention to the effects of group differences on the structure of intelligence. He wrote: "Another important influence upon the saturation of an ability with g appears to be the class of person at issue." (Spearman, 1927, p. 217). At the time he reported some data suggesting that among older as well as brighter individuals abilities are more specialized and the general factor plays a relatively small part. In his 1954 article Burt refers to his "1921 Report" in which the first evidence for intellectual differentiation was recorded. Burt applied a battery of tests to a group of boys aged 9 to 10 and then retested the same group with the same tests four years later when they were 13 to 14 years old. He found that the influence of the general factor had declined and that the influence of the group factors had increased.

In the late thirties, Garrett (1938), apparently unaware of Burt's findings, proposed a differentiation hypothesis with respect to the growth of intelligence. A number of years later he put forward his hypothesis in greater detail:

> "Abstract or symbol intelligence changes in its organization as age increases from a fairly unified and general ability to a loosely organized group of abilities or factors." (Garrett, 1946, p.373).

In order to support his hypothesis he puts forward evidence from a number of

studies. He mentions four studies in which there is a decrease in intercorrelation within a test battery as the age of the samples tested increases. He also quotes two studies (Thurstone, 1938; Thurstone and Thurstone, 1941) which seem to support his hypothesis. In the later study a battery of tests was given to eighth grade children. The six interpretable factors which were extracted were intercorrelated and a "second-order general factor," which was "probably equivalent to Spearman's g", was extracted. In a second study carried out on a smaller, though similar sample, the same second-order general factor emerged. It was found that inductive reasoning and the general factor correlated to the extent of .84. Garret mentions that in the earlier study carried out by Thurstone the subjects were older and that the same factor matrix emerged regardless of whether the transformations were oblique or orthogonal. Other studies are mentioned by Garret to support his hypothesis. One of the more prominent was that carried out by Garrett et al (1935). This study is mentioned in reply to the criticism that in most of the studies he quotes as supporting the hypothesis the tests employed at successive age levels were not identical. The investigators used seven memory tests and four non-memory tests. From the description of the tests each probably represents one factor except for two tests which may represent two factors each. The subjects were in three groups aged 9, 12 and 15. The average intercorrelations for the three age groups were: boys - .30, .21, and .18; girls - .27, .30 and .10. The proportion of variance accounted for by the first factor in the three age groups was: boys - .31, .32 and .12; girls - .31, .24 and .19. Similar results were obtained by Asch (1936) and Clark (1944).

In explaining how this phenomenon occurs Garrett maintains:

> "It seems highly probable that maturation has much to do with this differentiating process, but increasing experience and diverging interests must also contribute heavily." (p. 375).

A certain amount of theoretical support for this contention is mentioned by Burt (1954). He quotes Piaget's assertion that the transitions from one level to the next in the hierarchy of operations is characterized by a new co-ordination and by a differentiation of the systems of the preceding level. Burt also mentions Gesell's observation that:

> "The sequential patterning expresses itself in progressive differentiations within a total system: environmental factors support, inflect and specify; the basic forms and order are determined by intrinsic factors". (cited in Burt, 1954, p. 79).

Hayes (1962) adds that if intelligence is seen as an adaptive mechanism, serving to promote survival, it would be appropriate for maturing individuals to devote progressively less time and energy to acquiring new abilities and progressively more time and energy to making use of those already acquired. He says this is precisely what would happen if experience-producing-drive (EPD) strength decreased in the individual. Ferguson's work, however, emphasises that as a result of cultural factors prescribing what shall be learnt and at what age, different cultural patterns will lead to different patterns of abilities. One may assume then that while intellectual growth leads to greater differentiation, the culture in which it occurs will lead to a specific patterning of abilities. One might well assume that a restrictive environment would impede the progression of differentiation. This assumption is implicit in Ferguson's theory.

Guilford (1967), having surveyed the literature on the differentiation hypothesis, maintains that the evidence seems to be against the hypothesis. He cites a number of studies which apparently contradict the studies mentioned by Burt and Garrett in support of the hypothesis. Among the more important studies mentioned by Guilford are those of Chen and Chow (1948), O'Neil (1962), Curtis (1949) and Swineford (1949). Thus it appears that in the face of conflicting evidence the hypothesis remains equivocal. Burt (1954) gives a spirited defence of the hypothesis by pointing out some of the flaws in the studies mentioned as contradicting the earlier studies. Anastasi (1958) draws attention to methodological weaknesses in many of the studies. She maintains that the tests chosen for a particular study should elicit group factors unambiguously. In other words it is desirable to have more than one test representing a factor to be identified. She rules out the use of tests such as the WISC, WAIS, Wechsler-Bellevue and Army Alpha, as they are unsuitable. She also refers to the methods of analysis, choice of subjects and the age range as factors influencing the discrepant results.

If the field is assessed on a broad methodological basis certain trends may be discerned. The kinds of evidence for and against the hypothesis have been derived from intercorrelations between tests and factor analysis. If the hypothesis holds it is expected that a systematic decrease in the average size of the intercorrelations between tests with increasing age would be discerned. In other words zero correlations for younger groups should be absent, while in older groups they should be common. It should be pointed out that the size of correlations depends on the reliabilities of the tests - the lower the reliabilities the lower the correlations. Thus it is desirable to have tests with good reliabilities. In

making comparisons among different age groups, if the same battery is used, it is often impossible to retain the reliability of the test. Attempts to correct the correlations for attenuation can in addition lead to gross distortions (cf. McNemar, 1955, pp. 159 - 160).

Another implication of the hypothesis is that as a result of increasing age the correlations among factors should decrease. The customary way of estimating correlations among factors has been to use cosines of angles between pairs of primary (factor) vectors. Guilford (1967) does not accept this procedure as too much depends on the particular combination of tests that are analysed in a particular battery. If it is to be used then it is imperative that the same battery of tests be given to the groups under investigation. For purposes of the present study oblique rotation was used, but in an original and unique analysis. The technique employed will be described at the appropriate time.

The differentiation hypothesis would seem to be appropriate for an hierarchical model of intellectual factors, with successions of differentiations, first into broader abilities and then into narrower abilities. The majority of studies on this hypothesis, in fact, chose this model. Choice of this model is dependent on the appearance of a g factor. There should be a strong g factor in analysis of the abilities of children which should decrease in absolute and relative weight in the tests as age increases. In many studies the g test has been impossible to apply simply because g was not found. Those who insist on a g factor do obtain one but there is a great deal of arbitrariness as to where to locate its axis. This, of course, has some bearing upon the factor's relative weight or importance in the particular weight.

Yet another problem is the question of how many group factors to extract from the intercorrelations of a battery of tests. This question has been one of the most debated in factor analysis. Many investigators (e.g. Lienert and Crott, 1964) extract unequal numbers of factors from the intercorrelation matrices of their groups under consideration and use this as a criterion of differentiation. Others have used Kaiser's criterion of number of latent groups exceeding unity. This is also a rule-of-thumb decision, and although adequate for a well-defined set of factors, difficulties arise with it, when in different groups, gross fluctuations in factor variance are present. In some cases latent roots of .9999 have been obtained, which although falling just short of the criterion, are not regarded as indicating that another factor should be extracted. In the experience of the writer it has also been found when use is made of Kaiser's

decision rule, that in some cases, the residual matrix has indicated that quite a great deal of variance has not been accounted for. An inspection of the residual matrix has suggested the presence of other factors.

Although the differentiation hypothesis occupies an equivocal position in psychology it has generated a great deal of research. It has been applied to demonstrate the differentiating effects of a number of variables. Its application to the effects of an increase in age has already been referred to. The studies already mentioned refer mainly to age groups up to the early twenties. According to a number of investigators, intelligence as measured by tests increases rather markedly up to 18 to 21 years of age and then decreases rather slowly. (cf. Anastasi, 1958 pp. 239-243). According to Hofstätter (1954) the factor structure of intelligence for children, adolescents and adults all differ markedly. In a study of the abilities over a broader age range than those reported earlier, Balinsky (1941) using the Wechsler-Bellevue test battery, showed that the proportion of variance of the first centroid factor decreased from .38 in 9 year-olds to .20 in 25 - 29 year-olds with a subsequent increase to .45 in 50 - 59 year-olds. Lienert and Crott (1964) demonstrated similar findings. They make a point of associating differentiation with intelligence level. Wewetzer (1958) found a positive correlation between the degree of differentiation and the mean test performance. Similar findings were reported by Lienert (1961), who found that differences in intelligence level within the same age range are also accompanied by differentiation. In another study Lienert (1964) demonstrated that during an experimental lowering of performance level by means of pharmacological stress (the drug used was lysergic acid) a de-differentiation of the factor structure occurred. These findings led Lienert & Crott (1964) to reformulate the differentiation hypothesis to cover the broad range of age. They have written:

> "Intelligence, as measured by psychological tests, increases with age until about the end of puberty, and this increase is accompanied by a differentiation of the intelligence factor structure. On the other hand, structural integration takes place during adulthood, and it is parallelled by a corresponding decrease in test performance. This may be called differentiation-integration hypothesis" (p. 159).

Attention has been paid, in this review, to the changing composition of intelligence as a function of age. This was done purely because most of the work on the differentiation hypothesis has been carried out on this variable. The studies reviewed were chosen because they reflected some of the more important methodological problems one encounters when

testing the hypothesis. Differences in the patterning of ability as a function of education (Vernon and Parry, 1949); socioeconomic and ethnic groups (Roberts and Robinson, 1952) and culture (Guthrie, 1963) have been found. To the writer's knowledge, no attempt as yet, has been made to relate the differentiation hypothesis to cultural differences.

3. Formulation of Hypotheses

For purposes of this study Kroeber and Kluckhohn's definition of culture will be accpted.

> "Culture consists of patterns, explicit and implicit, of and for behaviour acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiments in artifacts; the essential core of culture consists of traditional (i.e., historically derived and selected) ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, on the other as conditioning elements of further action." (Kroeber and Kluckhohn, 1963, p. 357).

Emphasis will be placed on two aspects of culture, namely, literacy and urbanization. It has been shown in the previous chapter that a rural-illiterate environment may be considered impoverished and that an urban-literate environment may be considered, by comparison, to be enriched. Having reviewed factors affecting the nature of African intelligence, what is known about the structure of African intelligence and hypotheses relating to the differentiation of abilities it will now be possible to present the hypotheses which will be tested in the present investigation. The sample selected for the study was drawn from among the Venda people. The investigation was confined to adult Venda males. Two samples, one from an urban area and the other from a rural area, were drawn for comparative purposes. Fuller details on the nature of the sample will be given in the description of the final study.

The first hypothesis states that, as a result of the positive effects of literacy and urbanization, literate-urban Venda males will perform significantly better on a battery of cognitive tests than illiterate-rural Venda males.

The second hypothesis states that as cultural factors prescribe what shall be learned and at what age; literate-urban Venda males will show a different pattern of abilities in response to a battery of tests when compared with illiterate-rural Venda males who responded to the same battery.

The third hypothesis states that, literate-urban Venda males, because they have been exposed to an enriched environment will display greater differentiation in response to a battery of tests than illiterate-rural Venda males whose environment, by comparison, is impoverished.

In order to test these hypotheses adequately two control groups were added for comparative purposes. An urban illiterate sample and a rural literate sample formed these control groups.

CHAPTER III.

THE ORGANIZATION OF MENTAL ABILITIES OF A VENDA GROUP IN CULTURAL TRANSITION.

1. Introduction

Studies on the cognitive abilities of Africans may be divided into two classes. The first kind arose out of the need to have tests with which to classify or select subjects in industry or in schools. Once tests had been constructed, investigators utilized them in fundamental studies aimed at mapping the structure of intellect. As a result of a number of investigations which suggested that the structure of African intellect was far less complex than that of Europeans, interest in the structure of intellect of illiterate and semi-literate subjects dwindled. The focus of attention shifted largely towards subjects who were at schools in the higher classes.

The general attitude which emerged from these earlier studies was that, as unitary factors were typically found, the structure of the intellect of illiterate and semi-literate Africans could best be described in terms of blanket concepts such as g and general adaptability. Two factors influenced this view of African intelligence. The first was that there were not really sufficiently diverse numbers of tests to obtain a clear picture of abilities. Commenting on this aspect Grant and Schepers (1969) observed that, "..... the factor structures obtained were more descriptive of the status of test development at that particular moment in time than of the structure of intellect." (p. 181). The second aspect which influenced this particular view of African intellect was the fact that all the investigators were adherents to the British factor analytic school of thought. It was not surprising then that through a lack of diverse enough test batteries and the inevitable discovery of g that African intellect was described as being "simpler" than the intellect of Europeans. In many ways these findings effectively stifled further research in this area.

In recent years a great deal of inter-cultural research has been undertaken. Most of the results have been interesting but many have been ambiguous. In explaining their results inter-cultural investigators are often hard pressed to find acceptable explanations. One of the main reasons for this situation is the fact that important variables which are likely to affect the outcome of their findings are largely neglected. While in no way meaning to disparage inter-cultural research, it is felt that more

attention, in future, should be paid to intra-cultural research. In other words, the effects of certain variables on cognition, within a culture, should be examined thoroughly before an explanation of differences between cultures is offered. As in most research, it is often necessary to go back to fundamental issues before making progress on the problem which has been selected for investigation.

In the investigation to be reported here the issues mentioned above were kept in mind At the time of formulating the study there was a strong suspicion that the structure of African intellect was far more complex than most studies to date have suggested. This belief led the investigator to go back to the fundamental task of assembling a diverse battery of tests with which to conduct the study. By choosing to investigate illiterate and semi-literate subjects, severe restrictions were placed on the selection of tests. The tests, in general, had to be confined to those of a performance kind.

In the literature, the two most frequently recurring variables which have been shown to influence the level of performance on cognitive tasks are literacy and other factors which are likely to improve as a result of moving from a rural to an urban environment. It was decided, therefore, that the effects of these two variables on intelligence should be examined. It was also decided that the investigation should be confined to a single ethnic group. This is an aspect of studies on non-western groups which Doob (1965), for one, has greatly emphasized.

2. Aim and Scope of the Study

The aim of this study is to test the hypotheses stated at the end of Chapter II. Briefly, the essence of these hypotheses was:

that, literacy and urbanization lead to better performances on cognitive tests;

that, as cultures prescribe what shall be learned and at what age, a change in culture (in terms of literacy and urbanization) leads to a change in the pattern of abilities of those who have undergone this change;

that, an enriched environment (in terms of literacy and urbanization) leads to a greater differentiation of abilities.

In each hypothesis literacy and urbanization were taken as two specific aspects of culture. Both aspects, however, are regarded as factors which lead to not only better performances on cognitive tests, but also

to changes in the actual structure and differentiation of mental abilities. From any review of the nature of human intelligence it will be noticed that intelligence is frequently defined in terms of adaptation to the environment. This does not, however, exclude the importance of biogenic factors. According to Ferguson (1956) they "fix limiting conditions." Within these boundaries, however, the range of variation in ability attributable to learning is substantial. If intelligence arises partly out of the individual's adaptation to the environment, it would then be reasonable to assume that a change in environment or the conditions under which learning is to occur would lead to a change in both the level of performance on intelligence tests and in the structure of intelligence. Of course, as both the theories of Hebb and Ferguson imply, the age at which an individual adapts to his environment is of crucial importance.

In Chapter II two theories on the differentiation of abilities were presented i.e. Ferguson's theory and the Burt-Garret hypothesis. In the investigation to be reported here the meaning of "differentiation" in terms of these two theories will be examined. The third hypothesis will be tested in terms of both theories. In a sense, by contrasting how well the results fit these two theories, the factor analytic methodology of the British and American schools of thought will be assessed in terms of their validities.

3. Description and Selection of the Sample

The sample which was selected for testing the three hypotheses was drawn from among the Venda ethnic group. The traditional home of the Venda is in the North-Eastern part of the Transvaal. The majority of Venda appear to have lived in the mountains of the Zoutpansberg from earliest times, as they still do to-day. The country is rugged and therefore as a group they have lived in relative isolation since they occupied this area. Even today, contact with the influence of Western civilization is restricted. Apart from missionary schools and hospitals, European farmers, health officials and a few enterprises such as irrigation schemes and saw mills the area has been left largely untouched by the spread of Western culture. This is especially true of those more isolated mountainous regions of the area. A comprehensive description of both the region and the people has been given by Stayt (1968). Like most of the Bantu-speaking tribes of Southern Africa Venda society has an elaborate kinship system and a complex system of social grouping. The economy is still of a subsistence kind though with the migration of labour it is slowly being influenced by the effects of a money economy. Much of this is likely to change in the near

future as mineral deposits have been found in the area and this will lead to mines being opened.

A sample of 250 subjects was drawn from the Eastern sub-group of Venda and more specifically from the area in which Chief Nelwamondo has sovereignity. According to van Warmelo (1956) this group has "..... been least subject to foreigh influences and are no doubt the purest Venda to-day.." (p.65). In selecting the sample some attempt was made to obtain a random sample. Adult male Vendas were drawn from five different geographical areas. There were, however, numerous problems associated with obtaining this sample. Some of these problems will be mentioned briefly. Many of the selected subjects simply refused to be tested and on those days when it rained very few subjects could be persuaded to be transported to the testing centre which was situated at the Tshilidzini mission hospital. The testing of the subjects took place over a period of two days i.e. in the morning of the first day and the afternoon of the second day. Some subjects came for testing on the first day but failed to return on the second. Some subjects claimed to be Venda when they were selected but on close questioning in the testing room turned out to be Shangaan. In general it may be stated unequivocally that under these conditions it is virtually impossible to obtain a random sample in the rural areas.

A further sample of 248 subjects was obtained from the Chiawelo Township in the South Western Townships (SOWETO) of Johannesburg. In drawing this sample a voter's roll of the occupants of Chiawelo was obtained and every fourth house was selected. Provision was made to select, at random, one member of all the eligible members in a household. Use was made of the Kish grid system. One would expect to have less difficulty in selecting a random sample from an urban group. This, however, did not prove to be the case. Many of the subjects selected for the sample simply refused to be tested. In some cases although the subject was willing to be tested his employer refused to give him two days off from work. Each employer was visited and asked whether he would allow the selected subject two days leave. The majority were willing to give their permission. In some cases subjects could only be tested on half the tests as they did not turn up for testing on the second day

The urban part of the sample was not restricted to the subjects of Chief Nelwamondo. There were, in fact, subjects from most of the chieftainships in Vendaland. Testing of the subjects took place in the offices of the Johannesburg Non-European Affairs Department. The testing conditions were comparably good in both the rural and urban areas.

In comparing the two samples which were drawn the urban group is probably more representative of Venda in the cities than the rural sample is representative of country Venda. Neither can, however be described as meeting the specifications for random sampling. In general, although many problems were encountered in selecting the sample, there was a great deal of goodwill and co-operation on the part of those who were included in the sample. All subjects were paid for being tested and in those cases where employees of selected subjects refused to pay their wages for the two days, these were paid out of testing funds.

Subjects were eligible for inclusion in the sample if they were: Venda, male, between the ages of 17 and 55, had no scholastic education or had gone only as far as standard six, were physically fit and were not disabled in any way and had been resident in the area where they were encountered for a period of at least six months. The majority of those finally selected had been in the particular area for at least twelve months.

For purposes of testing the mental abilities of the subjects those who had had eight years of scholastic education were excluded from the sample. This was done with the reliability of the tests in mind. Most standard six subjects score full marks on the kind of test used for samples of this kind. By eliminating standard sixes from the sample the number of subjects in the rural group dropped to 214 and in the urban group 218 subjects remained. In other words 36 were excluded from the rural group and 30 were excluded from the urban group. Thus the proportion excluded from the two groups was more or less equal.

4. The Urban-Rural Scale Applied to the Sample

The Urban-Rural Scale (Grant, 1969) was applied to all 498 subjects who were originally selected. The results for the two groups (rural and urban) were item-analysed separately and then in a combined form by means of the NP.50 item analysis programme (cf. Appendix A). One of the items, namely item 17 (cf. Appendix A) was excluded from the analysis as 95% of the total sample disagreed with the statement. In addition the key for item 8 was reversed. In other words (a) was regarded as an urban response.

The reliability coefficient obtained for the rural group alone was .49 and for the urban group alone .73. For the two groups combined the reliability coefficient was .76. These reliability coefficients were all obtained by means of the Kuder-Richardson formula 20. For the two groups combined, the reliability of the scale was also determined by means of Horst's (1953) formula 21. The reliability coefficient obtained by means

of this formula was .79.

The rural group was more homogeneous than the urban group and this is the main reason for the discrepancy between the two coefficients. In order for a measuring device to achieve optimum reliability the sample on which it is tested should be as heterogeneous as possible. From the reliabilities reported it may be concluded that the two Venda groups are far more homogeneous than the Zulu sample on which the Urban-Rural scale was developed. It should be remembered though, that the Zulu sample was specially selected in such a way that maximum variance on the scale could be achieved.

FIGURE 2.

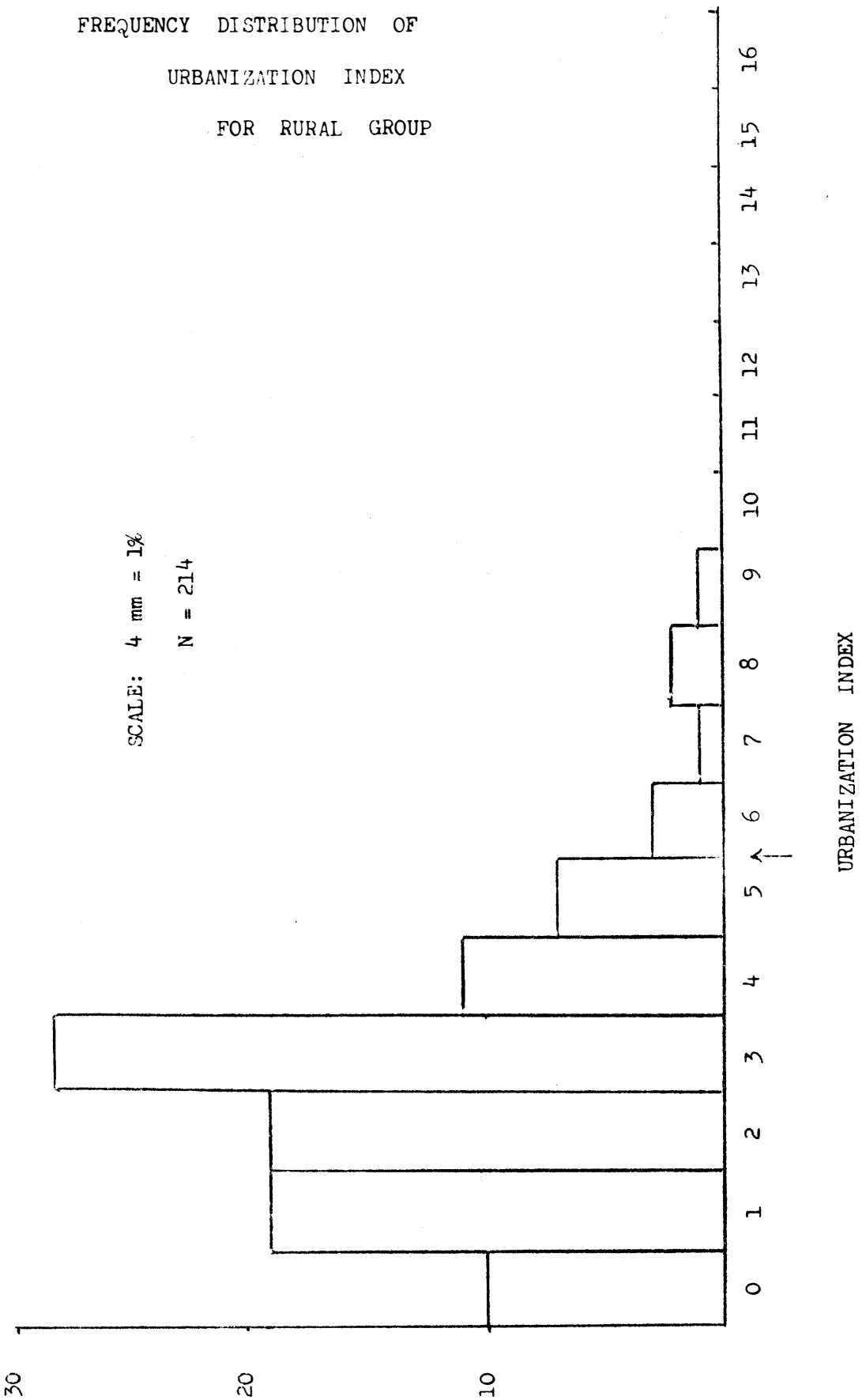
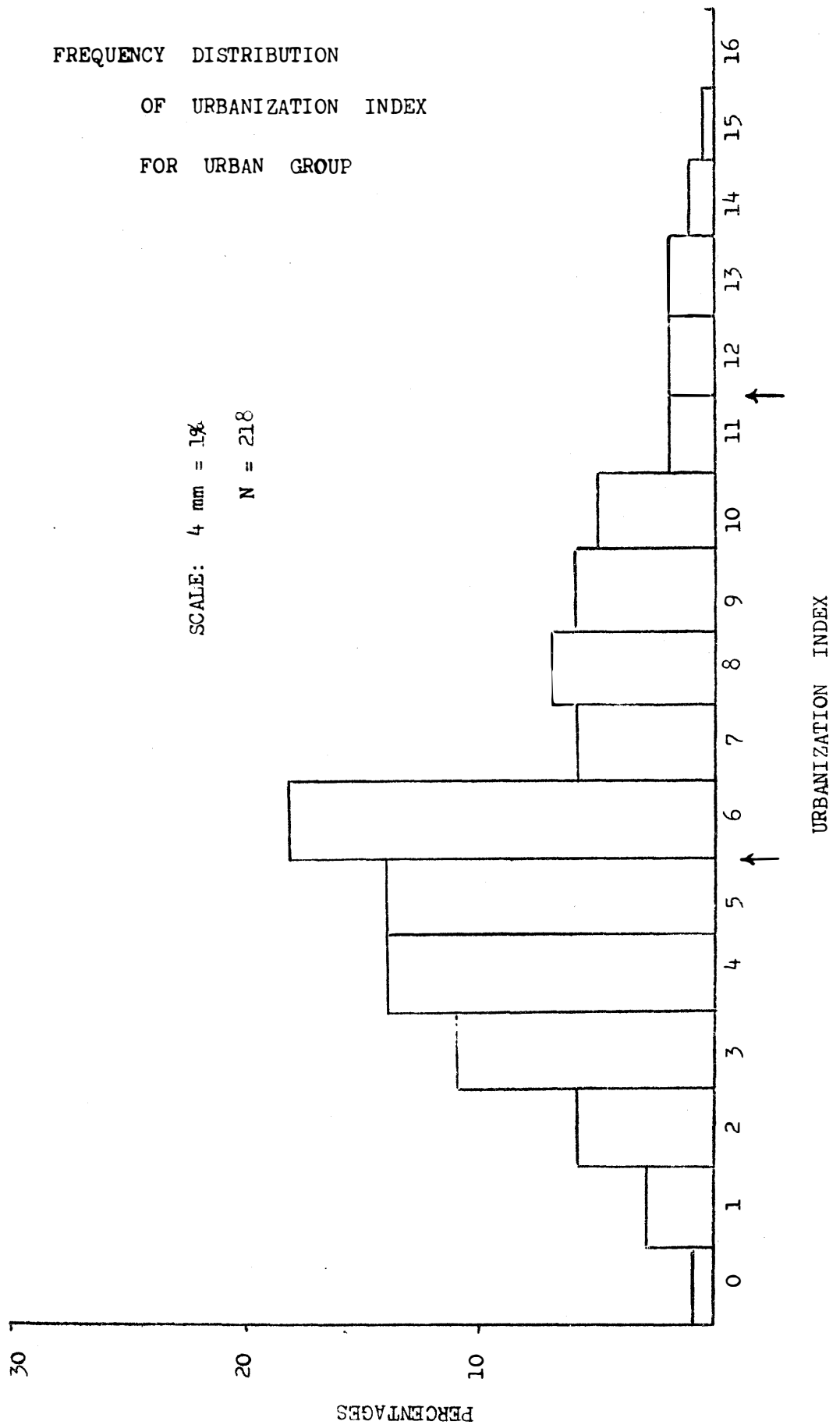

FREQUENCY DISTRIBUTION OF
URBANIZATION INDEX
FOR RURAL GROUP
SCALE: 4 mm = 1%
N = 214
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
URBANIZATION INDEX

FIGURE 3.


FREQUENCY DISTRIBUTION
OF URBANIZATION INDEX
FOR URBAN GROUP
SCALE: 4 mm = 1%
N = 218
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
URBANIZATION INDEX
10
20
30
PERCENTAGES

Figures 2 and 3 show the frequency distributions of the urbanization index for the rural and urban groups respectively. In both distributions, subjects with standard six have been excluded. Both distributions are positively skewed but the distribution for the urban group is less exaggerated. It also has a greater variance than the distribution for the rural group. The distribution for the rural group was not surprising as one would expect rural individuals to score lowly on the Urban-Rural scale. For the urban group it had been expected that many more subjects would have fallen in the class 12 and above, which is regarded as a truly urban category. (cf. Grant, 1969). Two possible explanations may be put forward to explain these distributions. Either the scale is invalid for the Venda sample or Venda people, in general, are resistant to the changes which urbanization brings about.

The first point of view will be considered in terms of construct validity. Although the reliability is lower for the Venda sample than it was for the Zulu sample it is still acceptably high. It was shown in Grant's 1969 article that the items yielding the optimum reliability of the scale are virtually the same as the items describing the major principal axis. It may therefore be assumed, in view of the size of the reliability coefficient obtained for the Venda group, that the items would also describe a similar dimension. In terms of the instrinsic content validity of the scale the Urban-Rural Scale also appears to be valid. This is especially true after having eliminated a non-valid item and having adjusted another.

It would seem that the likeliest explanation for the positively skewed distribution obtained for the urban sample is that urban Venda within this educational range are still rural-oriented. Evidence for this contention may be obtained by examining one of the item parameters. Less than 20% of the urban sample (excluding the standard sixes) were born in an urban area. The rest of the sample immigrated to the city after the age of 18 years. In the Zulu sample, place of birth was shown to be the most important single indicator of urbanization. For the Venda sample although it was the third most reliable item it may also be assumed to be an important indicator. In the light of this observation it may not be so surprising that the distribution is positively skewed. This impression is also reinforced by certain observations, regarding the Venda as a group, made in the report of the Non-European Affairs Department (1965). It is probable that the Venda are resistant to change because of the well-defined and integrated socio-cultural aspects of Venda life. They may be regarded, like Mayer's (1961) Xhosa group to be largely "encapsulated." A factor encourag-

ing this isolation might well be the fact that Chiawelo is supposed to be exclusively for Venda inhabitants. (A few Shangaans are to be found living in Chiawelo.) It is interesting to note that the Venda have a saying:

"Muvenḓa Mubikwa na ive; ive ḽa vhibra Muvenḓa a sala."

which roughly translated means:

"Cook the Venda with a stone; the stone melts and the Venda remains."

In order to obtain an extreme rural group the 15 subjects in the rural group who obtained a score of above 5 were excluded. This left a total of 199 subjects. The urban group was left unchanged (N = 218). As the variance on the Urban-Rural scale was so restricted and because the error of measurement had increased as a result of the lowered reliability it was decided that the groups would be treated separately in terms of place of residence. This was also done to achieve comparable numbers in the two groups. These two groups were further sub-divided into those with nil schooling and those with schooling between 1 and 7 years. Thus four groups were constituted which henceforth will be referred to as Rural Illiterate (RI, N = 94), Urban Illiterate (UI, N = 93), Rural Literate (RL, N = 105) and Urban Literate (UL, N = 125). Further information relating to the age, level of schooling and urbanization indices of the four groups will be found in Tables 4 to 7.

It will be noticed from these tables that the Rural Literate group is much younger than the other three groups. This came about as a result of age and education being negatively correlated and because the rural areas are depleted of men in the age range 25 to 45. For rural samples the distribution of age is usually bi-modal as men in the prime of life move to the cities to seek work. The rural areas are thus left with younger and older men. In the urban sample the distribution of age was similar to that observed for SOWETO in general (Non-European Affairs Department Report, 1965). In interpreting the results obtained on the cognitive tests age discrepancies will therefore be taken into account.

5. The Selection of the Final Battery

Two pilot studies were conducted with the express intention of selecting a diverse battery of tests. Including Grant and Schepers's study, altogether 18 different tests were examined from the point of view of their reliabilities and the factors on which they loaded. It was decided that 16 of the tests would be used in the final study. The Abstract Spatial Relations Test and the Fill-the-Square Test were excluded on the grounds of doubtful reliability. The tests chosen for the final battery are listed in Table 2.

TABLE 2

Summary of loadings of tests on factors

(Derived from pilot studies)

TEST	Grant and Schepers		Pilot Study I		Pilot Study II	
	P.S.	P.A.	P.F.R.	P.S.	C.R.	Sp.
1. Sorting I	.88			.87	.51	.62
2. Sorting II	.70	.42		.78	.73	.40
3. Cube	.52	.42	.43	.51		.66
4. Tripod	.49	.35	.37	.60		.73
5. Form Percep.	.39		.68	.36	--	--
6. F.B.II	--	--	.61		--	--
7. F.B.III	--	--	.58		--	--
8. F.B.IV	--	--	.74		--	--
9. Fret Rep.		.79	--	--	--	--
10. Fret Con.		.69	--	--	--	--
11. Pattern Rep.		.75	--	--	--	--
12. Circles	.30	.77	--	--	--	--
13. Form Series		.43	--	--	.76	.39
14. Symbol Series	--	--	--	--	.70	
15. Squares Detec.	--	--	--	--	.40	.53
16. Symco	--	--	--	--	.48	.40

Double dashes (--) indicates test not used in study.

Blank spaces indicate loadings of less than .30.

Descriptions of these tests will be found in Appendix C.

In the same table the factors on which each test loaded in the pilot studies are also summarised. The factors obtained from the pilot studies may be described in the following terms:

(a) Perceptual Speed (P.S.)

This factor is characterized by the task of finding in a mass of destracting material a given configuration which is borne in mind during the search. This includes the ability to compare pairs of items. Perceived configurations are compared with remembered ones. Tests of this ability are all speeded and in no case is the configuration so hidden as to cause difficulty if plenty of time were available.

(b) Perceptual Analysis (P.A.)

This factor is characterized by the task of breaking down or analysing perceptual material into its component parts. Having analysed the material the subject has to discover the similarities and differences which exist among the stimuli. He then has to synthesize the material in such a way that the given configuration or part of the given configuration is duplicated.

(c) Perception of Form Relations (P.F.R.)

This factor is characterized by the task of having to manipulate visual objects (i.e. forms) in such a way that when a correct relationship is obtained it reproduces part of or the whole of a new form which is merely suggested by an outline. The subject finds it necessary to rotate, turn, twist or invert these forms while seeking a solution. He is required to recognize the new position, location or changed appearance of objects which have been moved or modified within a stimulus pattern which is usually complex. In the early stages of the task a great deal of trial and error behaviour may be observed.

(d) Conceptual Reasoning (C.R.)

This factor is defined as the ability to discover or apply a rule by relating concepts to one another. Before this can be carried out the attributes of the given stimuli have to be defined and distinguished from one another. Having sorted out the differences and similarities among the stimuli the subject is required to discover the culling rule governing the sequence of stimuli, or he has to apply a given rule to the stimuli presented.

In some cases attributes in one and the same item may have different rules governing them. The subject is required then, to discover the rules governing each attribute. For this reason quite a heavy load is placed on immediate memory recall. Inferences have to be made, usually, from compounds of "fused" stimuli. In other words the attributes which are subject to change have to be disembedded from the complex of attributes.

(e) Space (Sp.)

This factor represents the ability to perceive spatial patterns accurately and to compare them with each other. In other words the subject always has a spatial model available against which he is able to compare the model under construction. This factor includes the perception of 3-dimensional space.

In the pilot studies conducted the only tests which were common to all three studies were the sub-tests of the G.A.B. These studies were all of an exploratory nature. Thus, the results obtained should be regarded as tentative. On a superficial basis it would seem that the 16 tests potentially measure five abilities. It is also clear from the factor loadings that some of the tests are multi-dimensional.

Before the battery was finalised some of the tests were modified. The items of the Symbol Series were re-arranged on the basis of the difficulty values obtained in the pilot study. Kohs blocks was modified by replacing the cubes with tiles and the patterns were printed in a booklet form. The test was renamed the Pattern Reproduction test. The last five items in the Symmetry Completion Test were dropped and a time limit of 1½ minutes was imposed on each item of the Squares Detection Test.

6. Administration of the Final Battery and Procedure

The four sub-tests of the G.A.B. and the three Formboards were administered by means of a silent 16 mm. ciné film. Formboard I was used as a buffer test but it was not scored.

The rest of the tests were administered verbally in Venda with the aid of demonstration posters. Manuals, with standard test patters were written and translated into Venda. Two Venda-speaking Africans were trained in the administration of the tests. Manuals including norms based on the samples tested are available for inspection in the Test Library of the Psychometric Division of the National Institute for Personnel Research.

Although testing was carried out in two different testing centres the tests were administered in the same sequence and under virtually the same conditions. The sequence of tests and the time limits are shown in Table 3. In the same table the rest pauses and lunch break are also reflected. Tests 1 to 13 were administered during the morning of the first day and tests 14 to 17 were administered on the afternoon of the second day. Groups of fifteen or less were tested in each session. Four invigilators assisted the test administrator in handing out the test materials, marking the tests, and collecting the materials once tests had been completed by the subjects. One of the assistants operated the stop watch and gong for those tests which were timed. At the end of each testing session subjects were thanked for doing the tests and were then paid for their efforts.

7. Statistical Analysis and Results

In the analysis of the data which follows all calculations are based on raw scores except where it is specifically mentioned that other scores were used. The analysis will be divided into five sections and each will be presented under separate headings.

(a) General Descriptive Statistics

The means, standard deviations, coefficients of skewness and kurtosis and observed ranges of the four groups on the sixteen tests and the biographical variables are shown in Tables 4 to 7. The reliability coefficients of the sixteen tests are also reflected in these tables. Sichel's (1950) modification of the Kuder-Richardson formula 3 was used to calculate the reliabilities of the sub-tests of the G.A.B. and the Formboards. As no appropriate technique is available for calculating the reliabilities of the Formboards separately they were treated as sub-trials of the same test and each board was given the same reliability coefficient. The Kuder-Richardson formula 21 with Tucker's correction (Kuder and Richardson, 1937; Tucker, 1949) was used to calculate the reliabilities of the two Fret tests, the Form Series Test, the Symbol Series Test and the Symmetry Completion Test. Ferguson's (1951) extension of the Kuder-Richardson formula 20 was used to calculate the reliabilties of the Form Perception Test, the Pattern Reproduction Test, the Circles Test and the Squares Detection Test.

(b) Comparison of Mean levels of Performance on the Tests

Before comparing the mean levels of performance of the four groups on the tests F-ratios were calculated in order to determine whether differ-

TABLE 3

Sequence and times of final test battery

SEQUENCE	TEST	TIMES
1.	Sorting I	(i) 2'30" (ii) 1'30"
2.	Fret Repetition	Untimed
3.	Fret Continuation	Untimed
4.	Form Series	Untimed
	BREAK - 10 MINUTES	
5.	Form Perception	2' per item.
6.	Pattern Reproduction	(P) 30" (i) 30" (ii) 30" (iii) 1'30" (iv) 2' (v) 4' (vi) 5'
7.	Symbol Series	Untimed
8.	Sorting	(i) 5' (ii) 3'
	BREAK - 10 MINUTES	
9.	Formboard I	30"
10.	Formboard II	1'45"
11.	Formboard III	4'
12.	Formboard IV	10'
13.	Cube Construction	(i) 2' (ii) 5' (iii) 7' (iv) 10'
	LUNCH - ONE HOUR	
14.	Circles	(i) - (v) 1'30", (vi) - (xiii) 1'
15.	Squares Detection	1'30" per item.
16.	Symmetry Completion	Untimed.
17.	Tripod Assembly	(i) 3' (ii) 2' (iii) 2'

TABLE 4

RURAL ILLITERATE

Means, standard deviations, skewness, kurtosis, observed ranges and reliabilities

Variable	$\bar{X}$	S.D.	Sk	Kt	OBSERVED RANGE		Reliability
					Max	Min	
1. Sorting I	67.33	32.68	0.53	0.05	159	2	.74
2. Sorting II	58.97	29.54	0.52	-0.07	145	9	.91
3. Cube	20.11	13.24	0.88	0.21	60	2	.87
4. Tripod	24.56	15.35	0.68	-0.33	63	0	.88
5. Form Percep.	18.73	5.21	-0.65	-0.43	27	5	.63
6. F.B.II	4.67	3.69	0.98	0.58	17	0	.71
7. F.B.III	9.33	5.23	0.56	-0.72	20	0	.71
8. F.B.IV	7.00	4.86	2.09	4.74	24	0	.71
9. Fret. Rep.	6.53	3.05	-0.75	-0.54	10	0	.86
10. Fret. Con.	5.17	3.56	0.00	-1.54	10	0	.92
11. Pattern Rep.	16.28	8.24	0.90	0.52	39	2	.72
12. Circles	25.18	9.45	-0.16	-0.66	48	6	.84
13. Form Series	5.30	4.73	0.64	-0.47	18	0	.91
14. Symbol Series	3.27	2.89	0.91	0.25	12	0	.83
15. Squares Detec.	14.43	7.09	-0.09	-0.54	30	0	.81
16. Symco	7.12	5.08	0.60	-0.68	19	0	.89
17. Age	41.85	9.12	-0.58	-0.54	55	20	
18. Education	0.00	0.00	0.00	0.00	0	0	
19. Urb. Index	1.85	1.25	0.32	-0.38	5	0	

TABLE 5

URBAN ILLITERATE

Means, standard deviations, skewness, kurtosis, observed ranges and reliabilities

Variable	$\bar{X}$	S.D.	Sk	Kt	OBSERVED RANGE Max	OBSERVED RANGE Min	Reliability
1. Sorting I	100.83	36.94	-0.14	-0.84	160	18	.81
2. Sorting II	86.70	33.34	0.41	-0.74	157	27	.86
3. Cube	25.84	12.97	0.21	-0.69	60	0	.79
4. Tripod	32.59	14.14	0.15	-0.19	63	0	.83
5. Form Percep.	20.93	4.60	-0.76	0.02	27	7	.57
6. F.B.II	6.15	3.49	0.61	0.08	16	0	.63
7. F.B.III	11.90	5.23	-0.09	-0.94	20	0	.63
8. F.B.IV	8.43	5.28	1.29	1.59	24	0	.63
9. Fret Rep.	7.68	2.44	-1.34	1.07	10	1	.83
10. Fret Con.	6.42	3.03	-0.63	-0.85	10	0	.87
11. Pattern Rep.	20.53	8.99	0.36	-0.81	39	4	.70
12. Circles	30.56	7.73	-0.65	0.56	47	6	.74
13. Form Series	7.27	4.60	0.43	-0.88	18	1	.87
14. Symbol Series	4.26	3.23	0.40	-0.89	12	0	.84
15. Squares Detec.	16.16	7.10	0.07	-0.81	30	1	.78
16. Symco	9.12	5.41	0.12	-1.18	20	0	.89
17. Age	45.39	7.11	-0.70	0.18	55	24	
18. Education	0.00	0.00	0.00	0.00	0	0	
19. Urb. Index	5.33	2.60	0.54	0.23	13	0	

TABLE 6

RURAL LITERATE

Means, standard deviations, skewness, kurtosis, observed ranges and reliabilities

Variable	$\bar{X}$	S.D.	Sk	Kt	OBSERVED RANGE Max	Min	Reliability
1. Sorting I	89.09	34.67	0.09	-0.72	160	10	.79
2. Sorting II	102.31	36.60	-0.33	-0.98	156	19	.91
3. Cube	24.44	12.67	0.58	-0.29	60	1	.79
4. Tripod	34.84	14.74	0.06	-0.77	63	0	.81
5. Form Percep.	20.36	5.04	-1.04	1.03	27	3	.66
6. F.B.II	7.14	4.03	0.83	0.99	20	0	.67
7. F.B.III	11.92	5.60	-0.09	-1.09	20	0	.67
8. F.B.IV	8.11	4.78	1.79	3.61	24	1	.67
9. Fret Rep.	8.81	1.74	-2.58	8.62	10	0	.83
10. Fret Con.	7.73	2.60	-1.35	0.98	10	0	.87
11. Pattern Rep.	22.73	9.67	0.02	-1.02	39	5	.78
12. Circles	35.06	7.67	-1.23	3.39	48	2	.78
13. Form Series	9.89	4.47	-0.05	-0.73	18	0	.85
14. Symbol Series	6.34	3.52	-0.06	-1.11	12	0	.86
15. Squares Detec.	20.04	6.24	-0.22	-0.69	30	5	.78
16. Symco	11.27	5.37	-0.43	-0.84	20	0	.91
17. Age	26.12	7.95	1.52	1.84	55	17	
18. Education	4.34	1.73	-0.09	-1.02	7	1	
19. Urb. Index	2.73	1.38	-0.24	-0.66	5	0	

TABLE 7

URBAN LITERATE

Means, standard deviations, skewness, kurtosis, observed ranges and reliabilities

Variable	$\bar{X}$	S.D.	Sk	Kt	OBSERVED RANGE Max	Min	Reliability
1. Sorting I	118.78	34.15	-0.92	-0.02	160	27	.78
2. Sorting II	120.09	27.50	-0.57	-0.38	160	43	.71
3. Cube	31.22	15.44	0.03	-1.05	60	1	.82
4. Tripod	37.70	15.37	-0.50	-0.18	63	0	.84
5. Form Percep.	22.02	4.20	-1.01	1.17	27	6	.53
6. F.B.II	8.24	4.31	0.31	-0.42	20	0	.62
7. F.B.III	13.99	5.50	-0.38	-1.19	20	2	.62
8. F.B.IV	9.42	5.50	1.22	0.88	24	1	.62
9. Fret Rep.	8.91	1.86	-2.36	5.89	10	1	.89
10. Fret Con.	8.21	2.37	-1.80	2.74	10	0	.88
11. Pattern Rep.	26.96	8.72	-0.38	-0.92	39	6	.73
12. Circles	35.90	7.17	-0.80	0.62	48	13	.76
13. Form Series	11.00	4.52	-0.25	-0.97	18	0	.86
14. Symbol Series	7.34	3.56	-0.40	-1.02	12	0	.88
15. Squares Detec.	19.78	6.83	-0.40	-0.72	30	2	.79
16. Symco	11.61	5.38	-0.71	-0.76	19	0	.90
17. Age	38.76	10.24	-0.40	-0.80	55	17	
18. Education	4.76	1.52	-0.03	-1.05	7	2	
19. Urb. Index	6.39	3.26	0.63	-0.27	15	1	

ences between variances were statistically significant. The F-ratios obtained are shown in Table 8. In order to determine whether the observed differences between means were significant t-tests (McNemar, 1959, p. 109) and Welch tests (cf. Pearson and Hartley, 1958 pp. 26 - 27 and p. 136) were performed. Welch tests were performed in those instances where the F-ratio was significant and t-tests were used in those instances where the F-ratio was not significant. The comparisons of the means of each group with every other group, together with indications of significance, are shown in Tables 9 to 14. It should be noted that the t or v values which have been asterisked (*) indicate non-significance at the 5% level. All others are significant.

(c) Relationships between Tests and Biographical Variables

Each test was correlated, by means of Pearson's product-moment correlation technique, with age, education and urbanization index. These calculations were carried out on the four groups combined in order to avoid truncations in the correlation coefficients. The correlations obtained are shown in Table 15. It should be noted again that all correlation coefficients which has been asterisked (*) are not significant at the 5% level. All others are significant.

(d) Factor Analyses

For each group the tests were intercorrelated by means of Pearson's product-moment technique. The lower half of the intercorrelation matrices appear in Tables 16 to 19. Each matrix of intercorrelations was subjected to an iterative principal factor analysis procedure. Squared multiple correlations were used for the initial communality estimates and the number of factors to be iterated on was estimated by Kaiser's criterion (Kaiser, 1960, p. 146). The latent roots and the proportion of the variance (percentage trace) accounted for by each principal component, for the four groups are compared in Table 20. (In the factor analysis programme used, unities are placed in the diagonal first which leads to a component analysis at which stage the latent roots are calculated. If Kaiser's criterion is specified the programme reads the number of latent roots of unity or more. Squared multiple correlations are placed in the diagonal and then the number of factors specified by Kaiser's criterion are extracted). Iteration was continued until the communalities converged within a tolerance of .0005. Kaiser's decision rule yielded three factors for the Urban Illiterate group and two factors each for the other three groups. The lower halves of the

TABLE 8

F-ratios for four groups compared

RI = Rural Illiterate, UI = Urban Illiterate, RL = Rural Literate, UL = Urban Literate

VARIABLE	RI x UI	RI x RL	RI x UL	UI x RL	UI x UL	RL x UL
1. Sorting I	1.28	1.12	1.09	1.14	1.17	1.03
2. Sorting II	1.27	1.53	1.15	1.20	1.47	1.77
3. Cube	1.04	1.09	1.36	1.05	1.41	1.48
4. Tripod	1.18	1.09	1.00	1.09	1.18	1.09
5. Form Percep.	1.28	1.07	1.54	1.20	1.20	1.44
6. F.B.II	1.12	1.19	1.36	1.33	1.52	1.14
7. F.B.III	1.00	1.15	1.10	1.15	1.11	1.04
8. F.B.IV	1.18	1.03	1.26	1.22	1.08	1.32
9. Fret Rep.	1.56	3.09	2.70	1.97	1.73	1.14
10. Fret Con.	1.38	1.88	2.26	1.36	1.64	1.20
11. Pattern Rep.	1.19	1.38	1.12	1.16	1.06	1.23
12. Circles	1.49	1.52	1.74	1.02	1.16	1.14
13. Form Series	1.06	1.12	1.09	1.06	1.03	1.02
14. Symbol Series	1.26	1.49	1.52	1.19	1.21	1.02
15. Squares Detec.	1.00	1.29	1.08	1.29	1.08	1.20
16. Symco	1.13	1.12	1.12	1.02	1.01	1.00
17. Age	1.64	1.31	1.26	1.25	2.07	1.66
18. Urb. Index	4.32	1.20	6.76	3.59	1.56	5.61
19. Education						1.30

All F-ratios underlined are significant at 5% level.

TABLE 9

Comparison of Means (Rural Illiterate x Urban Illiterate)

VARIABLE	RURAL ILLITERATE $\bar{X}$	URBAN ILLITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	67.33	100.83	33.50	6.57
2. Sorting II	58.97	86.70	27.73	6.02
3. Cube	20.11	25.84	5.73	2.99
4. Tripod	24.56	32.59	8.03	3.72
5. Form Percep.	18.73	20.93	2.20	3.05
6. F.B.II	4.67	6.15	1.48	2.82
7. F.B.III	9.33	11.90	2.57	3.36
8. F.B.IV	7.00	8.43	1.43	1.93
9. Fret Rep.	6.53	7.68	1.15	v = 2.81
10. Fret Con.	5.17	6.43	1.25	2.58
11. Pattern Rep.	16.28	20.53	4.25	3.37
12. Circles	25.18	30.56	5.38	v = 4.20
13. Form Series	5.30	7.27	1.97	2.89
14. Symbol Series	3.27	4.26	.99	2.21
15. Squares Detec.	14.43	16.16	1.73	1.67
16. Symco	7.12	9.12	2.00	2.61
17. Age	41.85	45.39	3.54	v = 2.92
18. Urb. Index	1.85	5.33	3.48	v = 5.18

* Not significant at 5% level. All others significant.

d.f. = 185

t.05 = 1.66

$v_1 = 93$, $v_2 = 92$

v.05 = 1.64

TABLE 10

Comparison of Means (Rural Illiterate x Rural Literate)

VARIABLE	RURAL ILLITERATE $\bar{X}$	URBAN ILLITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	67.33	89.09	21.76	4.56
2. Sorting II	58.97	102.31	43.34	v = 9.05
3. Cube	20.11	24.44	4.33	2.35
4. Tripod	24.56	34.84	10.28	4.80
5. Form Percep.	18.73	20.36	1.63	2.24
6. F.B.II	4.67	7.14	2.47	4.52
7. F.B.III	9.33	11.92	2.59	3.38
8. F.B.IV	7.00	8.11	1.11	1.61*
9. Fret Rep.	6.53	8.81	2.28	v = 2.24
10. Fret Con.	5.17	7.73	2.56	v = 5.61
11. Pattern Rep.	16.28	22.73	6.45	5.08
12. Circles	25.18	35.06	9.88	v = 7.89
13. Form Series	5.30	9.89	4.59	7.01
14. Symbol Series	3.27	6.34	3.07	v = 6.60
15. Squares Detec.	14.43	20.04	5.61	5.90
16. Symco	7.12	11.27	4.15	5.60
17. Age	41.85	26.12	15.73	12.90
18. Urb. Index	1.85	2.73	.88	4.73

* Not significant at 5% level. All others significant.

d.f. = 197 $v_1 = 93$, $v_2 = 104$

t.05 = 1.65 v.05 = 1.64

TABLE 11

Comparison of Means (Rural Illiterate x Urban Literate)

VARIABLE	RURAL ILLITERATE $\bar{X}$	URBAN ILLITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	67.33	118.78	51.45	11.31
2. Sorting II	58.97	120.09	61.12	15.61
3. Cube	20.11	31.22	11.11	5.73
4. Tripod	24.57	37.70	13.13	6.26
5. Form Percep.	18.73	22.02	3.29	v = 4.96
6. F.B.II	4.67	8.24	3.57	6.59
7. F.B.III	9.33	13.99	4.66	6.38
8. F.B.IV	7.00	9.42	2.42	3.45
9. Fret Rep.	6.53	8.91	2.38	v = 6.59
10. Fret Con.	5.17	8.21	3.04	v = 7.07
11. Pattern Rep.	16.28	26.96	10.68	9.27
12. Circles	25.18	35.90	10.72	v = 9.08
13. Form Series	5.30	11.00	5.70	9.00
14. Symbol Series	3.27	7.34	4.07	v = 9.31
15. Squares Detec.	14.43	19.78	5.35	5.62
16. Symco	7.12	11.61	4.49	6.31
17. Age	41.85	38.76	3.09	2.36
18. Urb. Index	1.85	6.39	4.84	v =15.17

* Not significant at 5% level. All others significant.

d.f. = 217

t.05 = 1.65

$v_1 = 93$, $v_2 = 124$

v.05 = 1.64

TABLE 12

Comparison of Means (Urban Illiterate x Rural Literate)

VARIABLE	URBAN ILLITERATE $\bar{X}$	RURAL ILLITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	100.83	89.09	11.74	2.30
2. Sorting II	86.70	102.31	15.61	3.14
3. Cube	25.84	24.44	1.40	.77*
4. Tripod	32.59	34.84	2.25	1.09*
5. Form Percep.	20.93	20.36	0.57	.82*
6. F.B.II	6.15	7.14	0.99	1.86
7. F.B.III	11.90	11.92	0.02	.03*
8. F.B.IV	8.43	8.11	0.32	.45*
9. Fret Rep.	7.68	8.81	1.13	v = 3.67
10. Fret Con.	6.42	7.73	1.31	3.25
11. Pattern Rep.	20.53	22.73	2.20	1.66
12. Circles	30.56	35.06	4.50	4.10
13. Form Series	7.27	9.89	2.62	4.05
14. Symbol Series	4.26	6.34	2.08	4.34
15. Squares Detec.	16.16	20.04	3.88	4.06
16. Symco	9.12	11.27	2.15	2.80
17. Age	45.39	26.12	19.27	18.00
18. Urb. Index	5.33	2.73	2.60	v = 8.47

* Not significant at 5% level. All others significant.

d.f. = 196 $v_1 = 92$, $v_2 = 104$

t.05 = 1.65 v.05 = 1.64

PB

TABLE 13

Comparison of Means (Urban Illiterate x Urban Literate)

VARIABLE	URBAN ILLITERATE $\bar{X}$	URBAN LITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	100.83	118.78	17.95	3.66
2. Sorting II	86.70	120.09	33.39	v = 7.51
3. Cube	25.84	31.22	5.38	v = 2.61
4. Tripod	32.59	37.70	5.11	2.54
5. Form Percep.	20.93	22.02	1.09	1.80
6. F.B.II	6.15	8.24	2.09	v = 3.70
7. F.B.III	11.90	13.99	2.09	2.85
8. F.B.IV	8.43	9.42	0.99	1.35*
9. Fret Rep.	7.68	8.91	1.23	v = 3.91
10. Fret Con.	6.42	8.21	1.79	v = 4.52
11. Pattern Rep.	20.53	26.96	6.43	5.29
12. Circles	30.56	35.90	5.34	5.21
13. Form Series	7.27	11.00	3.73	5.97
14. Symbol Series	4.26	7.34	3.08	6.67
15. Squares Detec.	16.16	19.78	3.62	3.79
16. Symco	9.12	11.61	2.49	3.37
17. Age	45.39	38.76	6.63	v = 4.11
18. Urb. Index	5.33	6.39	1.06	v = 2.49

* Not significant at 5% level. All others significant.

d.f. = 216 $\quad v_1 = 92, \quad v_2 = 124$

t.05 = 1.65 $\quad v.05 = 1.64$

TABLE 14

Comparison of Means (Rural Literate x Urban Literate)

VARIABLE	RURAL LITERATE $\bar{X}$	URBAN LITERATE $\bar{X}$	DIFFERENCE	t/v VALUE
1. Sorting I	89.09	118.78	29.69	6.51
2. Sorting II	102.31	120.09	17.78	v = 4.03
3. Cube	24.44	31.22	6.78	v = 3.60
4. Tripod	34.84	37.70	2.86	1.44*
5. Form Percep.	20.36	22.02	1.66	v = 2.64
6. F.B.II	7.14	8.24	1.10	1.99
7. F.B.III	11.92	13.99	2.07	2.81
8. F.B.IV	8.11	9.42	1.31	1.95
9. Fret Rep.	8.81	8.91	0.10	.43*
10. Fret Con.	7.73	8.21	0.48	1.44*
11. Pattern Rep.	22.73	26.96	4.23	3.45
12. Circles	35.06	35.90	0.84	.86*
13. Form Series	9.89	11.00	1.11	1.87
14. Symbol Series	6.34	7.34	1.00	2.14
15. Squares Detec.	20.04	19.78	0.26	.29*
16. Symco	11.27	11.61	0.34	.48*
17. Age	26.12	38.76	12.64	v =10.43
18. Education	4.34	4.76	0.42	1.93
19. Urb. Index	2.73	6.39	3.66	v =11.37

* Not significant at 5% level. All others significant.

d.f. = 228 $v_1 = 104$, $v_2 = 124$

t.05 = 1.65 v.05 = 1.64

TABLE 15

Correlations between tests and biographical variables

(Four groups combined)

TESTS	AGE	EDUCATION	URBAN INDEX
1. Sorting I	-.18	.31	.37
2. Sorting II	-.31	.56	.27
3. Cube	-.13	.24	.22
4. Tripod	-.30	.27	.19
5. Form Percep.	-.05*	.19	.12
6. F.B.II	-.29	.34	.12
7. F.B.III	-.18	.24	.16
8. F.B.IV	-.11	.14	.08*
9. Fret Rep.	-.23	.38	.13
10. Fret Con.	-.27	.37	.18
11. Pattern Rep.	-.23	.40	.24
12. Circles	-.37	.44	.23
13. Form Series	-.28	.46	.20
14. Symbol Series	-.34	.48	.22
15. Squares Detec.	-.34	.33	.11
16. Symco	-.29	.34	.15

* Indicates not significant at 5% level.

TABLE 16

RURAL ILLITERATE

INTERCORRELATION MATRIX

Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sorting I																
2. Sorting II	.54															
3. Cube	.56	.41														
4. Tripod	.56	.42	.40													
5. Form Percep.	.30	.19	.21	.48												
6. FB II	.53	.54	.41	.53	.27											
7. FB III	.34	.27	.25	.33	.26	.52						(N = 94)				
8. FB IV	.22	.29	.22	.36	.42	.34	.39									
9. Fret Rep.	.41	.43	.38	.34	.40	.33	.36	.30								
10. Fret Con.	.49	.45	.43	.44	.33	.49	.44	.35	.70							
11. Pattern Rep.	.52	.44	.59	.56	.24	.55	.37	.44	.36	.55						
12. Circles	.60	.51	.66	.53	.38	.55	.29	.42	.46	.61	.59					
13. Form Series	.42	.46	.42	.51	.38	.47	.29	.40	.50	.62	.62	.52				
14. Symbol Series	.36	.43	.44	.34	.19	.40	.30	.38	.32	.50	.56	.50	.70			
15. Squares Detec.	.50	.49	.44	.51	.37	.56	.49	.42	.48	.53	.55	.66	.48	.41		
16. Symco	.47	.55	.47	.64	.42	.44	.40	.33	.46	.51	.58	.54	.64	.53	.57	

TABLE 17

URBAN ILLITERATE

INTERCORRELATION MATRIX

Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sorting I																
2. Sorting II	.37															
3. Cube	.30	.25														
4. Tripod	.51	.28	.49													
5. Form Percep.	.31	.20	.17	.24												
6. FB II	.31	.39	.36	.49	.14						(N = 93)					
7. FB III	.38	.27	.46	.50	.36	.33										
8. FB IV	.19	.05	.26	.41	.11	.18	.41									
9. Fret Rep.	.29	.31	.46	.33	.30	.25	.38	.34								
10. Fret Con.	.26	.31	.33	.31	.24	.22	.43	.30	.63							
11. Pattern Rep.	.47	.36	.50	.48	.19	.34	.49	.42	.44	.50						
12. Circles	.45	.52	.55	.54	.38	.42	.46	.38	.60	.52	.61					
13. Form Series	.29	.20	.31	.33	.18	.19	.24	.31	.34	.43	.42	.45				
14. Symbol Series	.37	.27	.36	.39	.21	.31	.30	.34	.27	.37	.48	.48	.57			
15. Squares Detec.	.47	.24	.44	.51	.30	.25	.38	.32	.41	.41	.46	.54	.47	.35		
16. Symco	.49	.34	.47	.51	.31	.20	.36	.36	.49	.44	.58	.59	.46	.42	.54	

TABLE 18

RURAL LITERATE

INTERCORRELATION MATRIX

Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sorting I																
2. Sorting II	.55															
3. Cube	.40	.38														
4. Tripod	.49	.38	.52													
5. Form Percep.	.38	.32	.42	.44												
6. FB II	.58	.49	.55	.50	.44											
7. FB III	.31	.20	.48	.41	.30	.41						(N = 105)				
8. FB IV	.22	.25	.40	.28	.34	.37	.41									
9. Fret Rep.	.43	.46	.41	.37	.40	.35	.30	.18								
10. Fret Con.	.40	.46	.44	.39	.36	.37	.14	.23	.66							
11. Pattern Rep.	.44	.54	.58	.39	.45	.50	.18	.35	.39	.43						
12. Circles	.53	.62	.59	.55	.55	.55	.40	.36	.53	.57	.57					
13. Form Series	.40	.57	.49	.48	.41	.41	.17	.35	.35	.36	.56	.51				
14. Symbol Series	.42	.55	.52	.47	.32	.40	.30	.27	.46	.46	.57	.52	.67			
15. Squares Detec.	.30	.33	.56	.41	.34	.43	.31	.26	.48	.42	.47	.45	.33	.45		
16. Symco	.52	.55	.65	.66	.42	.57	.44	.34	.54	.48	.50	.64	.54	.54	.48	

TABLE 19

URBAN LITERATE

INTERCORRELATION MATRIX

Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sorting I																
2. Sorting II	.37															
3. Cube	.43	.30														
4. Tripod	.47	.27	.64													
5. Form Percep.	.36	.25	.39	.51												
6. FB II	.30	.29	.31	.37	.27											
7. FB III	.32	.24	.49	.43	.29	.29						(N = 125)				
8. FB IV	.29	.21	.35	.25	.30	.32	.39									
9. Fret Rep.	.27	.25	.35	.31	.28	.33	.34	.28								
10. Fret Con.	.31	.33	.43	.33	.32	.32	.30	.26	.59							
11. Pattern Rep.	.47	.33	.55	.52	.52	.47	.51	.42	.50	.56						
12. Circles	.36	.31	.59	.59	.46	.35	.52	.30	.41	.53	.62					
13. Form Series	.25	.26	.37	.28	.35	.19	.29	.30	.36	.44	.51	.40				
14. Symbol Series	.41	.31	.50	.47	.31	.31	.47	.27	.45	.45	.63	.50	.55			
15. Squares Detec.	.45	.31	.57	.59	.49	.40	.47	.39	.39	.56	.64	.61	.40	.54		
16. Symco.	.47	.32	.53	.47	.40	.35	.51	.29	.44	.55	.60	.60	.47	.52	.66	

TABLE 20

Comparison of latent Roots and Percentage Trace

for all four groups

	RURAL ILLITERATE		URBAN ILLITERATE		RURAL LITERATE		URBAN LITERATE	
	L.R.	P.T.	L.R.	P.T.	L.R.	P.T.	L.R.	P.T.
1.	7.77	48.59	6.73	42.07	7.62	47.63	7.26	45.39
2.	1.17	7.32	1.20	7.53	1.26	7.89	1.09	6.83
3.	.98	6.15	1.07	6.68	.99	6.25	.95	5.91
4.	.92	5.73	.99	6.19	.88	5.50	.88	5.51
5.	.89	5.58	.96	6.02	.78	4.91	.80	5.00
6.	.72	4.50	.77	4.81	.68	4.29	.77	4.83
7.	.62	3.89	.68	4.28	.66	4.11	.64	4.02
8.	.50	3.14	.59	3.69	.51	3.20	.63	3.91
9.	.47	2.93	.56	3.52	.46	2.88	.55	3.46
10.	.45	2.81	.49	3.04	.42	2.64	.53	3.31
11.	.37	2.33	.40	2.52	.37	2.29	.40	2.48
12.	.30	1.89	.40	2.48	.36	2.24	.37	2.30
13.	.25	1.59	.35	2.20	.30	1.91	.33	2.09
14.	.21	1.31	.31	1.95	.25	1.55	.30	1.90
15.	.20	1.23	.25	1.59	.24	1.47	.25	1.58
16.	.16	1.01	.23	1.43	.20	1.24	.24	1.48

matrices of residuals appear in Tables 21 to 24. Each factor matrix was then rotated by means of the varimax procedure. The orthogonal unrotated factor matrices together with the varimax rotations and the communalities, uniquenesses and specificities of the tests are shown in Tables 25 to 28.

Before going to describe the next stage of the analysis it should be mentioned that for each group covariance matrices were computed. A number of likelihood ratio tests (Morrison, 1967 pp. 152 - 153) were carried out to test the equality of the covariance matrices. In the first all four groups were compared. The asymptotic χ^2 statistic was equal to 518.42 and since the number of degrees of freedom was 408 this value was significant at the 1% level. The next step was carried out to determine whether these differences were due to urbanization or education. The covariance matrices of the Rural Illiterate group and the Urban Illiterate group were compared. The asymptotic χ^2 statistic was equal to 140.19 and since the number of degrees of freedom was 136 this value was not significant at the 5% level. Similarly the covariance matrices of the Rural Literate group and the Urban Literate group were compared. The asymptotic χ^2 statistic was equal 150.60 and since the number of degrees of freedom was 136 this value was not significant at the 5% level. It was taken then that the differences detected in the first likelihood ratio test were due to the effects of literacy. If a likelihood ratio test is significant it means that the manifest variable covariance matrices differ. This implies that factor matrices, and/or factor covariance matrices and/or residual covariance matrices are different.

In the intergroup procedure, which was applied in the last stage of the analysis, it is assumed that there is a single factor matrix common to all groups. Any differences found are accounted for in terms of factor covariance matrices and residual covariance matrices.

(e) Inter-Group Factor Analysis

The rationale underlying inter-group factor analysis and the mathematical formulation of the procedure are presented in Appendix B. The procedure was formulated by M.W. Browne and the programme was written by M. Barrett. Both are members of the Psychometric Division of the National Institute for Personnel Research.

In order to carry out the inter-group procedure it is necessary to have the sample correlation matrices (cf. Tables 16 to 19) for each group and the standard deviation vectors (cf. Tables 4 to 7) for each group. The first step was that the standard deviations for each group were rescaled so that the within groups variance was unity for each variable.

TABLE 21

RURAL ILLITERATE

MATRIX OF RESIDUALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.																
2.	.06															
3.	.03	-.06														
4.	.10	-.01	-.02													
5.	.06	-.06	.04	.12												
6.	.04	.09	-.05	.05	-.04											
7.	.03	-.03	-.01	-.04	-.07	.18										
8.	-.07	.00	-.01	-.02	.06	.00	.06									
9.	.02	.05	.04	-.10	.03	-.09	.01	-.07								
10.	.00	-.02	-.02	-.08	-.06	-.02	.03	-.07	.22							
11.	-.04	-.08	.04	.04	-.07	.02	.00	.09	-.08	.00						
12.	.01	-.02	.08	-.01	.06	.00	-.09	.05	.00	.03	-.04					
13.	-.08	-.01	-.04	-.01	.00	-.05	-.11	-.01	.03	.05	.06	-.06				
14.	-.09	.00	.00	-.10	-.08	-.04	-.02	.07	-.06	.03	.06	-.02	.23			
15.	.00	.02	-.02	-.01	-.02	.04	.08	.01	.01	-.03	-.01	.08	-.08	-.06		
16.	-.04	.07	.00	.11	.04	-.08	-.01	-.08	-.01	-.06	.01	-.05	.07	.05	-.02	

TABLE 22

URBAN ILLITERATE

MATRIX OF RESIDUALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.																
2.	.06															
3.	-.09	-.07														
4.	.00	-.09	.03													
5.	-.08	.00	-.09	-.03												
6.	-.05	.11	.03	.04	-.06											
7.	-.01	-.06	.05	.03	.10	-.02										
8.	-.09	-.15	-.03	.09	-.07	-.02	.13									
9.	-.01	-.02	.04	.02	.00	.02	-.04	.04								
10.	-.02	.03	-.05	.00	-.02	.02	.06	-.02	.01							
11.	.02	.02	.03	-.05	-.10	-.01	.04	.06	-.04	.03						
12.	-.03	.11	.02	-.03	.04	.01	-.07	-.01	.00	-.03	.00					
13.	-.02	.04	-.01	-.01	.01	.04	-.03	-.04	.00	.01	-.04	.02				
14.	.01	.05	.01	-.04	.01	.07	-.03	.01	-.02	.02	.01	.03	.05			
15.	.07	-.06	.03	.03	.06	-.06	-.02	-.01	.00	.00	-.04	.00	.03	-.09		
16.	.07	.02	.03	.02	.04	-.01	-.07	.00	.01	-.03	.04	-.01	-.02	-.04	.04	

TABLE 23

RURAL LITERATE

MATRIX OF RESIDUALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.																
2.	.09															
3.	-.07	-.08														
4.	.06	-.04	-.03													
5.	.00	-.06	-.04	.03												
6.	.13	.05	-.01	.00	.02											
7.	.02	.03	-.01	.00	-.03	-.02										
8.	-.06	.01	.00	-.06	.06	.01	.05									
9.	.01	-.02	-.04	-.04	.04	-.07	.07	-.07								
10.	-.02	-.04	.02	-.01	.01	-.03	-.03	.00	.22							
11.	-.02	.00	.09	-.07	.05	.03	-.08	.07	-.08	-.06						
12.	.00	.05	-.02	.00	.07	-.01	.02	.00	.01	.06	-.01					
13.	-.05	.05	.02	.05	.03	-.03	-.05	.09	-.11	-.12	.05	-.05				
14.	-.04	.00	.03	.02	-.08	-.06	.06	-.01	-.02	-.03	.04	-.05	.15			
15.	-.08	-.07	.09	-.01	-.02	.00	-.02	-.03	.10	.05	.05	-.03	-.07	.03		
16.	.01	.02	.03	.09	-.06	-.01	.00	-.05	.03	-.01	-.05	-.01	.01	-.01	-.01	

TABLE 24

URBAN LITERATE

MATRIX OF RESIDUALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.																
2.	.12															
3.	-.02	-.01														
4.	.01	-.02	.04													
5.	.01	.00	-.05	.04												
6.	.02	.08	-.05	.01	-.01											
7.	-.04	-.02	.03	-.04	-.07	-.02										
8.	.03	.01	.01	-.08	.03	.09	.11									
9.	-.01	-.01	.00	.04	-.01	.04	.01	.01								
10.	-.02	.02	.03	.02	-.01	-.01	-.07	-.05	.07							
11.	.01	-.04	-.03	-.03	.06	.06	.01	.03	-.01	-.03						
12.	-.09	-.02	.03	.02	.02	-.02	.05	-.06	-.01	.05	-.01					
13.	-.04	.01	.01	-.02	.06	-.09	-.04	.04	-.05	-.02	.02	-.02				
14.	.03	-.01	.02	.02	-.08	-.04	.05	-.06	.00	-.07	.04	-.03	.13			
15.	-.01	-.03	-.02	.00	.03	.01	-.02	.02	-.05	.05	-.01	.00	-.03	-.01		
16.	.05	-.01	-.01	-.04	-.03	-.03	.05	-.06	-.02	.02	-.04	.03	.02	-.02	.06	

TABLE 25

RURAL ILLITERATE

Unrotated factor matrix, Varimax Rotation, communalities, uniquenesses and specificities

Tests	UNROTATED MATRIX		VARIMAX ROTATION		h^2	u^2	s^2
	I	II	A	B			
1. Sorting I	.69	-.23	.68	.26	.53	.47	.21
2. Sorting II	.65	-.14	.59	.30	.44	.56	.47
3. Cube	.65	-.37	.74	.13	.56	.44	.31
4. Tripod	.69	.07	.49	.50	.48	.52	.40
5. Form Percep.	.48	.39	.12	.61	.39	.61	.24
6. FB II	.69	-.05	.56	.40	.48	.52	.23
7. FB III	.52	.20	.27	.49	.31	.69	.40
8. FB IV	.52	.30	.21	.56	.36	.64	.35
9. Fret. Rep.	.62	.18	.36	.53	.42	.58	.44
10. Fret. Con.	.75	.09	.52	.55	.57	.43	.35
11. Pattern Rep.	.76	-.16	.69	.36	.60	.40	.12
12. Circles	.79	-.16	.71	.38	.66	.34	.18
13. Form Series	.75	.07	.53	.53	.56	.44	.35
14. Symbol Series	.64	-.08	.54	.35	.42	.58	.41
15. Squares Detec.	.75	.07	.53	.53	.56	.44	.25
16. Symco.	.76	.05	.55	.52	.58	.42	.31

TABLE 26

URBAN ILLITERATE

Unrotated factor matrix, Varimax Rotation, communalities, uniquenesses and specificities.

Tests	UNROTATED MATRIX			VARIMAX ROTATION			h^2	u^2	s^2
	I	II	III	A	B	C			
1. Sorting I	.60	.25	-.05	.57	.14	.29	.42	.58	.39
2. Sorting II	.47	.13	.17	.43	.28	.09	.27	.73	.59
3. Cube	.63	.07	.06	.47	.33	.28	.41	.59	.38
4. Tripod	.70	.36	-.07	.71	.12	.33	.63	.37	.20
5. Form Percep.	.39	.01	.12	.28	.27	.12	.16	.84	.41
6. FB II	.47	.32	.08	.56	.12	.10	.33	.67	.30
7. FB III	.62	.13	.13	.51	.34	.20	.42	.58	.21
8. FB IV	.48	-.07	-.11	.24	.23	.37	.25	.75	.38
9. Fret. Rep.	.67	-.35	.38	.22	.80	.19	.72	.28	.11
10. Fret. Con.	.64	-.35	.16	.17	.64	.34	.56	.44	.31
11. Pattern Rep.	.74	.00	-.04	.47	.37	.45	.56	.44	.14
12. Circles	.83	.00	.13	.55	.52	.36	.70	.30	.04
13. Form Series	.60	-.30	-.44	.09	.22	.76	.63	.37	.24
14. Symbol Series	.60	-.05	-.34	.30	.14	.61	.48	.52	.36
15. Squares Detec.	.67	.00	-.10	.41	.29	.45	.45	.55	.33
16. Symco.	.73	-.07	-.07	.40	.38	.48	.54	.46	.35

TABLE 27

RURAL LITERATE

Unrotated factor matrix, Varimax Rotation, communalities, uniquenesses and specificities

Tests	UNROTATED MATRIX		VARIMAX ROTATION		h^2	u^2	s^2
	I	II	A	B			
1. Sorting I	.65	-.05	.54	.36	.42	.58	.37
2. Sorting II	.69	-.31	.74	.17	.57	.43	.34
3. Cube	.75	.21	.47	.63	.61	.39	.18
4. Tripod	.68	.15	.45	.54	.49	.51	.32
5. Form Percep.	.59	.08	.41	.42	.35	.65	.31
6. FB II	.70	.16	.46	.55	.51	.49	.16
7. FB III	.49	.55	.05	.73	.54	.46	.13
8. FB IV	.45	.25	.21	.47	.27	.73	.40
9. Fret. Rep.	.64	-.15	.60	.27	.43	.57	.40
10. Fret. Con.	.63	-.23	.64	.20	.45	.55	.42
11. Pattern Rep.	.71	-.16	.66	.30	.53	.47	.25
12. Circles	.81	-.03	.66	.47	.66	.34	.12
13. Form Series	.68	-.20	.66	.25	.50	.50	.35
14. Symbol Series	.71	-.19	.68	.28	.54	.46	.32
15. Squares Detec.	.60	.06	.44	.41	.37	.63	.41
16. Symco	.81	.08	.59	.55	.66	.34	.25

TABLE 28

URBAN LITERATE

Unrotated factor matrix, Varimax Rotation, communalities, uniquenesses and specificities

Tests	UNROTATED MATRIX		VARIMAX ROTATION		h^2	u^2	s^2
	I	II	A	B			
1. Sorting I	.57	-.14	.52	.27	.35	.65	.43
2. Sorting II	.44	.03	.30	.32	.19	.81	.52
3. Cube	.72	-.22	.68	.32	.57	.43	.25
4. Tripod	.71	-.42	.81	.16	.68	.32	.16
5. Form Percep.	.57	-.15	.52	.27	.35	.65	.18
6. FB II	.50	.00	.37	.33	.25	.75	.37
7. FB III	.61	-.09	.51	.34	.38	.62	.24
8. FB IV	.47	-.01	.35	.31	.22	.88	.40
9. Fret. Rep.	.58	.34	.21	.64	.45	.55	.44
10. Fret. Con.	.67	.37	.25	.77	.59	.41	.29
11. Pattern Rep.	.83	.09	.56	.62	.70	.30	.03
12. Circles	.76	-.08	.62	.45	.58	.42	.18
13. Form Series	.57	.23	.27	.55	.38	.62	.48
14. Symbol Series	.70	.11	.45	.55	.51	.49	.37
15. Squares Detec.	.79	-.07	.63	.48	.63	.37	.16
16. Symco.	.76	.06	.52	.56	.58	.42	.32

From the correlation matrices of each group four separate factor matrices were obtained by means of the iterative principal factor technique. Squared multiple correlations were used for the initial communality estimates and the number of factors to be iterated on was specified as 5. In each analysis iteration was continued until the communalities converged within a tolerance of .0005. It was decided that five factors should be extracted for a number of reasons. The main reason for choosing this number was that the results from the exploratory pilot studies suggested that the battery was measuring five factors. The factor matrix common to all four groups which was obliquely rotated (cf. Table 33) yielded such clear-cut results that the writer felt justified in extracting five factors. During the course of the analysis three factors were extracted from the correlation matrix based on all four groups together. This matrix was rotated to simple structure but the results were equivocal.

Each factor matrix was rotated orthogonally by means of the Varimax procedure. The rotated factor matrices for each group are shown in Tables 29 to 32. The rotated factor matrices for each group were then rescaled by means of the rescaled standard deviations. A factor matrix common to all four groups were obtained from the factor matrices specific to each group. The obtained factor matrix was then rotated obliquely by means of the Promax procedure (cf. Appendix B). The obliquely rotated factor matrix common to all groups is shown in Table 33. The within group factor covariance matrix is shown in Table 34.

TABLE 29

RURAL ILLITERATE

Varimax Rotation (five factors extracted)

Tests	I	II	III	IV	V
1. Sorting I	.72	.16	.11	.18	.17
2. Sorting II	.53	.09	.26	.21	.21
3. Cube	.66	.05	.27	.16	.06
4. Tripod	.52	.51	.21	.03	.21
5. Form Per.	.13	.75	.09	.20	.13
6. FB II	.53	.13	.21	.07	.52
7. FB III	.17	.14	.12	.18	.72
8. FB IV	.12	.36	.30	.10	.37
9. Fret. Rep.	.25	.22	.16	.84	.17
10. Fret. Con.	.38	.15	.36	.55	.29
11. Pat. Rep.	.55	.15	.48	.08	.27
12. Circles	.67	.24	.29	.23	.17
13. F.S.T.	.29	.28	.73	.27	.12
14. Sym. Ser.	.29	.05	.75	.12	.17
15. Squares Detec.	.49	.27	.23	.23	.41
16. Symco.	.46	.37	.43	.19	.19

TABLE 30

URBAN ILLITERATE

Varimax Rotation (five factors extracted)

Tests	I	II	III	IV	V
1. Sorting I	.20	.28	.04	.20	.62
2. Sorting II	.12	.61	.26	-.07	.27
3. Cube	.20	.25	.30	.42	.23
4. Tripod	.19	.30	.04	.62	.42
5. Form Per.	.04	.09	.24	.08	.39
6. FB II	.10	.60	.05	.35	.08
7. FB III	.07	.20	.31	.51	.29
8. FB IV	.28	-.05	.23	.53	.06
9. Fret. Rep.	.13	.14	.74	.22	.21
10. Fret. Con.	.29	.13	.64	.18	.16
11. Pat. Rep.	.37	.26	.34	.38	.29
12. Circles	.31	.41	.49	.28	.38
13. Form Series	.71	.04	.23	.13	.19
14. Sym. Ser.	.65	.24	.12	.22	.15
15 Squares Detec.	.32	.07	.25	.31	.50
16. Symco.	.37	.09	.35	.25	.52

TABLE 31

RURAL LITERATE

Varimax Rotation (five factors extracted)

Tests	I	II	III	IV	V
1. Sorting I	.21	.26	.25	.64	.10
2. Sorting II	.46	.06	.31	.55	.17
3. Cube	.31	.58	.30	.11	.39
4. Tripod	.33	.51	.24	.33	.06
5. Form Per.	.15	.33	.25	.29	.31
6. FB II	.15	.45	.16	.51	.32
7. FB III	.03	.71	.10	.14	.02
8. FB IV	.16	.42	.04	.12	.29
9. Fret. Rep.	.17	.19	.77	.22	.05
10. Fret. Con.	.19	.10	.70	.24	.19
11. Pat. Rep.	.42	.15	.26	.27	.62
12. Circles	.29	.37	.42	.44	.28
13. Form Series	.75	.18	.13	.26	.23
14. Sym Ser.	.66	.24	.33	.17	.17
15. Squares Detec.	.20	.37	.43	.06	.31
16. Symco.	.38	.51	.38	.36	.11

TABLE 32

URBAN LITERATE

Varimax Rotation (five factors extracted)

Tests	I	II	III	IV	V
1. Sorting I	.41	.14	.12	.10	.41
2. Sorting II	.21	.20	.13	.06	.34
3. Cube	.60	.22	.19	.30	.21
4. Tripod	.81	.11	.08	.15	.23
5. Form Per.	.47	.14	.20	.05	.32
6. FB II	.22	.23	.02	.11	.51
7. FB III	.28	.15	.12	.76	.24
8. FB IV	.13	.09	.17	.26	.45
9. Fret. Rep.	.15	.52	.19	.17	.28
10. Fret. Con.	.21	.84	.20	.06	.20
11. Pat. Rep.	.40	.37	.34	.25	.48
12. Circles	.56	.38	.18	.32	.18
13. Form Series	.17	.24	.80	.10	.15
14. Sym. Ser.	.36	.29	.44	.27	.24
15. Squares Detec.	.54	.37	.20	.22	.34
16. Symco.	.43	.41	.26	.29	.26

TABLE 33

Factor Matrix common to all groups (Promax Rotation)

Tests	I P.F.R.	II P.A.	III C.R.	IV P.S.	V Sp.
1. Sorting I	-.02	.01	.00	.45	.33
2. Sorting II	-.13	.12	.13	.58	.01
3. Cube	.24	.03	.18	.13	.31
4. Tripod	.15	-.10	.06	.13	.62
5. Form Per.	.00	.13	.00	-.01	.51
6. FB II	.27	-.03	.01	.53	.00
7. FB III	.70	.06	-.02	.01	.06
8. FB IV	.41	.00	.22	-.05	.07
9. Fret. Rep.	.05	.82	-.06	-.02	.06
10. Fret. Con.	.02	.67	.12	.10	.00
11. Pat. Rep.	.16	.04	.41	.28	.08
12. Circles	.08	.23	.12	.30	.29
13. Form Series	-.03	.05	.83	-.06	.04
14. Sym. Ser.	.11	-.03	.66	.09	.03
15. Squares Detec.	.21	.19	.13	.05	.34
16. Symco.	.15	.16	.26	.07	.34

TABLE 34

Within Group Factor Covariance Matrix

	P.F.R.	P.A.	C.R.	P.S.	Sp.
P.F.R.	1.00	.41	.38	.47	.53
P.A.	.41	1.00	.55	.49	.47
C.R.	.38	.55	1.00	.52	.54
P.S.	.47	.49	.52	1.00	.60
Sp.	.53	.47	.54	.60	1.00

If Table 33 is compared with Table 2 (summary of loadings of tests of factors - derived from pilot studies) it will be noticed that tests which had high loadings in the pilot studies are, in general, represented in the same factors yielded by the inter-group procedure. The factor loadings of these tests have been underlined in Table 33. Tests which had factor loadings of between .40 and approximately .50 in the pilot studies are also represented in the same factors of the factor matrix common to all groups. These have been underlined with a broken line. It would appear then that the inter-group procedure has largely confirmed the factors which were expected when the battery was initially selected.

The factor covariance matrix for each group was obtained and from these the vectors of factor variances and the factor correlation matrices were derived. The factor variances are shown in Table 35.

TABLE 35

Factor Variances

FACTORS	GROUP R.I.	U.I.	R.L.	U.L.
P.F.R.	0.8599	0.8585	0.9555	1.2481
P.A.	1.8746	1.1083	0.6472	0.5582
C.R.	1.0129	0.8924	1.1157	0.9732
P.S.	1.0802	1.0572	1.4085	0.5541
Sp.	1.2284	0.8567	0.6981	1.1886

These factor variances have weighted averages over groups of unity. The factor correlation matrices for all four groups are shown in Table 36. In Table 37 the factor correlation matrices are compared. The differences between factor correlations which have been underlined will be discussed in the next section.

In order to assess the goodness of fit of the model the square root of the average squared element of the residual matrix was obtained for each of the four groups. These were .094, .080, .090 and .081 for the groups R.I, U.I., R.L. and U.L. respectively. The square root of the average of all squared residuals was .087. It may be concluded from these coefficients that the model fitted the data reasonably well.

8. Discussion

An inspection of Tables 4 to 7 will show that all the tests for all groups were on the whole of an appropriate level of difficulty. Each group covered the whole range of each test and apart from some of the tests being too easy for some groups and others being too difficult for other groups it may be concluded that the test battery chosen was, in general, appropriate for the design of the project. It should be noted that FB IV was too difficult for all groups and that the Fret Repetition Test by contrast was largely too easy. For all groups the Form Perception test was negatively skewed, indicating that it was also too easy for all the groups. It is interesting to note that the number of negatively skewed tests increases as a function of literacy and urbanization. Those tests which are appreciably affected by these two factors will be seen in Table 15 to be those which correlate higher with education and urbanization.

An examination of Tables 4 to 7 will show that apart from the Form Perception Test and the Formboards all the tests have an acceptably high reliability over all groups. The reliability of the Form Perception Test was low mainly because the test is too short. The reliabilities obtained for the Formboards are somewhat misleading. In calculating the reliabilities for these tests Kuder Richardson formula 3 was used. The intercorrelations between the sub-tests of the Formboards enter into these calculations. It has been shown that FB II loads on a different dimension to the dimension on which the other two tests loaded (cf. Table 33). It will also be seen from the intercorrelation matrices that FB II has smaller correlations with the other two boards than the correlations of FB III with FB IV. Thus it is not surprising that the overall reliabilities of these tests are somewhat

TABLE 36

Factor correlation matrices for all four groups

P.F.R. = Perception of Form Relations
P.A. = Perceptual Analysis
C.R. = Conceptual Reasoning
P.S. = Perceptual Speed
Sp. = Space.

(a) RURAL ILLITERATE

	P.F.R.	P.A.	C.R.	P.S.	Sp.
P.F.R.	1.00	.46	.37	.59	.29
P.A.	.46	1.00	.54	.47	.49
C.R.	.37	.54	1.00	.53	.47
P.S.	.59	.47	.53	1.00	.50
Sp.	.29	.49	.47	.50	1.00

(b) URBAN ILLITERATE

	P.F.R.	P.A.	C.R.	P.S.	Sp.
P.F.R.	1.00	.53	.45	.39	.63
P.A.	.53	1.00	.55	.38	.48
C.R.	.45	.55	1.00	.33	.51
P.S.	.39	.38	.33	1.00	.51
Sp.	.63	.48	.51	.51	1.00

TABLE 36 (Continued)

(c) RURAL LITERATE

	P.F.R.	P.A.	C.R.	P.S.	Sp.
P.F.R.	1.00	.20	.20	.30	.75
P.A.	.20	1.00	.51	.61	.67
C.R.	.20	.51	1.00	.69	.65
P.S.	.30	.61	.69	1.00	.80
Sp.	.75	.67	.65	.80	1.00

(d) URBAN LITERATE

	P.F.R.	P.A.	C.R.	P.S.	Sp.
P.F.R.	1.00	.47	.49	.70	.52
P.A.	.47	1.00	.69	.60	.34
C.R.	.49	.69	1.00	.50	.54
P.S.	.70	.60	.50	1.00	.68
Sp.	.52	.34	.54	.68	1.00

TABLE 37

Comparison of factor correlation matrices

	R.I.	U.I.	d	R.I.	R.L.	d	R.I.	U.L.	d	U.I.	R.L.	d	U.I.	U.L.	d	R.L.	U.L.	d
P.F.R. X. P.A.	.46	.53	.07	.46	.20	.26	.46	.47	.01	.53	.20	.23	.53	.47	.06	.20	.47	.27
P.F.R. X. C.R.	.37	.45	.08	.37	.20	.17	.37	.49	.12	.45	.20	.25	.45	.49	.04	.20	.49	.29
P.F.R. X. P.S.	.59	.39	.20	.59	.30	.29	.59	.70	.11	.39	.30	.09	.39	.70	.31	.30	.70	.40
P.F.R. X. Sp.	.29	.63	.34	.29	.75	.46	.29	.52	.23	.63	.75	.12	.63	.52	.11	.75	.52	.23
P.A. X. C.R.	.54	.55	.01	.54	.51	.03	.54	.69	.15	.55	.51	.04	.55	.69	.14	.51	.69	.18
P.A. X. P.S.	.47	.38	.09	.47	.61	.14	.47	.60	.13	.38	.61	.23	.38	.60	.22	.61	.60	.01
P.A. X. Sp.	.49	.48	.01	.49	.67	.18	.49	.34	.15	.48	.67	.19	.48	.34	.14	.67	.34	.33
C.R. X. P.S.	.53	.33	.20	.53	.69	.16	.53	.50	.03	.33	.69	.36	.33	.50	.17	.69	.50	.19
C.R. X. Sp.	.47	.51	.04	.47	.65	.18	.47	.54	.07	.51	.65	.14	.51	.54	.03	.65	.54	.11
P.S. X. Sp.	.50	.51	.01	.50	.80	.30	.50	.68	.18	.51	.80	.29	.51	.68	.17	.80	.68	.12

R.I. = Rural Illiterate, U.I. = Urban Illiterate, R.L. = Rural Literate, U.L. = Urban Literate

depressed. The formula used was, however, the most suitable available.

Attention is drawn to the age differences among the four groups. The Rural Literate group is the youngest followed by the Urban Literate group, followed by the Rural Illiterate group and the Urban Illiterate group is the oldest. Most of the tests are significantly negatively correlated with age. This indicates that the older an individual the poorer he performs on the tests. The influence of age is not, however, very marked. The average correlation between age and the tests is -.24 which indicates a common variance of only 5.8 percent. In explaining differences between the groups on the tests this aspect will be kept in mind.

It should be noted that urbanization indices also differ for the four groups. According to the results obtained the Urban Literate group is the most urbanized, followed by the Urban Illiterate group, followed by the Rural Literate group and the Rural Illiterate group which is least urbanized. If the criterion of 12 and above, as indicating true urbanization, is kept is mind then it can only be concluded that the samples are one the whole very rural-oriented. This may be characteristic of Venda males in this educational range. As education and the urbanization index are positively correlated (.30) it would appear that the chances of obtaining substantial numbers of truly urbanized individuals within the educational range of nil to 7 years of schooling are severly reduced. It is important to note that the relationship between education and urbanization is probably stronger than the obtained coefficient tends to indicate. Due to the restriction of range on the education variable the coefficient is probably lower than it should be.

In Table 15 it will be seen that although urbanization correlates significantly with the majority of tests the coefficients are, in general, low. These correlations are also probably higher than they appear to be because of the restriction of range on the urbanization variable. It has, nevertheless, been illustrated that the tests are influenced by urbanization as measured by the Urban-Rural scale which is essentially, a socio-cultural measure.

The differences in scholastic education as indicated in Tables 4 to 7 should be noted. The two illiterate groups are truly illiterate in that none of the individuals comprising the groups had ever been to school. In comparing the Rural Literate and Urban Literate groups it will be noticed that although the mean levels of education differ significantly at the 5% level (cf. Table 14) the difference is very small. It is also probable that

the quality of education in the rural areas is inferior to that in the urban areas. It is important to note that scholastic education correlates highest of all the biographical variables with the tests in the battery. The average correlation between education and the tests is .34 which indicates a common variance of 11.6%. This is understandable in terms of the method of administration and the fact that the tests have a distinct Western bias.

An inspection of Table 8 shows that quite a large number of F-ratios were significant. If this table is looked at in conjunction with Tables 4 to 7 a number of interesting inferences may be drawn. In Sorting II the two illiterate groups are homogeneously poorer than the two literate groups. As the test contains letters and numbers the illiterate groups are likely to have uniform difficulty with this test. For Cube construction the Urban Literate group showed far greater variability than any of the other groups. The test is one of the more difficult in the battery and it is a good measure of the Space factor. As a group the Urban Illiterates are likely to show the greatest variation in the different kinds of jobs held. Some of these jobs may demand spatial thought; others might be devoid of this factor. Thus greater variability in respect of spatial ability is to be expected among this group. In the two Fret Tests it will be noticed that the two literate groups were homogeneously superior to their illiterate counterparts. Thus specific scholastic training leads to a shrinkage of variance on simpler tests in which a pencil is used. Similarly in the Symbol Series Test the use of a pencil was uniformly disadvantageous for the Rural Illiterate group.

Regarding the age variable the Urban Literate group was the most heterogeneous, followed by the Rural Illiterate group, then the Rural Literate group and the Urban Illiterate group was the most homogeneous. Greater variability on the urbanization index was observed for the two urban groups. By contrast the two rural groups were singularly homogeneous.

In Tables 9 to 14 a clear trend in the means will be observed. A continuum in the form: Rural Illiterate, Urban Illiterate, Rural Literate, Urban Literate, with the first group performing worst and the last group performing best, may be discerned. The further the groups are apart on this continuum the greater are the differences in mean level of performance. It should also be noted that the Urban Illiterate group has a higher mean level of performance than the Rural Illiterate group and that the Urban Literate group has a higher mean level of performance than the Rural Literate group. Thus, if groups are matched in terms of education the urban group will perform better than the rural group. Therefore it may be inferred from

these results that scholastic education and urbanization, in this order of importance, lead to improvements in performance on cognitive tasks in general. Thus support for the first hypothesis has been obtained.

It should be noted that, as most of the tests correlated negatively and significantly with age, the differences observed between the means of the Rural Literate and Urban Literate groups are probably greater and in favour of the Urban Literate group. Similarly the differences in mean performance between the Urban Illiterate and Rural Literate groups are also subject to modification. Where differences were in favour of the latter group these are probably less than those observed. Consequently, many of the significant differences might have vanished if the groups had been matched for age. It is interesting to note that the former group actually performed better than the latter group on Sorting I and Cube, notwithstanding the age discrepancy. This probably came about as a result of industrial experience. It would appear then that an urban environment plays an important role in determining the level of performance on cognitive tests. It should be remembered that the urban-rural dichotomy was based on the criterion of geographic residence. The observed differences between groups on the urban-rural scale reflect only one small aspect in which the groups differed.

The differentiation of abilities as a function of literacy and urbanization will now be examined in the light of the analyses performed. The results of the methodology typically used to explain the Burt-Garret hypothesis will be examined first. In terms of the average correlations obtained from the matrices of inter-correlations for the four groups the trend (from greater to less differentiation) would be Urban Illiterate (.39), Urban Literate (.42), Rural Literate (.45) and Rural Illiterate (.46). From the factor analyses conducted, in which Kaiser's criterion was used to determine the number of factors, it would appear again that the Urban Illiterate group is the most differentiated as it yielded three factors against the two in lack of the other groups. For the three groups which yielded two factors it is difficult to discern, according to this criterion, which of them is the more differentiated. In order to overcome this stumbling block the amount of variance accounted for by the major principal component or g is typically examined. (cf. Table 20). It would appear again that the Urban Illiterate group (42.07%) is the most differentiated followed by Urban Literate (45.39%), followed by Rural Literate (47.63%) and the least differentiated is the Rural Illiterate (48.59%). If we now examine the amount of variance accounted for by the first group factor the trend is:

Rural Literate (7.89%), Urban Illiterate (7.53%), Rural Illiterate (7.32%) and Urban Literate (6.83%). It should be noted that as a sign of differentiation the percent of variance accounted for by the first group factor increases. If the amount of variance accounted for by the next group factor is examined it will be noticed that the order is changed: Urban Illiterate (6.68%) Rural Literate (6.25%), Rural Illiterate (6.15%) and Urban Literate (5.91%).

By examining the results in this manner it would be concluded, in general, that the two urban groups are more differentiated than the two rural groups. Thus only one aspect, namely urbanization, would be construed as resulting in greater differentiation. Literacy would appear to be a non-differentiating variable. There are, however, a number of disconcerting aspects which are not explained by examining the results from this point of view. A surprising aspect is that the Urban Illiterate group appears to be the most differentiated group. This is contrary to all expectations. One may well ask why the group factors do not show a systematic increase in amount of variance accounted for? To what extent are the differences between the average correlations from each intercorrelation matrix significant? Why, in view of the series of likelihood ratio tests which were performed, does literacy appear to be a non-differentiating variable? These results also appear to be in conflict with the findings of Hudson et al (1962) which suggested that the factor structures of uneducated groups differed significantly from the factor structures of groups with scholastic education.

Guilford's (1967) criticisms (cf. Chapter 3, pp. 56 - 60) of the methodology applied in hierarchical models, the equivocal results obtained in most studies in which the Burt-Garrett differentiation hypothesis was tested and the difficulties associated with testing this hypothesis (cf. Chapter II) are now called to mind. By examining the results obtained from the typical point of view of the adherents of the Burt-Garrett hypothesis too many questions are left unanswered. Referring to the method of making inferences from unrotated matrices, Guilford (1967) has asked ".... should the mere nature of an arbitrary method of extracting temporary factors be used as a foundation for a psychological theory?" (p. 60). From the equivocal results obtained Guilford's question seems most appropriate.

At the outset, Ferguson's theory of the differentiation of abilities was deemed to be both tenable and testable. His theory is psychologically sound, it has been supported by investigations in the field of psychomotor abilities and it does not depend on explanations derived from questionable numerical values. The inter-group factor analysis procedure was expressly

used with Ferguson's theory in mind. At the time it seemed to be the only factor analytic technique which could be utilized in a study such as the present one.

It has already been mentioned that five factors were decided upon for extraction and the reasons for this decision have been outlined. The inter-group procedure begins with the factor matrices which have been rotated by means of the Varimax procedure. If these matrices (Tables 29 to 32) are examined it will be noticed that the only factors which emerge clearly in all four groups are Conceptual Reasoning and Perceptual Analysis. In some cases the two factors are well defined and in others they appear as doublets. The other factors seem to be somewhat unclear and confused. It should be remembered that the Varimax procedure yields a matrix in the orthogonal form. As the factors are correlated to different extents for each of the groups it is not surprising that the picture from the Varimax position is confusing. It should also be remembered that for purposes of the inter-group procedure, factor matrices rotated orthogonally by means of Varimax, is merely a convenient point of departure.

An important assumption in the inter-group procedure is that there is a factor matrix common to all groups. This matrix was obtained and rotated obliquely to simple structure by means of the Promax procedure. The resultant matrix is shown in Table 33. An inspection of this table will show that it largely confirms what the pilot studies suggested. Two factors, P.F.R. and P.A. are strictly-speaking doublets. As was pointed out earlier, however, if these two factors are not extracted a confusing picture is obtained. The fact that these two dimensions are in the form of doublets is a comment on the composition of the battery. More tests of a related kind are required to overdetermine these factors. A modified version of Thurstone's copying test or the Bender-Gestalt would probably bolster the Perceptual Analysis factor and additional formboards which require the fitting together of separate pieces would probably over-determine the Perception of Form Relations factor. The Conceptual Reasoning factor would be clearer if a test such as the Object Series Test were added.

An inspection of the factor variances (Table 35) shows an interesting trend. Along the continuum Rural Illiterate, Urban Illiterate, Rural Literate, Urban Literate there is a shrinkage in the variance for the Perceptual Analysis factor and a growth in the variance of the Perception of Form Relations factor. These results are consistent with what happens to the variance of the tests which define these two factors. If a factor for

a particular group had not been present then the inter-group procedure would have shown it to have no factor variance. Thus it is obvious, that for all four groups, all five factors are present.

In Table 60 the factor correlation matrices for all four groups are presented. If it is assumed that correlations between factors of .60 and above indicate a strong relationship between factors it will be seen that there are distinct differences between the two illiterate groups on the other hand. In the Urban Illiterate there is only one intercorrelation between factors which exceeds .60 namely P.F.R. X. Sp. which is .63. In the Rural Illiterate the only intercorrelation approaching the .60 criterion is that between P.F.R. and P.S. P.F.R. and Sp., as was pointed out in Chapter V, belong in the realm of spatial thinking. As the Urban Illiterate group is a group working in industry, where opportunities for being exposed to spatial problems are greater than in the rural areas, spatial ability could well have reached a rough limit of overlearning. Thus in tests of a similar kind positive transfer is likely to occur. For the Rural Illiterate group it appears that the correlation between P.F.R. and P.S. can be accounted for in terms of either the speed element in the tests representing these two factors or in terms of what one might call "positional space." Being unable to read the discs in Sorting II and being unable, because of unfamiliarity, to name the objects in Sorting I, Rural Illiterate subjects might well have had to rely on keeping in mind the position of a particular object in the sorting tray. It is important to note, however, that for these two groups only one intercorrelation each between factors approach or meet the criterion of a strong relationship between factors.

By contrast a very different picture is presented by the two literate groups. In the Rural Literate group there are six intercorrelations between factors which are greater than .60. It will be seen that all factors are strongly influenced by Space. The correlation of .80 between Space and Perceptual Speed is of particular interest. Among the tests describing Space are Cube Construction and Tripod Assembly. Among the tests describing Perceptual Speed are Sorting I and Sorting II. These four tests constitute the General Adaptability Battery. To all intents and purposes then the G.A.B. only measures one ability for the Rural Literate group. This ability is not g as many British factor analytic adherents would maintain, but an ability which could best be described as "spatial speed." Similarly for the Urban Literate group the correlation between these two factors is also high (.68) and probably here too a single ability is operating. Since the intercorrelation between these two factors is, by comparison low, for

the two illiterate groups these findings would explain the differences in factor structures which Hudson et al (1962) noticed.

In the Urban Literate group there are four intercorrelations between factors which are .60 or greater. It will be noticed that the Space factor is not as persuasive for this group as it is for the Rural Literate group. This aspect, and indeed the fewer number of factor correlations exceeding .60, may be explained in terms of Hayes's E.P.Ds. It has been shown that there is a large discrepancy in age between the two groups. Hayes has suggested that, as a function of age, the number of E.P.Ds decrease. Thus it may be expected that the older a group becomes the less it is going to use the abilities it has overlearned. This in turn would reduce the positive transfer effects of abilities.

In the Rural Literate group it will be noticed that P.S. is strongly related to both P.A. and C.R. It was shown in an earlier pilot study that tests from P.S and C.R. loaded on the same dimension. Since P.A. is also strongly related to P.S. this might well mean that for the Rural Literate group the tests representing these factors demand only a discriminatory ability of the subjects. Similarly for the Urban Literate group both C.R. and P.S. are strongly related to P.A. These results explain also why Kaiser's criterion yielded only two factors for these two groups. The two factors obtained for both groups can roughly be divided into a "spatial speed" factor and a "discrimination" factor. For the Rural Illiterate group the structure is less clear but the two factors obtained are roughly equivalent to the two mentioned above. For the Urban Illiterate group the same factors are present but Conceptual Reasoning as a factor has made a more distinct appearance.

The reason for the significant statistic is also explained by these results. As a function of literacy fewer abilities are brought into play when solving an apparently "diverse" array of cognitive tasks. It has been shown that literacy is extremely important in determining how subjects approach cognitive tasks and that urbanization, within the scholastic educational range nil to 7 years of schooling, hardly affects the mental structure. If a change from illiterate to literate is regarded as a cultural change then the second hypothesis is supported in respect of literacy but not in respect of urbanization. Had a more truly urbanized group been included in the study then urbanization might have been shown to affect the structure of intellect. An important aspect of these findings which should be mentioned is that schooling is a concentrated form of overlearning which in most cases occurs during childhood. Urbanization on the other hand is less formal

and if a group is "encapsulated" a change in culture is unlikely to occur.

Do these results mean that the two literate groups are less differentiated than the two illiterate groups? On the contrary; what these results show is that, as a function of having attended school, literate subjects have attained abilities, which through learning, have a crude stability or invariance. Ferguson, in explaining the correlations between factors, refers to the operation of positive transfer. Positive transfer, however, can only occur if the prior acquisitions have attained a state of invariance. From the correlations between factors obtained for the two illiterate groups it would appear that their abilities have not reached a state of invariance. This may be explained in terms of a lack of opportunity to develop these abilities to a state of invariance within an "illiterate culture".

Ferguson (1954) regards learning as the process by which the abilities of man are differentiated but ".... the process of differentiation is aided and abetted by the abilities which the individual already possesses" (p. 110). It should be remembered that in Ferguson's terms an ability is an overlearned acquisition. Thus it may be concluded that since the two literate groups have attained certain abilities, as measured by the test in the battery, they are likely to be more differentiated than their illiterate counterparts. This is not to say that illiterates have no overlearned acquisitions or abilities it merely indicates that, in terms of the abilities measured by the present battery of tests, less differentiation was detected. Thus, it may be taken that the third hypothesis was supported in terms of literacy but not in terms of urbanization. Again, if a more truly urbanized group had been included in the study, the effects of urbanization as a differentiating variable might have been shown.

In Table 37 the factor correlation matrices of the four groups have been compared. The largest differences between the intercorrelations have been underlined. A number of interesting inferences may be drawn from these figures. On the whole the differences between the two illiterate groups are very small. It is only in terms of spatial thinking that they differ. This is consonant with the differences in respect of spatial ability which have been repeatedly mentioned in the literature. If the two rural groups are compared then a similar difference will be noted. It seems therefore that acculturation in terms of literacy and urbanization are important to the development of spatial thinking. The Rural Illiterate group seems not to have reached a point of invariance as far as this ability is concerned.

The differences between Urban Illiterate and Rural Literate are quite pronounced but it is in terms of C.R. and P.S. that the greatest difference can be seen. For the Urban Illiterate group the factors are uncorrelated. It seems that the similarity between the two tasks were not perceived by the Urban Illiterate group mainly because they did not, or could not, attach verbal labels to the perceptual stimuli contained in the tests representing these factors. In comparing the two Urban groups the greatest difference between the intercorrelations is in respect of P.F.R. X P.S. For the Urban Illiterate group the factors were uncorrelated. It would appear that the Urban Literate group when solving the sorting tasks relied heavily on the positions of the compartments, not because they could not read the symbols or name the objects but because it proved to be an effective short-cut method. It will be seen from the comparisons of the mean levels of performance that the Urban Literate performed best of all the groups on the tests representing these factors. The Rural Literate group did not however devise this short-cut method.

When comparing the two literate groups it will be seen that there is quite a large difference in terms of P.A. X Sp. For the Urban Literate the two factors were relatively uncorrelated. This is probably due to the fact that the P.A. factor for the Urban Literate group had very little variance compared to the variance on the Space factor. Thus through a restriction of range the correlation would automatically be lower.

Conclusion

The methodology used in this study has important implications for psychology in general. When comparing different groups by means of factor analytic techniques, an inter-group procedure such as that used in this study is preferable to the standard factor analytic techniques. New light has also been thrown on the problem of how many factors to extract if different samples are used. The results obtained in conventional factor analysis, though reflecting the content of a matrix accurately, do not provide a deeper insight into the effects of sample differences. The inter-group procedure seems to provide valuable additional information.

One of the hypothesis put forward was shown to be supported in full by the results. It was shown that literacy and urbanization both lead to improved scores on cognitive tests. The two other hypothesis were supported in terms of literacy but not in terms of urbanization. It was shown that literacy leads to a different patterning of abilities and that it

also brings about greater differentiation of abilities, not in terms of the Burt-Garrett hypothesis, but in terms of Ferguson's theory.

In conclusion the overall results of this study have shown that both urbanization and scholastic education are important factors in helping Africans to adapt to the demands of a Western-technological culture. By improving these conditions in any African country, the potentialities of Africans are more likely to be realised.

APPENDIX A

URBAN-RURAL SCALE

SECTION A

NOTE. URBAN areas are the following cities and towns and their townships: JOHANNESBURG, PRETORIA, GERMISTON, BENONI, SPRINGS, BLOEMFONTEIN, DURBAN, PIETERMARITZBURG, CAPE TOWN, EAST LONDON, KIMBERLEY, PORT ELIZABETH, VEREENIGING/VANDERBIJLPARK.
All other areas are RURAL.

1. R U — Where were you born?

Response: . . . . . .

* IF ANSWER IS URBAN AREA RING U.

2. R U — Do you own fields or land in a rural area?

Response: Yes ( ) No ( )

* TICK OFF THE RESPONSE. IF ANSWER IS NO RING U.

3. R U — Where do your parents live?

Response: . . . . . OR,

IF PARENTS ARE DECEASED ASK -

Where did your parents live when they were alive?

Response: . . . . . .

* IN EITHER CASE IF ANSWER IS URBAN AREA RING U.

4. R U — Do your parents own fields or land in a rural area?

Response: Yes ( ) No ( ) OR,

IF PARENTS ARE DECEASED ASK -

Did your parents own fields or land in a rural area when they were alive?

Response: Yes ( ) No ( )

* TICK OFF THE RESPONSE. IN EITHER CASE IF THE ANSWER IS NO RING U.

SECTION B

5. R U

What tribe does your father belong to?

Response: . . . . . .

Your mother? . . . . . .

Your wife? (IF MARRIED) . . . . . .

* IF ANY OF THE RESPONSES IS A TRIBE DIFFERENT FROM THAT OF THE INTERVIEWEE RING U.

6. R U

What grade or standard did your brothers and sisters pass at school? (NOTE: Write down the response between the brackets. If a standard is given add two).

Brother		Sister	
1.	( )	1.	( )
2.	( )	2.	( )
3.	( )	3.	( )
4.	( )	4.	( )
5.	( )	5.	( )
6.	( )	6.	( )

TOTAL NUMBER OF YEARS ( )

AVERAGE ( )

* IF AVERAGE IS 4 AND ABOVE RING U.

7. R U

Do you attend bioscopes?

Response: Yes ( ) No ( )

* TICK OFF THE RESPONSE. IF ANSWER IS YES RING U.

8. R U

If you were to hold a party would you

(a) pay for it yourself ( )

(b) expect a contribution in the form of money, food or drink from your guests ( )

* TICK OFF THE RESPONSE. IF ANSWER IS (b) RING U.

SECTION C

In this section each question is accompanied by a numbered list of possible rural and urban responses. Place a tick against those given by the interviewee. If he does not give any of those responses listed then ask him to CHOOSE between the first rural and first urban responses listed. *IF ANY RURAL RESPONSES ARE GIVEN DO NOT RING U. HE MUST HAVE ONLY URBAN RESPONSES TO HAVE U RINGED.

9. R U

If you were given R500 and told to spend it within a week how would you spend it?

RURAL Responses. 1. Buy cattle or other farm animals ( ), 2. marry additional wives ( ), 3. buy agricultural implements ( ), 4. buy a table and chairs ( ), 5. get an iron roof for the house ( ) 6. buy window panes ( ), 7. cannot imagine what he would spend it on ( ), 8. buy seed ( ), 9. buy a tractor ( ).

URBAN Responses. 1. Buy a motor vehicle ( ), 2. buy electrical appliances e.g. a) radiogramme ( ), b) transistor radio ( ), c) washing machine ( ), 3. bicycle ( ) 4. lounge or dining room suite ( ), 5. kitchen scheme ( ), 6. curtains ( ), 7. bank what is over ( ).

10. R U

What would you like to do during your lifetime that would make you happy and proud of yourself?

RURAL Responses. 1. Raise a large herd of cattle ( ) 2. attain higher status in the tribe ( ), 3. do something appreciated by the tribe ( ), 4. make bricks for houses ( ), 5. become a woodworker or carpenter ( ), 6. weaver ( ), 7. sharpen blunt tools ( ), 8. agricultural demonstrator ( ), 9. become a Christian ( ).

SEE ALSO QUESTION 9. IF ANY OF THOSE RESPONSES ARE GIVEN FILL THE NUMBER OF THE RESPONSE IN IN THE SPACE PROVIDED . . . . . .

. . . . . .

URBAN Responses. 1. Open his own business ( ), 2. be his own boss ( ), 3. educate himself ( ), 4. educate his children ( ), 5. make a lot of money ( ), 6. be a salesman ( ), 7. become a machine operator in a factory ( ).

SEE ALSO QUESTION 9. IF ANY OF THOSE RESPONSES ARE GIVEN FILL THE NUMBER OF THE RESPONSE IN IN THE SPACE PROVIDED . . . . . .

. . . . . .

SECTION C (Continued)

11. R U

What do you think you will be doing, regarding a job, five years from now?

RURAL Responses. 1. Staying and working in the rural areas ( ), 2. going back to rural areas ( ), 3. retiring to the rural areas ( ), 4. do not know ( ).

URBAN Responses. 1. Continuing to work or going to work in the urban areas ( ), 2. working for his family i.e. in urban areas ( ), 3. opening his own business ( ).

12. R U

What material possessions would you like to buy for your home, if you could afford them?

SEE QUESTION 9. FILL IN THE NUMBER OF THE RESPONSES IN THE SPACE PROVIDED.

RURAL Responses. . . . . .

. . . . . .

URBAN Responses. . . . . .

. . . . . .

See SECTION D on next page.

SECTION D

This section is devoted to questions about tribal chiefs. A certain amount of difficulty may be experienced by the interviewer in obtaining responses. If the interviewer encounters resistance to the questions he should approach the subject in an indirect way and thereby judge the interviewee's attitude towards tribal chiefs.

13. R U

How do you feel about tribal chiefs?

What do you like about them? . . . . . .

. . . .

. . . .

What do you dislike about them? . . . . . .

. . . .

. . . .

IF THE ATTITUDE EXPRESSED IS DISLIKE OR AMBIVALENT

i.e. LIKE AND DISLIKE RING U.

14. R U

Do you live under the jurisdiction of a chief?

Response: Yes ( ) No ( )

* IF THE ANSWER IS NO RING U.

IF THE ANSWER IS YES ASK

Do you pay allegiance to him?

Response: Yes ( ) No ( )

* IF THE ANSWER IS NO RING U.

SECTION E

THE INTERVIEWEE IS TOLD "I want you to tell me whether, on the whole, you agree or disagree with each statement I put to you."

15. R U A chief should always be obeyed.

Agree ( ) Disagree ( )

* IF ANSWER IS DISAGREE RING U.

16. R U A chief is justified in taking tribal funds provided he repays them later.

Agree ( ) Disagree ( )

* IF ANSWER IS DISAGREE RING U.

17. R U A sick person will die if he is seen by a person who is evil or touched by evil.

Agree ( ) Disagree ( )

* IF ANSWER IS DISAGREE RING U.

APPENDIX B

INTER-GROUP FACTOR ANALYSIS

by M.W. BROWNE

Factor analysis is essentially a descriptive technique. When a factor analysis model is used to describe differences between populations a more parsimonious description is obtained if the factor matrix is taken to be invariant over populations and factor variances and covariances alone are allowed to vary. The alternative of permitting different factor matrices in different populations leads to difficulties in matching factor variates and in interpreting differences between populations. These difficulties are avoided if the relationships between manifest variables and factor variables (as represented by factor loadings) are assumed to remain constant between populations. Since factor variables are defined in terms of their factor loadings with manifest variables, this implies that the same factors are examined in different populations. Differences in manifest variable covariance matrices between populations are then interpreted only in terms of differences in the smaller factor variable covariance matrices.

Let Σ_g (p x p) represent the manifest variable covariance matrix for the g^{th} population, C_g (m x m) the factor covariance matrix for the g^{th} population, $D_{U(g)}$ (p x p) the diagonal unique variable covariance matrix for the g^{th} population, and Λ (p x m) the factor pattern matrix which is common to all populations. The inter-group factor analysis model is:

$$\Sigma_1 = \Lambda C_1 \Lambda' + D_{\upsilon(1)}$$

$$\Sigma_2 = \Lambda C_2 \Lambda' + D_{\upsilon(2)}$$

. .

. .

. .

$$\Sigma_G = \Lambda C_G \Lambda' + D_{\upsilon(G)} \quad .$$

As pointed out by Meredith (1964 a), it is of considerable importance to note that this model refers to manifest variable covariance matrices, not to correlation matrices.

Let

$$D_{\sigma(g)} = \text{Diag}\,[\Sigma_g] \quad .$$

Then the manifest variable correlation matrix for the g^{th} group is

$$P_g = D_{\sigma(g)}^{-\frac{1}{2}} \Sigma_g D_{\sigma(g)}^{-\frac{1}{2}}$$

$$= [D_{\sigma(g)}^{-\frac{1}{2}} \Lambda] C_g [D_{\sigma(g)}^{-\frac{1}{2}} \Lambda]' + [D_{\upsilon(g)} D_{(g)}^{-1}] .$$

Expressing the model in terms of correlation matrices implies that the single factor matrix Λ is replaced by a different rescaling $[D_{\sigma(g)}^{-\frac{1}{2}} \Lambda]$ in each population and all advantages of the model are lost. Although it is not permissible to apply different rescalings in different populations, it is permissible to apply the <u>same</u> rescaling to these different populations.

A modification of the second procedure given by Meredith (1964 b, pp. 188 - 194) was used to obtain estimates of Λ and of $C_1, C_2 \ldots\ldots C_G$. Since C_g is gramian there is a T_g (m x m) such that

$$C_g = T_g T_g' \quad .$$

Then

$$\Sigma_g = \Phi\Phi' + D_{\upsilon(g)}$$

where

$$\Phi_g = \Lambda T_g$$

and

$$P_g = \Gamma_g \Gamma_g' + D_{\upsilon(g)} D^{-1}_{\sigma(g)}$$

where

$$\Gamma_g = D^{-\frac{1}{2}}_{c(g)} \Phi_g$$

Let R_g denote a sample correlation matrix based on a sample of size N_g from the g^{th} population. Let $D_{s(g)}$ denote the corresponding diagonal matrix of sample variances.

Estimates $\hat{\Gamma}_g$, g = 1, 2 ..... G, of the Γ_g were obtained by minimising the sum of squared nondiagonal elements of the matrices $(R_g - \hat{\Gamma}_g \hat{\Gamma}_g')$. The well-known iterative principal factor computing procedure followed by a Varimax rotation was employed. For convenience, sample variances were rescaled,

$$D^*_{s(g)} = \left[\sum N_g D_{s(g)}\right]^{-1} D_{s(g)} \quad ,$$

to give a weighted average of unity,

$$N^{-1} \sum N_g D^*_{s(g)} = I \quad ,$$

$$N = \sum N_g \quad .$$

The factor matrices $\hat{\Gamma}_g$ (which correspond to correlation matrices) were rescaled to give factor matrices $\hat{\Phi}_g$ (which correspond to covariance matrices):

$$\hat{\Phi}_g = D^{\frac{1}{2}}_{S(g)}\hat{\Gamma}_g \quad .$$

Estimates $\hat{\Lambda}$ and $\hat{T}_g$ of Λ and T_g, g = 1, 2 ....., were obtained by minimising the weighted sum of squares

$$N^{-1}\sum_g N_g \, tr[(\hat{\Phi}_g - \hat{\Lambda}\hat{T}_g)(\hat{\Phi}_g - \hat{\Lambda}\hat{T}_g)'] \quad .$$

The $\hat{\Lambda}$ and $\hat{T}_g$, g = 1 ..... G, which minimise this sum of squares are not unique. In order to obtain a particular solution Meredith (1964 b) imposed the constraints:

$$\hat{\Lambda}'\hat{\Lambda} = I \quad .$$

In the solution used here other constrints were employed: the factor variances were chosen to have weighted averages of unity,

$$N^{-1}\sum N_g Diag[\hat{C}_g] = N^{-1}\sum N_g Diag[\hat{T}_g\hat{T}'_g] = I$$

while $\hat{\Lambda}$ was initially identified using the principal axes characterisation and subsequently rotated obliquely to simple structure. The principal axes characterisation $\hat{\Lambda}_p$ was obtained by taking the first m principal components of the matrix

$$N^{-1}\sum N_g(\hat{\Phi}_g\hat{\Phi}'_g)$$

A rotation to simple structure was carried out by means of the Promax* procedure (Hendrickson and White, 1964) to obtain a

*A small modification was introduced in that the rows of the target matrix were rescaled so as to have sums of squares equal to the original communalities.

factor pattern matrix $\hat{\Lambda}_s$ and corresponding factor correlation matrix $\bar{C}$. The estimated factor covariance matrix, $\hat{C}_g$, for each population was then obtained from:

$$\hat{T}_g = (\hat{\Lambda}_s'\hat{\Lambda}_s)^{-1}\hat{\Lambda}_s'\hat{\Phi}_g \quad ,$$

$$\hat{C}_g = \hat{T}_g\hat{T}_g' \quad , g = 1 \ldots\ldots G.$$

As a check on computation the relationship,

$$\bar{C} = N^{-1}\sum N_g\hat{C}_g \quad ,$$

was used.

Factor variances were given by the diagonal elements of the $\hat{C}_g$ while factor correlations were obtained by rescaling in the usual manner.

In order to assess the fit of the model the square root of the average squared element of the residual matrix $(\hat{\Phi} - \hat{\Lambda}_s\hat{T}_g)$ was obtained for each group. The square root of the average of all squared residuals was also computed.

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APPENDIX C

DESCRIPTION OF TESTS

(Published studies in which these tests or modifications of these tests have been applied are indicated after each description).

THE GENERAL ADAPTABILITY BATTERY

(a) Sorting Test I

The apparatus for this test consists of a wooden tray divided into 16 compartments. In each compartment a single sample item such as a washer, nail, screw, rivet or nut, is attached. Altogether there are 16 different kinds of objects which differ, if not in kind, then in size and material. A second tray, without compartments, contains five replicas of each of the sample items. Therefore there are 80 items in this second tray.

The testee is required to sort the items as rapidly as possible into their appropriate compartments. There are two trials in this test, each with a specific time limit. The testee's score is the total number of discs correctly sorted.

(b) Sorting Test II

The apparatus consist of a tray with 16 compartments. At the back of each compartment, on an inclined plane, a sample brass disc is attached. Each disc has a symbol, either a letter or digit, or combinations of two letters or two digits, stamped in the centre of it. Altogether there are 16 different discs. A second tray, without compartments, contains five replicas of each of the sample discs. Therefore there are 80 discs in this second tray.

The testee is required to sort the items as rapidly as possible into their appropriate compartments. There are two trials in this test, each with a specific time limit. The testee's score is the total number of discs correctly sorted.

(c) Cube Construction Test

The apparatus consists of 27 one-inch cubes and four model blocks. 8 Of these cubes have 3 sides painted red and the other 3 sides white; 12 have 2 sides painted red and the other 4 sides white; 6 have 1 side painted

red and the other 5 sides white and one cube is painted completely white. For ease of administration these cubes are arranged in three separate compartments according to the number of sides of the cubes painted red. The model blocks simulate assemblies of 8, 12, 18 and 27.

A model block is placed in front of the testee together with the requisite number of cubes. He is required to assemble the given cubes into an exact replica of the model block, i.e. all the red sides should be outside and all the white sides inside. There are 4 trials altogether, each with a specific time limit. The first trial is not scored and the errors made are pointed out to the testees. The next three trials are scored according to the number of cubes correctly positioned. Testees who have correctly assembled all the cubes receive an additional bonus point.

(d) Tripod Assembly Test

The apparatus consists of 18 metal parts which can be assembled to form a tripod with a weight suspended from it. The legs of the tripod are prevented from splaying by an assembly of links which are joined to the legs of the tripod, and a centre ring. The pieces are presented in a standard form in a wooden tray.

The testee is required to assemble the individual pieces to reproduce a tripod, after having been shown a model with some indication of the inter-relation of the parts. There are three trials in this test, each with a specific time limit. Before each trial the model is shown briefly. The score is based on the number of pieces correctly assembled and the bonus points are allocated according to correct assembly. (cf. Biesheuvel, 1952a).

FORM PERCEPTION TEST

In this test outlines of different geometrical shapes are printed on the pages of a booklet. The outlines are symmetrical in shape and only one appears on each page. The same set of three pieces accompanies each item. The pieces are geometrical in shape and made of paper which is blackened on one side and gummed on the other. The smallest piece is a right-angled isosceles triangle. The middle piece, of the same shape, is a combination of two of the smaller pieces. The largest piece is a combination of three of the smaller pieces and is in the shape of a trapezium. The test contains one practice item and nine test items.

The subject has to position the three pieces within the outline and when he is satisfied that they fit, he has to stick them in position. A time limit of two minutes is imposed upon each item and it is scored by allocating one mark for each piece correctly placed. (cf. Grant and Schepers, 1969).

FORMBOARDS

Each set contains four formboards which will be referred to as FB I, FB II, FB III and FB IV. Each of these boards is made of wood and faced with an eighth of an inch thick of aluminium sheet. Quarter of an inch deep recesses of different geometrical shapes are cut into the surface of each board. FB I contains six recesses and six single pieces. FB II contains twenty recesses and as many pieces to fill them. FB III contains eight recesses and fourteen pieces. Six of the recesses require double insets and the remainder single insets. FB IV contains six recesses and eighteen pieces. Two of the recesses require double insets, two triple insets, and two quadruple insets. Each formboard is accompanied by a separate sheet of cardboard. For standard administration purposes the pieces which fill the recesses in the formboards are presented on the cardboard sheets. Each piece has a specific position on the sheet which is indicated as a silhouette. They are not placed in the same positions as those in the recessed board and having been rotated they have a different orientation.

The task of the subject is to fill as many of the recesses as he can within a limited time. The time limits are as follows: FB I, thirty seconds; FB II, one minute and forty-five seconds; FB III, four minutes and FB IV, ten minutes.

FB I is not usually scored as it is a practice board. In the other boards one mark is allotted for each piece correctly fitted into a recess, and a bonus mark is added for each complete inset having two or more parts. (cf. Biesheuvel, 1952a).

FRET REPETITION TEST

This test consists of a booklet containing two practice items and ten test items. Each item is printed on a separate page. At the top of the page is a configuration of dots joined by means of continuous straight lines to form a pattern similar to those found on Greek vases. At the

bottom of the page only the dots are presented. The testee is required to join these dots by means of straight lines to reproduce the model pattern. No time limit is imposed on the test but it has been found that testees require only a minute or two to reproduce the pattern. One mark is credited for each pattern correctly reproduced. (cf. Hector, 1960; Grant and Schepers, 1969).

FRET CONTINUATION TEST

This test consists of a booklet containing two practice items and ten test items. Each item is printed on a separate page. It has a configuration of dots joined by means of continuous straight lines at the top of the page but an incomplete reproduction of the model pattern is presented at the bottom of the page. The testee is required to trace the given part of the pattern with a pencil and then continue it on his own until he has completed it. No time limit is imposed. Testees generally require two to three minutes for each item. One mark is credited for each pattern correctly completed. (cf. Hector, 1960; Grant and Schepers, 1969).

PATTERN REPRODUCTION TEST (MODIFIED KOHS)

This test contains one practice item and six test items. The items are printed on the pages on a booklet. Only one item appears on each page. On each page of the booklet there are two squares. The square on the left-hand side contains a complex pattern. The square on the right-hand side is the same size but is blank. The practice item and test items 1, 2 and 3 contain 3"x 3" squares. Test items 4, 5 and 6 contain $4\frac{1}{2}$"x $4\frac{1}{2}$" squares. For each item a set of tiles is given to the subject. For the practice item and the first three test items the subject receives four tiles. For the remaining test items the subject receives nine tiles. The items are arranged in an ascending order of complexity. The subject is required to assemble the tiles in the blank square in such a way that the complex pattern is reproduced. (cf. Grant and Schepers, 1969).

CIRCLES TEST

This test contains two practice items and eleven test items. The second practice item is, however, also marked and may therefore be considered as a test item. The items are printed on cards which slide into the left-hand side of a flat $4\frac{1}{2}$"x $4\frac{1}{2}$" container. The base of this container is

extended another 6" to the right. A black 4"x 4" square is printed on the surface of the extension. A compartmentalized box containing smaller cards accompanies each container. Each item card has printed on it a circle inside which are various symbols or shapes. For each item card there is a set of smaller cards which are kept in the compartmentalized box when not in use. These smaller cards have a quadrant of a circle printed on them. The quadrants contain symbols or shapes or parts of symbols or shapes. Four of the smaller cards, when assembled on the black square of the container, will reproduce the given pattern. In each set of cards there are, however, distractor cards. Items 1 to 5 have two distractors while items 6 to 13 have four distractors. The subject is required to sort out four pieces and assemble them to reproduce the given pattern. (cf. Grant and Schepers, 1969).

FORM SERIES TEST (F.S.T.)

This test contains four practice items and eighteen test items. The items are printed on a sheet of durable paper which is wrapped around a plywood board. This sheet of paper is affixed to the board by means of double-coated masking tape. Each item is a sequence of symbols; each symbol being a compound of a particular size, colour and shape. In the test, as a whole, three colours, three shapes and two sizes were drawn upon to construct the items.

Only part of a sequence is presented in each item and the testee is required to continue it by affixing two plastic forms, which he selects from a tray, to the strip of masking tape running down the side of the board. In marking the items of the test, credit is given only if both answer forms are correct in all respects i.e. the shape, colour and size of the two forms all have to be a correct continuation of the given sequence. The test is untimed. (cf. Grant, 1965; Grant and Schepers, 1969).

SYMBOL SERIES TEST (S.S.T.)

This test contains four practice items and twelve test items. The items are printed on both sides of an 8" x 12" sheet of white cardboard.

A sequence of symbols is presented and the subject is required to continue it. He does this by drawing in, with a pencil, two symbols in the two spaces provided at the end of the sequence. In marking the test the quality of the drawings is ignored. Subjects are given credit for an item if both spaces are filled in correctly. The test is untimed.

SQUARES DETECTION TEST (S.D.T.)

The test contains one trial sheet and six test sheets. On each sheet a 40 mm. x 40 mm. square, with a clearly defined dot at each corner, is printed in the top left-hand corner. The rest of the sheet is covered with dots which appear, at first glance, to be randomly scattered. The trial sheet contains sixteen dots and each of the test sheets twenty dots. The subject is required to detect squares, the same size as the same model square, from among the scattered dots. Having found a square he connects the four dots by drawing in the lines. There are no irrelevent dots. In test items 1 - 3 the completed squares are apart but they overlap in items 4 - 6. The items are made increasingly difficult by gradually bringing the squares closer together until they overlap. The test is untimed and the score is the total number of squares correctly detected. (cf. Hector, 1964).

SYMMETRY COMPLETION (SYMCO)

The test contains six practice and twenty-five test items. Two practice items precede the first five test items, and thereafter each succeeding set of five test items is preceded by one practice item. In other words, a practice item is done by the subject before he goes on to deal with each set of test items. The items of the test are printed on the pages of a booklet. Besides the test booklet each subject receives a pencil, a length of straight wire and a black metal oblong which has a small hole at each end.

Each item of the test appears on a separate page and is made up of one black and two grey oblongs. The oblongs are situated inside a black frame. As given, the item is incomplete, i.e. a black oblong is needed to complete the bilateral symmetry suggested by the other three oblongs. The subject is required to place the metal oblong within the black frame in such a way that bilateral symmetry is achieved. He first finds the symmetry line with the piece of wire. He then places the metal oblong in position and marks the spot by drawing in the two holes of the metal oblong.

The test is untimed. A response is considered correct if the two marks representing the holes in the oblong are both within a 5 mm. radius of the spots representing the correct position of the oblong. (cf. Hector, 1958; Fridjohn, 1960; Tekane, 1961; Tekane, 1963 and Reuning and Wittmann (1963).

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