SPECIAL REPORT

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NATIONAL INSTITUTE FOR PERSONNEL RESEARCH
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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UDC 159.955.6.072(680=963)
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I. M. KENDALL

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SUMMARY

Recent application of the Secondary Industry version of the Form Series Test (F.S.T.), a measure of conceptual reasoning ability, to urban factory workers has demonstrated that the test in its present form is too easy for literate Africans. This report describes the development of an advanced version of the F.S.T. which extends the range of item conceptual complexity quite considerably.

The report is in two parts. Part One describes the results from pilot studies conducted on two matched samples, each consisting of 180 male, urban factory workers. The first sample was administered an experimental 40-item version and the second sample the last 22 items only. These studies clearly demonstrated that perceptual cognitive strategies play a crucial role indetermining the level of performance on the F.S.T., and that the conceptual-analytic strategy originally postulated by Grant was of secondary importance only.

Part Two describes the application of the final, shortened version of the Advanced F.S.T. to 422 rural and urban male factory workers. The reliability of the new 30-item instrument was found to be 0,95 while the correlation between test performance and number of years of formal schooling was 0,66. Owing to the heterogeneous nature of the sample in terms of the education variable, the frequency distribution of scores is markedly bi-modal. By means of factor analyses of item intercorrelations, evidence is provided that the approach to the test on the part of literates, semi-literates and illiterates differs widely, with some indication that the perceptual and conceptual modes of reasoning become more differentiated as a function of literacy.

The performance of both the pilot and main samples on the Advanced F.S.T. suggested that a large measure of non-verbal rigidity characterized their approach toward the end of the test. In this connection, it is speculated that Africans at all educational levels, when solving the easier test items, develop a non-conceptual approach to problem-solving to such a marked degree that they meet with considerable difficulty in shifting to a conceptual approach for the more difficult items. The reasons for this phenomenon are not felt to be test-specific, but are

probably as much socio-cultural as temperamental.

The final part of the report draws attention to a comparison of the raw score frequency distributions between the existing and the new extended F.S.T. at five levels of formal schooling. The graph for the high-school educated (i.e. literate) group demonstrates a clear improvement in the discriminability of the F.S.T. at this level. Unfortunately, the new F.S.T. is by and large too difficult for illiterates which means that the test can not be administered to this group with any degree of confidence.

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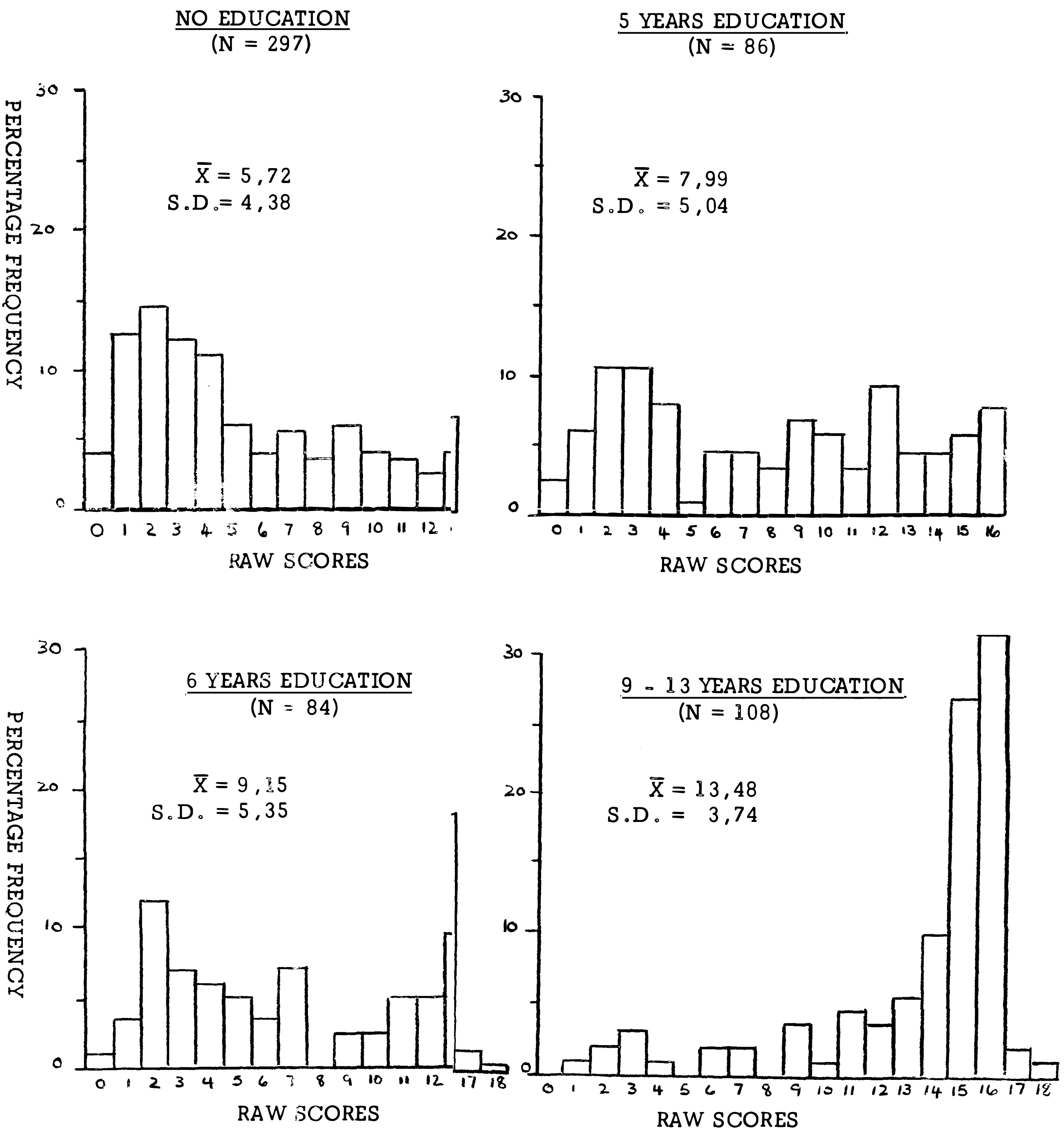
INTRODUCTION

The Form Series Test (F.S.T.) was constructed by Grant (1965)[1)] as a non-verbal measure of conceptual reasoning ability for use among Africans. It is an extensive adaptation of Morrisby's (1955)[2)] Compound Series Test and is currently available to test users in two forms: the "mines" version and the more advanced "secondary industry" version. Both versions consist of four practice and 18 test items. Each item is written as a sequence of forms, with each form being a compound of a particular size (big, medium, small), colour (red, yellow, dark blue) and shape (square, circle, triangle). Only part of the sequence is presented in each item, the task of the testee being to continue the sequence by affixing two plastic forms to the side of his test board.

In constructing the Secondary Industry version of the F.S.T., Grant (1965)[3)] pitched the range of difficulty of the test items at a level appropriate for industrial workers whose educational achievement as a group averaged three years of formal schooling. The test was constructed almost ten years ago, at a time when an extremely small percentage of the African labour force entering industry could boast a high-school education. It has since been the observation of the NIPR that the mean educational achievement of the African factory worker in the Transvaal has risen to around six years of formal schooling over the past ten years, with approximately 30 to 35% of recruits having spent eight or more years at school. Blake of the NIPR has made available some unpublished statistics which demonstrate that F.S.T. scores become highly skewed for subjects with eight or more years schooling. These are reported in Figure 1. It is clear from the graphs that the test as it stands is far too easy for subjects beyond the Standard V level, with the unfortunate result that it is not possible to measure differences in conceptual reasoning ability as reliably among literates as it is among semi-literates and illiterates. Therefore, when it is considered that a third of the population from which industry today draws its recruits are educationally too well-qualified to be administered the F.S.T. with any degree of confidence for selection and placement purposes, it can be appreciated that the time has arrived for the NIPR to revise its battery of tests for Africans.

PER EDUCATIONAL LEVELS



The decision was made to commence a programme of test revision and extension by concentrating on the Form Series Test. Apart from the experience that would be gained from such an exercise, a major factor motivating the choice of this test for purposes of revision is the simple fact that the F.S.T. is one of the few tests that have been constructed with a basic and rational item-generating model in mind. In order to assemble the original 18 items, Grant evolved a simple and ingenious code which adequately accounted for the major factors influencing the conceptual complexity of items. In his 1965 publication, Grant demonstrated the efficacy of his code in predicting the rank order of items in terms of difficulty with remarkable accuracy. The code is sufficiently comprehensive and flexible to allow for items of any given level of difficulty to be generated. Therefore, theoretically, versions of the test could be drawn up to match the intellectual sophistication of virtually any given population. Given the availability of such a code, it was felt that the development of an advanced version of the F.S.T. would present far fewer practical and theoretical problems than would the development of advanced versions of other types of tests which had been constructed in the absence of item-generating models.

The principle aim of the present study is thus to explore the possibility of extending the difficulty value of the existing F.S.T. in order to develop a measuring device that would enable industry to differentiate more finely and reliably between its literate African workers in terms of conceptual reasoning ability. A second, though less important, aim of the exercise is to attempt to measure differences in conceptual reasoning processes across as wide an educational spectrum as possible by means of a single test. Thus, although our focus will be primarily on the performance of literates, it is hoped that the advanced version of the F.S.T. will also prove to be applicable to less educated individuals.

PART ONE

PILOT STUDY

1.1. Some Preliminary Exercises

Before developing an experimental version of the advanced F.S.T. for exploratory use it was necessary to answer two important questions:

(i) To what extent is the code devised by Grant for generating test items able to predict the rank order of item difficulty at higher levels of conceptual complexity? and,

(ii) how difficult is the final advanced F.S.T. to be made?

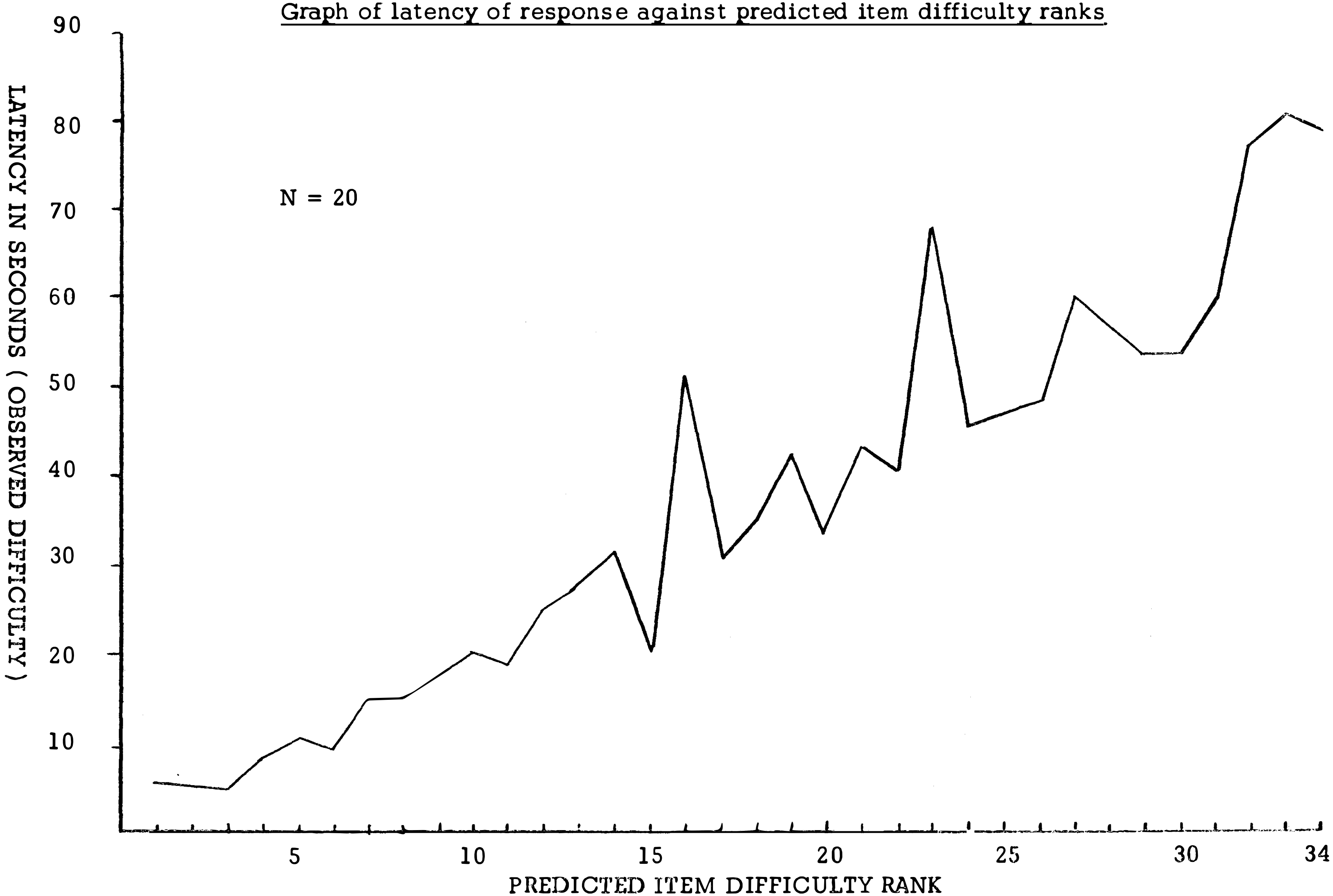
In order to investigate the efficiency of the item-writing code as a predictor of item difficulty, an experiment was conducted on 20 white NIPR staff members wherein the latency of response in solving each of 34 items graded in terms of predicted difficulty was noted. These items included 9 of the existing F.S.T. items (items in the F.S.T. are written in parallel pairs, thus every alternate item was selected) together with a further 25 new items of considerably greater complexity. The level of complexity in terms of conceptual rules governing the interrelationships between the forms in the series was extended to a point where it was known that the items could not possibly be appropriate for secondary industry workers, but this was done solely in order to test predictions from the model at higher levels of conceptual complexity.

Individual testing sessions were held and it was explained to the subjects that the object of the experiment was merely to derive measures that could be used to compare the level of complexity between different types of items, and was therefore not concerned with the absolute time taken to solve the test as a whole. Figure 2 presents a plot of the mean observed latencies of response (i.e. seconds taken to achieve a correct solution) against predicted rank item difficulty. A rank-order correlation coefficient of 0,97 was obtained between the two variables.

Anomalies in the graph were studied and it was concluded that in several instances minor adjustments to the predicted ranking of items needed to be made. On the whole, however, there was overwhelming evidence that the item-writing code could be used with confidence as an index of the rank level of conceptual complexity of an item.

FIGURE 2

Graph of latency of response against predicted item difficulty ranks



The second problem was more difficult to resolve, viz. what range of conceptual complexity would be appropriate for a population of industrial workers with a mean of no more than six years of formal schooling? Grant's (1965)[4)] method of relating the probability of a correct solution per item (termed the prescribed "easiness coefficient") to the stanine scale was not considered to be appropriate for purposes of the present study owing to the author's rejection of the opinion that the normal distribution is necessarily the best statistical model for test construction. Grant, in a personal communication to the author, has expressed his misgivings about the utilization of known properties of the normal distribution and the associated stanine scale in prescribing item easiness coefficients. From his experience with testing large samples of illiterate and semi-literate mineworkers he has observed that test score distributions are often more platykurtic than normal. Grant and Schepers (1969)[5)] remarked on the desirability of platykurtic distributions as follows:

> "Contrary to popular belief the goal of good test construction is not to produce normal distributions but rather platykurtic distributions. In other words what is required is to spread out the subjects as widely as possible on the score continuum. The truth of this statement is clarified when one inspects Kuder-Richardson formula 20 .... As the test variance increases so the reliability of the test also increases."
>
> (Grant and Schepers, 1969, pp. 189 - 190)

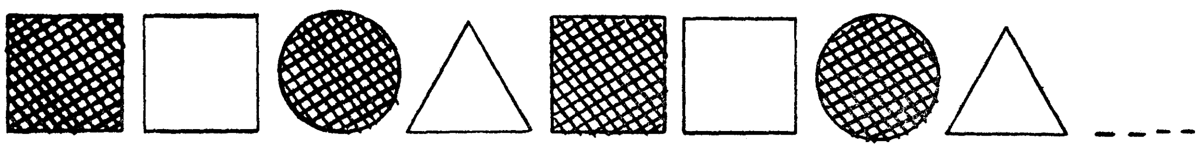
In prescribing "easiness coefficients" for each item in the advanced F.S.T., the present author was compelled to operate without the guidance of a statistical model. Matters were not made any easier by the fact that Grant's (1965)[6)] code for writing F.S.T. items, while being a good predictor of the rank order of item difficulty, at the same time offers little assistance in the *a priori* formulation of absolute item difficulty values. Fortunately, a valuable clue for establishing the upper cut-off in item difficulty value is provided on close inspection of the graphs in Figure 1, where it appears that items 17 and 18 in the existing version of the F.S.T. were still too difficult for the type of population for which the test was to be extended. Even at the high-school level (9 to 13 years education), as few as 3% of the sample obtained raw scores of 17 or 18. On the other hand, up to 30% of the high-school sample obtained raw scores as high as 16, which could indicate that item 16 in the existing F.S.T. is rather on the easy side. The object then, would be to generate items whose complexity would be intermediate between the complexity of item 16 and the complexity of item 17. Many of the items that had been generated for the latency of response experiment had fallen within this range. It was decided therefore to administer the same 34 items to a small sample of 12 African NIPR research workers and computer assistants (educational achievement being 13 years on average). The test was administered as a power test and it was established that the scores of the NIPR group ranged between 15 and 33. Easiness coefficients for each item were established and a rank-order correlation of 0,75 was calculated between predicted and observed item difficulty. It was reasoned, perhaps arbitrarily, that any item answered incorrectly by more than 50% of the NIPR sample would prove far too difficult for the less educated secondary industry population. On this basis it was established that the cut-off in item difficulty was round about the level of complexity expressed in item 17 and 18 of the existing F.S.T. Accordingly, items of greater complexity were omitted in drawing up the extended test.

1.2. The Code for Generating Items

Forty items were written for the new test, 18 of which are identical to those making up the existing version. The items were written in 20 sets of parallel pairs in order to conform with the practice for the existing versions of the test. Thus: items 1 and 2 form a pair; as do items 3 and 4; 5 and 6; and so on up to items 39 and 40. The items were therefore based on 20 permutations of the conceptual code. Before describing the results of the pilot study using the new advanced F.S.T., it might be well to outline the nature of the code that was used for generating the test items.*

* The code permutations that were selected for the new 40-item test are listed in Table 1. The new positions of the 18 original items are indicated by means of asterisks. The test has not been described in terms of the actual colours, shapes and sizes used for each item.

An item may read as follows:



The code for this item is:

I a^1b^1

II $a^2b^1c^1$

III a^n

The roman numerals I, II and III represent the three concept characteristics used in the F.S.T., viz. colour, shape and size. The symbols a, b and c represent the variations within the three characteristics. For example, it was decided that for the above item, I should represent colour, with a and b referring respectively to blue and red; that II should represent shape with a, b and c referring respectively to a square, a circle and a triangle; and that III should represent size, here referred to by n which denotes constancy in that the forms do not vary in size. In a parallel item, the same code permutation is used, but through changing the representations of I, II and III, (e.g. by letting I represent shape instead of colour) different combinations of forms can be arranged. The superscripts 1, 2, 3 and n refer to the alternations between characteristic variations. In our example, colour varies from form to form on a one-to-one basis, hence : I a^1b^1; shape varies on a two-to-one-to-one basis, hence II $a^2b^1c^1$; while size does not vary at all, hence III a^n.

Given the availability of a code for item-generating, the translation of the codes into actual items becomes a straightforward technical matter. Take for example a reasonably complex item in which the underlying code is:

I a^1b^1

II a^2b^1

III a^1b^3

TABLE 1

CODES FOR THE 40-ITEM EXPERIMENTAL EXTENDED F.S.T.

ITEM	CODE	
1 - 2 * (1 - 2)	I a^1b^1 II a^n III a^n	0
3 - 4 *(3 - 4)	I a^2b^2 II a^2b^2 III a^n	1
5 - 6 * (5 -6)	I a^1b^2 II a^1b^2 III a^n	1
7 - 8 * (7 - 8)	I a^1b^1 II a^2b^2 III a^n	2
9 - 10 * (9 - 10)	I a^1b^2 II a^2b^1 III a^n	1
11 - 12 * (11 - 12)	I $a^1b^1c^1$ II $a^1b^1c^1$ III a^n	1
13 - 14	I a^1b^2 II a^1b^2 III a^2b^1	1 1 1
15 - 16	I $a^1b^1c^1$ II a^1b^2 III a^1b^2	1 1 1
17 - 18	I $a^1b^1c^1$ II a^1b^2 III a^2b^1	1 1 1
19 - 20	I a^1b^3 II a^1b^3 III a^1b^1	1 2 2
21 - 22 * (13 - 14)	I a^1b^1 II a^1b^2 III a^n	$1\frac{1}{2}$
23 - 24	I a^1b^1 II a^2b^1 III a^n	$1\frac{1}{2}$
25 - 26 * (15 - 16)	I $a^1b^1c^1$ II a^1b^1 III a^n	$1\frac{1}{2}$
27 - 28	I a^1b^1 II a^1b^2 III a^1b^2	1 $1\frac{1}{2}$ $1\frac{1}{2}$
29 - 30	I a^1b^1 II a^1b^1 III a^2b^1	1 $1\frac{1}{2}$ $1\frac{1}{2}$
31 - 32	I $a^1b^1c^1$ II a^2b^2 III a^n	$1\frac{1}{3}$
33 - 34	I a^1b^2 II $a^2b^1c^1$ III a^n	$1\frac{1}{3}$
35 - 36	I a^3b^1 II a^2b^1 III a^n	$1\frac{1}{3}$
37 - 38 * (17 - 18)	I a^1b^1 II a^1b^2 III a^2b^2	2 $1\frac{1}{2}$ $1\frac{1}{3}$
39 - 40	I a^1b^1 II a^2b^1 III a^1b^3	2 $1\frac{1}{2}$ $1\frac{1}{3}$

* denotes the position of these items in the existing version of the F.S.T.

Many different items could be generated on the basis of this permutation of the code alone. We could say, for example, that 'I' could represent size with 'a' denoting small and 'b', big; that 'II' represents colour with 'a' denoting red and 'b' blue; and that 'III' represents shape with 'a' denoting triangle and 'b' square. The sequence for size is one small form alternating with one big form; for colour, two red forms followed by one blue form; and for shape, one triangle followed by three squares. In combination this item would be written as follows:

small red triangle;
big red square;
small blue square;
big red square;
small red triangle;
big blue square;
small red square;
big red square;
.............;
....

A parallel item to the one presented above might be:

big blue circle;
big yellow triangle;
small blue triangle;
big yellow triangle;
big blue circle;
small yellow triangle;
big blue triangle;
big yellow triangle;
................;
....

It should by now be obvious that in this item, characteristic I in the code represents colour, II size and III shape.

In drawing up the test items for the advanced version of the F.S.T., the principle was adopted of presenting the longest conceptual phase at least twice in order to avoid ambiguities arising from insufficient information. It is to be noted that none of the items involves phases exceeding four forms (though, of course, the model does make provision for longer phases). Most items are 8 forms long (i.e. two 4-form phases), but there are also a few items with only six or seven forms, these being the easier type of item where phases are not very long. In two instances 9 forms are used. An extra form was added to these particular series in order to prevent a subject from obtaining the correct solution by simply duplicating the first or last two forms in the series, thereby scoring a point when he has not utilised reasoning ability as required. In fact all series were checked for the possibility of obtaining a correct solution without necessarily using some form of reasoning, and where this was found, the situation was remedied by adding or subtracting a form from the series.

1.3. The Difficulty Levels of Items

The relative difficulty levels of items are established by studying the interaction of the alternations between the variations in the concept characteristics. Grant was able to distinguish between two broad levels of conceptual complexity; 'in-phase' and 'out-of-phase'. The extent to which an item is 'out-of-phase' was postulated to be indicative of the difficulty level of an item. On the basis of this relationship, Grant was able to rank his original items in order of increasing complexity, and found a rank-order correlation between predicted and observed difficulty to the order of 0,97. On the same basis, as already reported, the present author established rank-order correlations of 0,97 and 0,75 in the two preliminary experiments. Ranking of the items in the order reported in Table 1 was achieved in the following manner: First the superscripts for each characteristic were totalled and were then divided into one another. For items 1 to 8, which are all of the 'in-phase' variety, this resulted in quotients of 0, 1 and/or 2. In item 5, for example, the quotient 1 was arrived at by dividing 3 (i.e. 1 + 2) into 3 (i.e. 1 + 2). This item is in-phase in that the cycle for characteristic I fits exactly into the cycle for characteristic II.

The out-of-phase items vary considerably in complexity. The easiest type is represented by items 9 and 10. Variation a for characteristic I is out-of-phase with variation a for characteristic II, but the overall concept characteristic cycles still fit into one another to the extent that it is possible to perceive a 'pattern' almost at a glance. Items of this variety, yielding superscript quotients that are integers (1 or 2) can be made progressively more difficult by:

(i) introducing variation in a third concept characteristic as in item 13,

(ii) introducing a third variation in one of the characteristics as in item 15, and

(iii) increasing the length of a conceptual phase/cycle as in item 19.

Items can be made more difficult yet by manipulating the phases such that the superscript quotients are in terms of fractions (of a half or a third). The easiest type of item in this class is one where the phase for characteristic I fits into characteristic II's phase $1\frac{1}{2}$ times, and where the variation for characteristic III is held constant (see item 21). As with the in-phase items, and the easier perceptually-loaded type of out-of-phase item (items 9 to 20), items can be made progressively more complex by introducing variation in all three characteristics; additional variations in one or more characteristic; and longer phases. Furthermore, by deriving fractions of a <u>third</u> instead of a half, the conceptual complexity of an item, and therefore its difficulty value, can be taken to yet a higher plane.

1.4. <u>Levels of Abstraction</u>

Assessment of the difficulty values of F.S.T. items in the above manner suggested to Grant (1966)[7)] that a hierarchy of levels of 'abstraction' could underlie performance on conceptual reasoning ability tests when applied to Africans. Grant drew attention to three differing hypothetical styles or approaches a subject could adopt in solving F.S.T. items, which he termed the concrete, adaptable and abstract respectively.

The first approach was suggested through analysis of the errors made in attempting the test. Such analysis suggested that most of the incorrect responses were classifiable in terms of "stereotype duplication", defined as the tendency to attach answer discs to the F.S.T. board which are merely a repetition of the first or last two forms in the given series. This phenomenon has also been remarked upon by Laroche (1956)[8] in his error analysis of the progressive matrices test. Arguing in terms of Goldstein and Scheerer's (1941)[9] concrete-abstract dimension of reasoning, Grant suggested that subjects who engage in stereotype duplication manifest characteristics of the "concrete attitude". Such subjects would be forced to attempt roundabout ways of solving a problem with which they cannot cope, with the result that more often than not, their solutions are incorrect in terms of the test requirements.

Two further (and higher-order) strategies for solving F.S.T. items were discussed in Grant's (1966)[10] article, viz. the processes of "following the culling rule" and of "discovering the culling rule". Subjects who merely followed the rule relating test item concepts to one another were able to solve the in-phase items with relative ease. They were probably functioning at an "adaptable" level of reasoning in that performance on the in-phase items was shown to correlate higher with General Adaptability Battery (G.A.B.) performance than did performance on the out-of-phase items. Tests in the G.A.B. have been shown to have a heavy spatial-perceptual loading (Biesheuvel, 1954[11]; Grant, 1969[12]; Grant and Schepers, 1969[13]; Grant, 1970[14]; Kendall, 1971[15]) and a relatively low loading on the conceptual reasoning factor (Kendall, 1971[16]; Grant, 1972[17]).

Reuning (1972)[18], in a discussion of cognitive styles that may be operating in the African's attempt to solve items in a series test that is similar to the F.S.T. (viz. the Object Series Test), has described the process of "following the culling rule" as follows:

> "The testee can recognize that there is to be a repetition of a four-piece cycle; and by emulating this, one by one, or by memorizing the four combinations of characteristics (black and square, black and round, etc.) plus their sequential order, he can complete the task correctly. This imposes a load on memory, but for easy items with few pieces in a cycle, such an approach is feasible and sometimes successful. With items composed of longer cycles, cycles of varying lengths, and "out-of-phase"

> cycles, i.e. generally with more complex sequences, this method of solving the test becomes clumsy, slow, or breaks down and must eventually be replaced by the following method ......" (Reuning, 1972, p. 186.)

Reuning then proceeds to describe the method which corresponds with the third and most effective strategy for solving F.S.T. items discussed by Grant (1966)[19], viz. "discovering the culling rule":

> "The testee can 'abstract' the relevant structural properties of the sequence, viz. that it starts with a black square, changes colour every two pieces and shape every single one. The load on memory, even with relatively short cycles, is now much less than in the above case; but this approach requires, besides the initial abstracting process, that the testee deal with the relevant characteristics 'in abstracto', i.e. with <u>categories</u> of square versus round, black versus white, instead of dealing with the individual cases of quality combinations. This method of solving the task also requires that the testee assign one and the same individual object to two or more different categories almost simultaneously, ... depending on which of the abstracted qualities is in focus."
> (Reuning, 1972[20], p. 186.)

It can be argued that Grant's (1966)[21] third level of conceptual reasoning, which he termed 'abstraction', corresponds with the above-described process of "discovering the culling rule". In support of this contention, Grant has pointed out that several of Goldstein and Scheerer's (1941)[22] criteria for abstract thinking are valid descriptions of the process of rule discovery. These are:

(i) the ability to shift from one aspect of the situation to another;

(ii) to hold in mind simultaneously various aspects (in the case of the F.S.T., such aspects would be shape, colour and size variations);

(iii) to grasp the essentials of a given whole, to analyze the whole into parts and to isolate and synthesize these parts;

(iv) to form hierarchic concepts through abstracting common properties; and

(v) to plan ahead ideationally, to assume an attitude towards the mere possible and to think or perform symbolically.

It seems probable therefore, that there could be at least three qualitatively different approaches a subject may follow in solving conceptual reasoning problems. The concrete, adaptive and abstract levels of reasoning may well prove to be very real stages in the development of conceptual reasoning ability among Africans. Although the concrete approach to a test such as the F.S.T. does not enable a subject to score very high, it is not a completely random approach and represents, as Laroche (1956)[23)] has pointed out, a genuine attempt to cope with the test requirements. The adaptable approach on the other hand allows a subject to deal successfully with series in which perceptual cues assume salience, while an abstract approach to the test allows a subject to tackle the full range of items according to his ability.

1.5. Formulation of Hypotheses

Through consideration of the difficulty levels of F.S.T. items, and the discussion of cognitive approaches to conceptual reasoning problems, it should be possible to predict that at least two levels of item difficulty will become evident after analysis of the data. These levels will correspond to the "perceptually-loaded" (i.e. fundamentally in-phase) and "conceptually-loaded", (i.e. fundamentally out-of-phase) types of items, the point of marked increase in difficulty value being between items 20 and 21. By this is meant that it should be possible for subjects who adopt a more concrete, global and perceptual approach to problem solving, viz. those who "follow the culling rule" to attempt items 1 to 20 with relative ease. On the other hand, subjects who, from the beginning, have adopted a more abstract-analytic approach to the problems, or who are able, after item 21 to shift their strategy to a more abstract plane, should also be able to cope with items 21 to 40.

On the question of the relationship between performance on the in-phase and out-of-phase types of items, the hypothesis will be put forward that exposure to the perceptually-loaded items will have a facilitative effect on performance on the out-of-phase items. This hypothesis is based on Grant's observation that there is an increase in variance in F.S.T. scores for re-test groups.

This hypothesis will be tested in the present study by dividing the sample into two groups, matched for age, education and ethnic affiliation. The one group will be administered the full 40 items and will be termed F.S.T. sample P-C (perceptual-conceptual). The second group will be given a version commencing at item 19, and will be termed F.S.T. sample C (conceptual). The test of the hypothesis will be to examine the mean scores and test variances describing the performance of the two groups on items 19 to 40 (i.e. the last 22 items).

Finally, the hypothesis will be tested that the manner in which illiterates and semi-literates tackle the 40 items in the extended F.S.T. will differ qualitatively from the approach of literates. This hypothesis is in line with the findings from several studies which have demonstrated that the factor structure of an identical battery of tests differs when illiterates are compared with literates (cf. Hudson et al, 1962[24]; Grant, 1969[25]; Kendall, 1971[26]).

Stated more explicitly, the following hypotheses will be tested in the present study:

1) There will be at least two discernible levels of item difficulty in the 40-item experimental F.S.T. These will be reflected in the predicted bi-modal distribution of raw scores, and will extend across items 1 to 20 inclusive, which are perceptually-loaded, and items 21 to 40, which are conceptually-loaded;

2) Exposure to the first 20 items will improve performance on the last 20 items; and

3) The factor structure for the 40-item F.S.T. for illiterates and semi-literates will differ from the factor structure for

literates.

1.6. Method

1.6.1. Sample

A sample consisting of 360 male African workers was drawn from a large industrial establishment in the Vaal triangle. Subjects were selected at random and represented approximately 25% of the total non-white labour force at the plant. The age range of the sample was 18 to 64 (mean age 32,83 years) while educational achievement extended from illiteracy through to Senior Certificate level (i.e. 0 to 12 years of formal schooling) with a mean of 5,87 years. Fifty percent of the sample had therefore passed Standard IV. The sample was ethnically heterogeneous, with a predominance of Sothos and Zulus. The sample was considered to be typical of the population from which Transvaal secondary industry draws its recruits.

1.6.2. Procedure

Groups of 25 subjects were tested at a time. The test boards were placed before the subjects such that version P-C and version C were alternated from table to table. It was anticipated that subjects given version P-C and subjects given version C would constitute two random samples comparable in respect of age, educational achievement and ethnic affiliation. By alternating test boards, it was also possible to prevent subjects from copying their neighbours during the test.

Prior to testing, certain biographical information (viz. age, education and home language) was obtained. Comparative statistics in respect of these biographical variables for the two experimental groups (P-C and C) may be found in Table 2 and in Figures 3 and 4.

Instructions for the Form Series Test were delivered verbally by an African test administrator. Instructions were given in either Zulu or Sesotho, or in both, depending on the linguistic composition of the group being tested. The standard procedure for administering the test as described in the manual (Grant and Mauer, 1969)[27)] was followed. This procedure emphasises the role of over-learning in the psychological testing of Africans, use being made of demonstration posters and four practice items.

Test performance was scored on the spot, a credit being given only if <u>both</u> answer discs for an item were correct in all respects (i.e. shape, colour and size). Errors were noted on the subject's score sheet.

<u>TABLE 2</u>

<u>Description of sample : ethnic distribution</u>

ETHNIC GROUP	GROUP P-C		GROUP C	
	N	%N	N	%N
South Sotho	75	42%	84	47%
Zulu	51	28%	40	22%
Xhosa	21	12%	20	11%
Tswana	17	9%	22	12%
Pedi	7	4%	5	3%
Swazi	3	2%	1	0,5%
Shangaan	2	1%	2	1%
Venda	1	0,5%	1	0,5%
Ndebele	2	1%	3	2%
Baca			1	0,5%
Pondomise	1	0,5%	1	0,5%
	180		180	

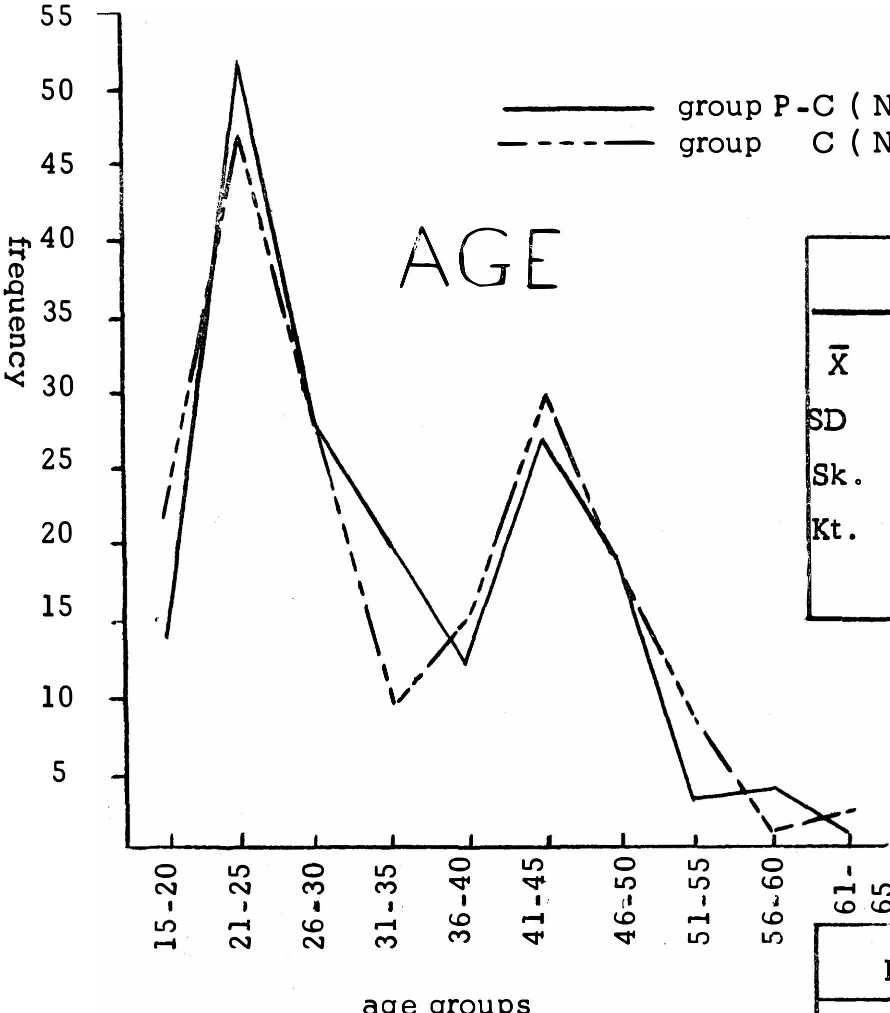
1.7. <u>Statistical Analysis and Results</u>

Throughout the analysis, the responses of the two experimental groups P-C and C were treated separately.

Inspection of Table 2 and Figures 3 and 4 will reveal that the two experimental groups were successfully matched in terms of age, educational achievement and ethnic affiliation. Student t-tests were performed using the age and education variables, and non-significent differences were found between the means for the two groups. F-ratios were also non-significant. The Chi-square was used in order to test for possible significant differences in terms of ethnic affiliation between the two groups. No such differences were found.

FIGURES 3 & 4

Age and education distributions for experimental groups P-C and C



	P - C	C
$\bar{X}$	32,71	32,95
SD	10,79	11,27
Sk.	0,62	0,48
Kt.	-0,69	- 0,99

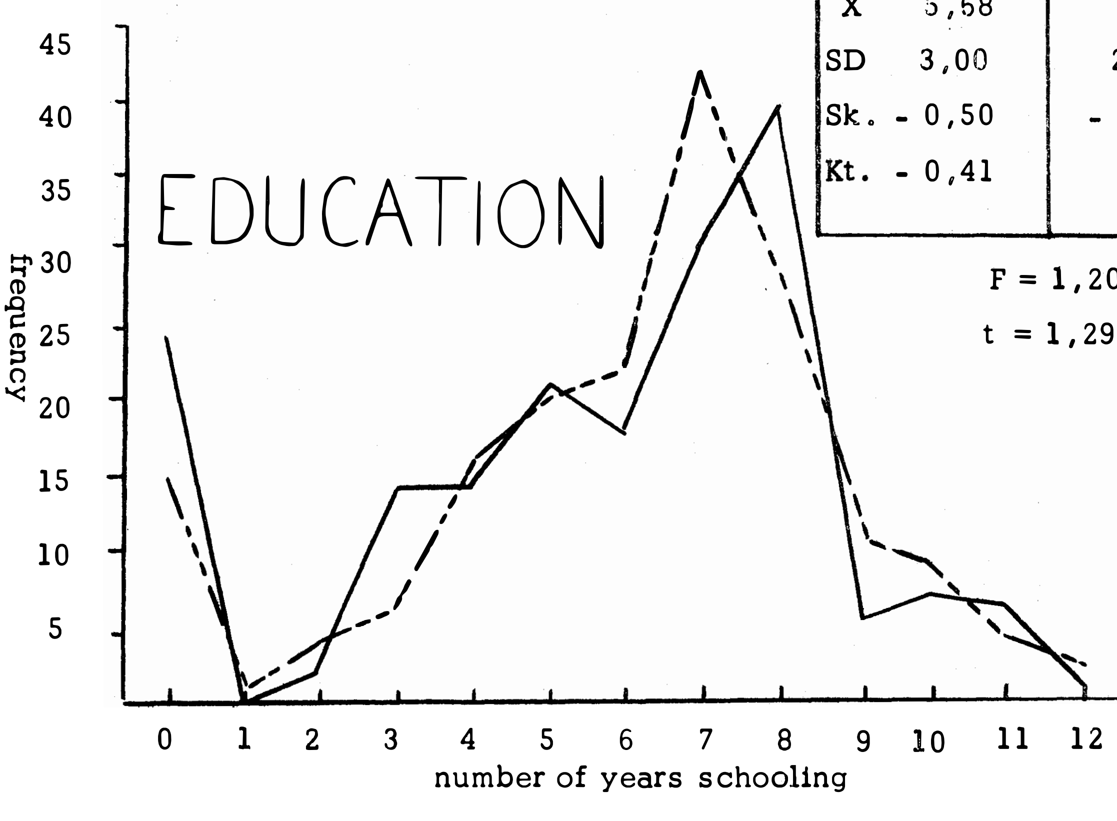
F = 1,09

t = 0,21

	P - C	C
$\bar{X}$	5,68	6,07
SD	3,00	2,74
Sk.	- 0,50	- 0,65
Kt.	- 0,41	0,18

F = 1,20

t = 1,29



Groups P-C and C constitute, therefore, two matched samples, in so far as age, educational achievement and ethnic affiliation are concerned.

1.7.1. Treatment of the data in experimental group P-C (40-item version)

The following computations and analyses were undertaken:

(i) inspection of observed item difficulty values, and calculation of the rank-order correlation between predicted and observed rankings of items,

(ii) calculation of intercorrelations between age, education and total F.S.T. scores (including both the 'new' 40-item score and the 'old' 18-item score), and descriptive statistics for these variables,

(iii) iterative item analysis and multiple factor analysis.

The results are given in the same sequence as the outline above.

(i) Item difficulty values

Figure 5A depicts the trend in the difficulty values of the items. The graph presents the proportion of subjects achieving the correct solution for each of the 40 test items. The correlation between the observed (y axis) and expected (x axis) ranks, using Spearman's formula, was found to be 0,94.

In the actual test, items were written in parallel pairs as already mentioned. The trend for items to become more difficult for the subject as the test proceeds is better demonstrated after averaging out the two observed difficulty values for each pair (items 1 and 2; 3 and 4; .... 39 and 40). The results are presented in Figure 5B. A rank-order correlation coefficient of 0,95 was established between predicted and observed values.

It is evident, both from the graphs and the rank-order correlations, that the code for generating items is an accurate indication of the rank conceptual complexity of an item. To account for almost 90% of the common variance between predicted and observed intellectual performance is no mean achievement in psychometric research.

To what extent are the two hypothesized levels of difficulty apparent in

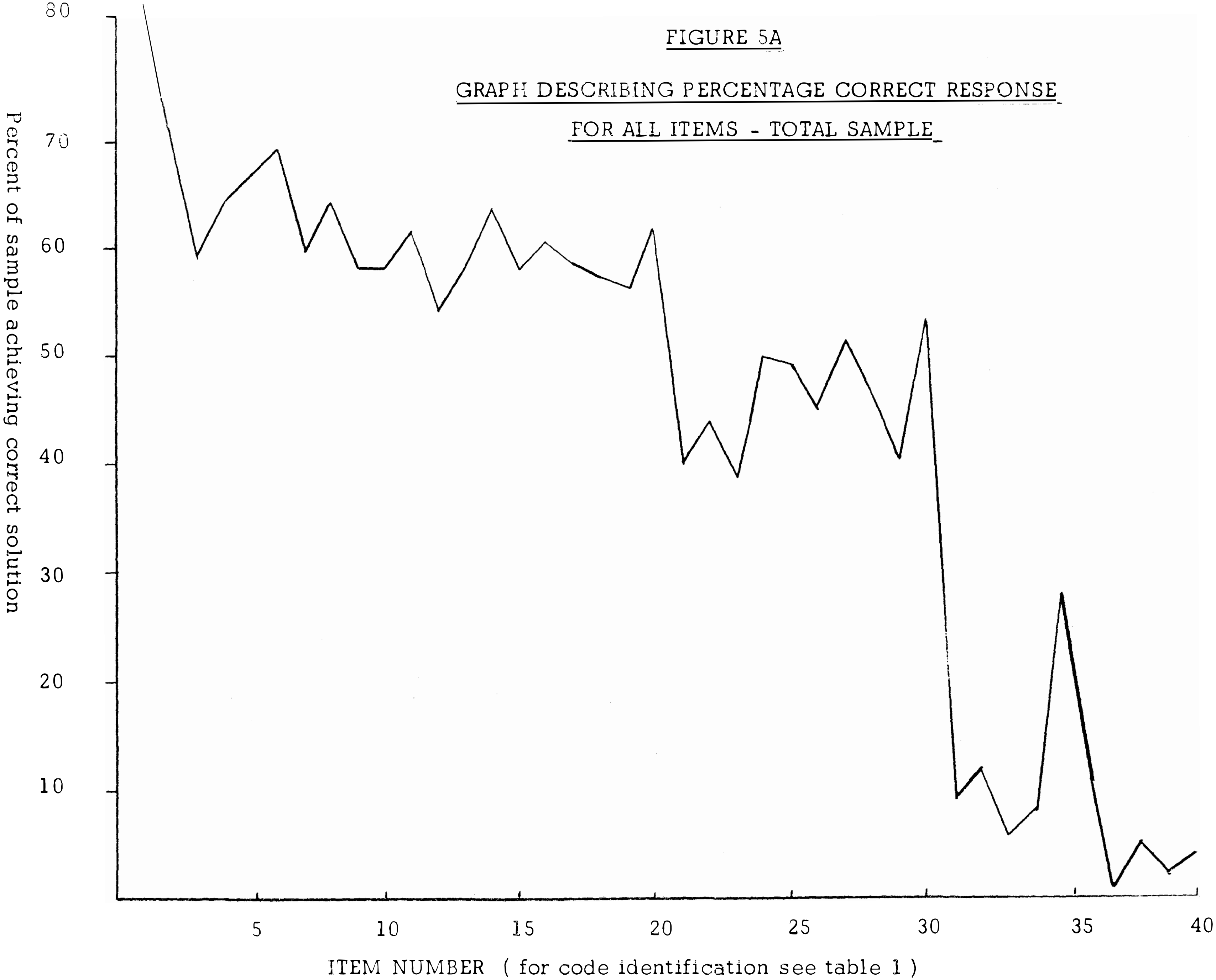


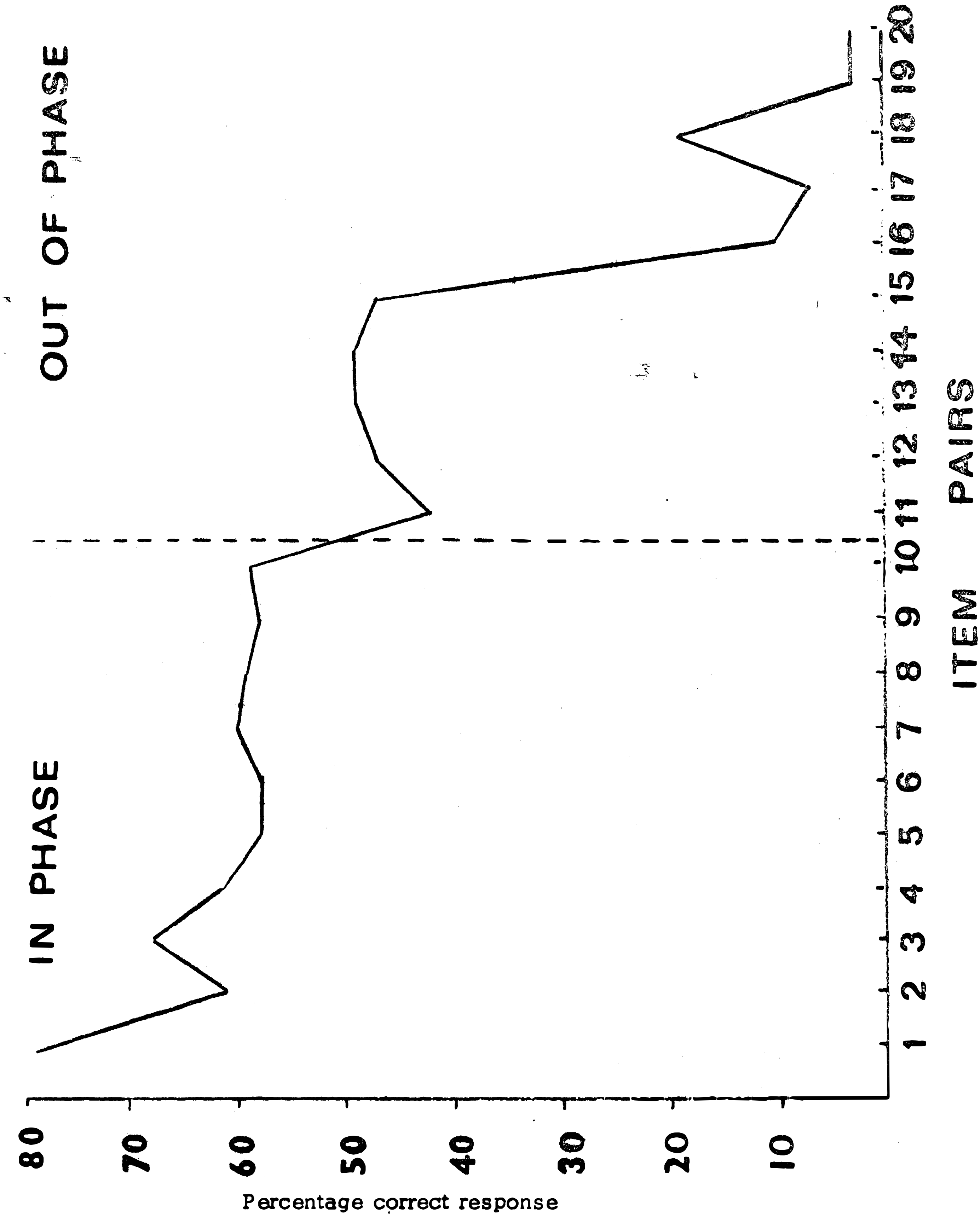
FIGURE 5A

GRAPH DESCRIBING PERCENTAGE CORRECT RESPONSE FOR ALL ITEMS - TOTAL SAMPLE

FIGURE 5B

ITEM DIFFICULTY LEVELS

(ITEM PAIRS)



these graphs? Figure 5A suggests at a glance that, contrary to expectation, there are not two, but in fact three, distinct levels. The first level covers items 1 to 20, as was predicted. The out-of-phase half of the test however can be broken down into two levels of difficulty, centred on items 21 to 30 inclusive and items 31 to 40 inclusive. These three major difficulty levels become more apparent on inspection of graph 5B. It is evident that approximately 60% of the sample are able to cope with the perceptually-loaded items, while between 40 to 50% are able to answer correctly the easier type of conceptually-loaded item. The third class of item was tackled successfully by as few as 5% of the sample.

(ii) Intercorrelations between F.S.T. scores, age and education

The matrix of intercorrelations between age, education and three F.S.T. scores (the new 40-item score, the old 18-item score wherein only the original 18 items had been scored, and the 22-item 'conceptual' score based on the last 22 items only) is presented in Table 3 below. The coefficients were established following Pearson's product-moment correlational technique. The intercorrelations among the three F.S.T. measures are subject to the part-whole effect for obvious reasons.

TABLE 3

INTERCORRELATIONS BETWEEN AGE, EDUCATION AND F.S.T. SCORES (GROUP P-C)

Variable	1	2	3	4	5
1. F.S.T. 40 items	-				
2. F.S.T. 18 items	0,98	-			
3. F.S.T. 22 items	0,97	0,93	-		
4. Age	-0,32	-0,32	-0,32	-	
5. Education	0,52	0,51	0,54	-0,26	-

All intercorrelations significant at the 1% level of confidence

Table 4 presents the means, standard deviations, coefficients of skewness and kurtosis and observed variable ranges for the above 5 variables.

TABLE 4

MEANS, STANDARD DEVIATIONS, SKEWNESS, KURTOSIS AND OBSERVED VARIABLE RANGES (GROUP P-C)

Variable	Mean	S.D.	Sk.	Kt.	Observed Range	
					Max.	Min.
1. F.S.T. 40-item	17,95	11,94	-0,28	-1,55	39,00	0,00
2. F.S.T. 18-item	9,56	5,80	-0,34	-1,49	18,00	0,00
3. F.S.T. 22-item	6,73	5,40	0,09	-1,24	21,00	0,00
4. Age	32,71	10,79	0,62	-0,69	62,00	19,00
5. Education	5,68	3,00	-0,50	-0,41	12,00	0,00

The reliability of the 40-item scale was estimated to be 0,97 (Kuder-Richardson 20); reliabilities for the old 18-item scale and the 22-item "conceptual" scale were estimated to be 0,94 and 0,91 respectively. As predicted, the distributions for both the 40- and the 18-item scales were basically bi-modal (see Figure 6 for the distribution of scores for group P-C on the new 40-item scale), though it could be argued that a third mode exists centred on raw score range 11 to 18.

(iii) Iterative item analysis and multiple factor analysis

An item analysis was run on the 40 items following Gulliksen's (1950)[28)] method which yields item parameters that are functionally related to the parameters of the total test. Table 5 summarises the results before iteration (i.e. on the complete 40-item scale). The parameter pj is the proportion of individuals responding to item j correctly. The parameter sj is the item standard deviation, while r_x refers to the point-biserial item-total correlation and $r_{xj}s_j$ to the Gulliksen index of item reliability, which is the product of r_x and sj.

Before iteration, the Kuder-Richardson estimate of reliability across all 40 items was calculated to be 0,969. This increased fractionally to 0,974 after the first iteration, wherein 7 of the more difficult items were discarded. The reliability of the test stood at 0,977 after eliminating a further 5 items (including items 1 and 2), but the distribution of raw scores was highly undesirable in terms of the resultant 28-item scale.

<u>FIGURE 6</u>

<u>Distribution of F.S.T. raw scores for group P - C</u>

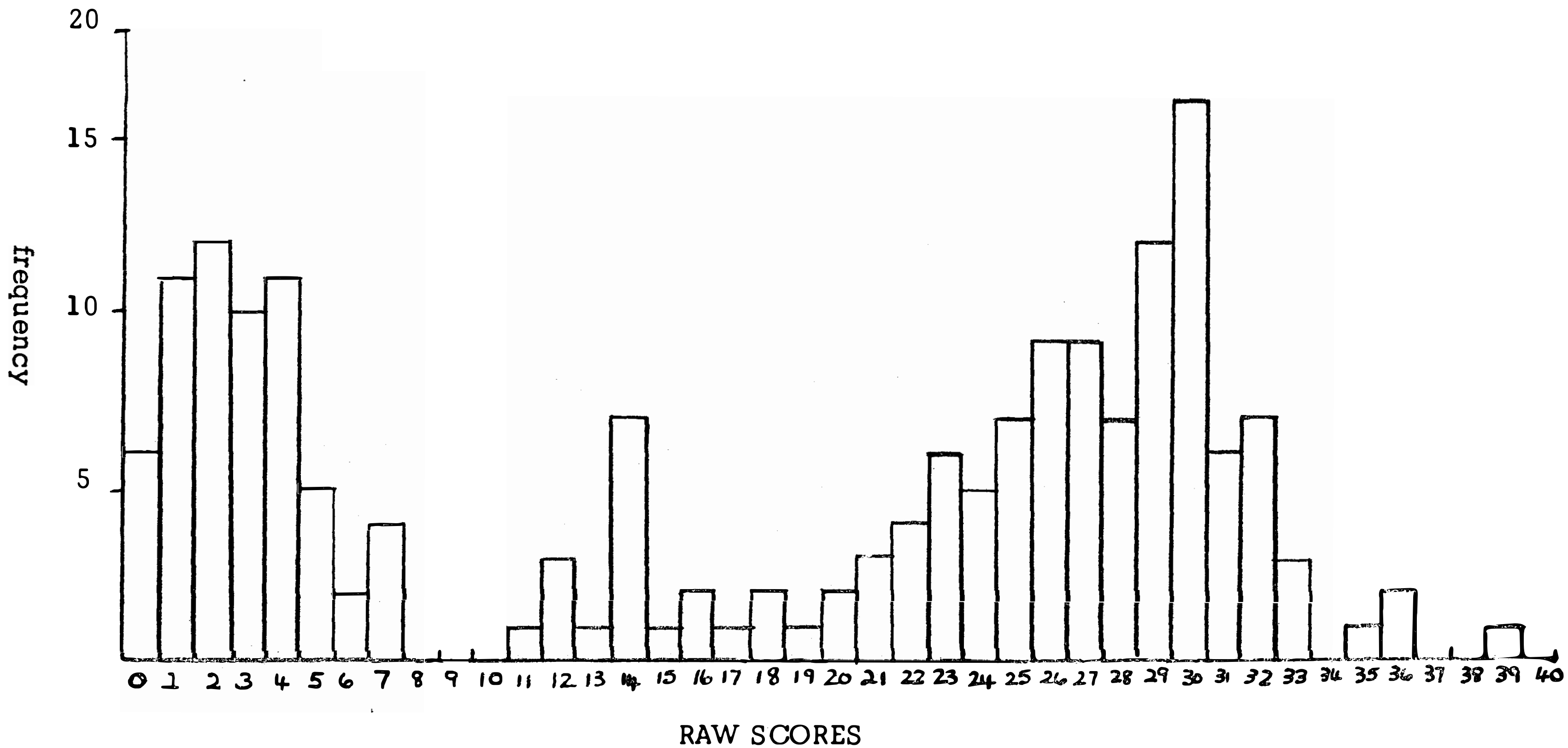


TABLE 5

ITEM ANALYSIS INFORMATION (BEFORE ITERATION) :

GROUP P - C

ITEM	Pj	Sj	$r_{xj}s_j$	r_x
1	0,828	0,378	0,186	0,493
2	0,706	0,456	0,274	0,601
3	0,589	0,492	0,350	0,712
4	0,639	0,480	0,336	0,699
5	0,667	0,471	0,297	0,630
6	0,689	0,463	0,349	0,754
7	0,594	0,491	0,318	0,648
8	0,644	0,479	0,361	0,754
9	0,578	0,494	0,399	0,807
10	0,578	0,494	0,425	0,860
11	0,617	0,486	0,425	0,875
12	0,539	0,498	0,420	0,842
13	0,578	0,494	0,444	0,899
14	0,633	0,482	0,426	0,885
15	0,578	0,494	0,422	0,854
16	0,606	0,489	0,439	0,899
17	0,583	0,493	0,419	0,849
18	0,572	0,495	0,418	0,844
19	0,567	0,496	0,355	0,716
20	0,622	0,485	0,407	0,839
21	0,400	0,490	0,347	0,708
22	0,444	0,497	0,351	0,705
23	0,383	0,486	0,316	0,650
24	0,550	0,497	0,387	0,778
25	0,539	0,498	0,400	0,803
26	0,450	0,497	0,372	0,749
27	0,517	0,500	0,410	0,821
28	0,472	0,499	0,399	0,799
29	0,406	0,491	0,358	0,729
30	0,533	0,499	0,336	0,673
31	0,089	0,285	0,096	0,336
32	0,122	0,328	0,121	0,369
33	0,056	0,229	0,055	0,241
34	0,078	0,268	0,068	0,254
35	0,283	0,451	0,200	0,444
36	0,106	0,307	0,069	0,223
37	0,011	0,105	0,016	0,156
38	0,050	0,218	0,062	0,286
39	0,017	0,128	0,022	0,172
40	0,039	0,193	0,048	0,250

The distribution was bi-modal, the modes being at raw scores 2 and 28'. Scoring these 28 items only leads to the same undesirable clustering of raw scores at the upper end of the scale, as was observed by Blake (1972)[29] and defeats the purpose of the exercise. As the estimate of reliability across all 40 items (0,969) is little different to that across 28 items (0,977), the author decided that no items should be dropped from the experimental version of the test.

The 40 items were intercorrelated using Pearson's product-moment technique. The resultant matrix is presented in Table 6. The inter-correlation matrix was subjected to a Jöreskog (1963)[30] factor analysis. The Measure of Sampling Adequacy was reported at 0,936 which indicates that the data are amenable to factor analysis. Kaiser's 'Little Jiffy 2' criterion for factor 'significance' (Kaiser, 1970)[31] suggested that the optimum number of factors to extract was four. Accordingly, a range of factor solutions from 2 to 4 factors was calculated. In each case the factor matrix was rotated to simple structure by means of the direct quartimin solution. Table 7 presents the rotated factor matrices after extracting 2 and 3 factors, and includes estimates of item communalities. The 4-factor solution is not reported owing to the fact that the fourth factor was not referenced by a single item at the 0,3 level. Mention will be made of the 4-factor solution in the general discussion however, for it throws light on the relationship of the first three factors to one another. Factor intercorrelations for the 2- and 3-factor solutions are reported at the foot of Table 7.

1.7.2. Treatment of the data in experimental group C (22-item version)

Calculations similar to the above were carried out in the analysis of the responses to the 22-item test in which only the 'conceptually-loaded' items were presented.

(i) Item difficulty values

These are portrayed in Figure 7. The correlation between the observed and expected ranks was found to be 0,84. Figure 7 also presents the plots of observed difficulty values after averaging out each pair. The rank-order correlation between expected and observed difficulty was found to be 0,83 and is identical to the rank-order correlation across

TABLE 6

ITEM CORRELATION MATRIX : GROUP P-C

ITEM	1	2	3	4	5	6	7	8	9	10
1	1.00									
2	0.45	1.00								
3	0.37	0.40	1.00							
4	0.39	0.43	0.78	1.00						
5	0.30	0.50	0.49	0.57	1.00					
6	0.30	0.49	0.54	0.54	0.75	1.00				
7	0.31	0.31	0.60	0.58	0.42	0.42	1.00			
8	0.37	0.41	0.54	0.50	0.39	0.55	0.54	1.00		
9	0.41	0.48	0.50	0.48	0.45	0.59	0.46	0.63	1.00	
10	0.38	0.53	0.54	0.55	0.52	0.62	0.58	0.66	0.70	1.00
11	0.49	0.54	0.62	0.62	0.53	0.65	0.54	0.66	0.76	0.76
12	0.38	0.45	0.54	0.51	0.46	0.61	0.53	0.62	0.68	0.79
13	0.44	0.53	0.61	0.60	0.54	0.69	0.55	0.66	0.73	0.82
14	0.48	0.52	0.63	0.63	0.54	0.68	0.55	0.66	0.77	0.77
15	0.44	0.56	0.61	0.60	0.54	0.62	0.53	0.61	0.68	0.80
16	0.47	0.55	0.62	0.60	0.56	0.73	0.56	0.73	0.71	0.78
17	0.39	0.47	0.60	0.58	0.48	0.58	0.59	0.67	0.71	0.74
18	0.41	0.45	0.51	0.52	0.46	0.61	0.57	0.69	0.69	0.74
19	0.37	0.49	0.50	0.51	0.40	0.57	0.44	0.54	0.61	0.55
20	0.40	0.53	0.61	0.56	0.47	0.59	0.50	0.67	0.68	0.70
21	0.31	0.40	0.47	0.47	0.43	0.50	0.35	0.46	0.49	0.58
22	0.26	0.41	0.41	0.37	0.37	0.48	0.33	0.50	0.61	0.67
23	0.21	0.31	0.40	0.38	0.32	0.43	0.35	0.47	0.47	0.56
24	0.33	0.42	0.56	0.48	0.43	0.55	0.50	0.59	0.70	0.63
25	0.35	0.40	0.54	0.51	0.43	0.56	0.51	0.64	0.63	0.72
26	0.32	0.41	0.44	0.45	0.40	0.54	0.45	0.56	0.57	0.64
27	0.35	0.45	0.52	0.52	0.50	0.67	0.47	0.63	0.59	0.73
28	0.28	0.42	0.52	0.48	0.48	0.54	0.49	0.56	0.61	0.65
29	0.29	0.41	0.48	0.50	0.42	0.53	0.43	0.52	0.57	0.59
30	0.22	0.35	0.44	0.36	0.40	0.48	0.45	0.47	0.55	0.58
31	0.14	0.16	0.22	0.19	0.18	0.21	0.22	0.23	0.27	0.23
32	0.17	0.13	0.28	0.25	0.16	0.25	0.20	0.21	0.32	0.25
33	0.05	0.16	0.10	0.13	0.17	0.16	0.15	0.13	0.06	0.16
34	0.13	0.10	0.20	0.18	0.16	0.20	0.11	0.13	0.16	0.16
35	0.25	0.22	0.22	0.32	0.24	0.32	0.27	0.31	0.41	0.36
36	0.16	0.14	0.21	0.18	0.20	0.19	0.14	0.14	0.22	0.18
37	0.05	0.07	0.09	0.08	0.07	0.07	0.09	0.08	0.09	0.09
38	0.10	0.04	0.19	0.17	0.16	0.15	0.19	0.12	0.14	0.20
39	0.06	0.08	0.11	0.10	0.09	0.09	0.02	0.10	0.11	0.11
40	0.09	0.13	0.17	0.15	0.14	0.14	0.17	0.09	0.17	0.17
	1	2	3	4	5	6	7	8	9	10

(Table continued)

TABLE 6 (Cont.)

	11	12	13	14	15	16	17	18	19	20
11	1.00									
12	0.78	1.00								
13	0.85	0.81	1.00							
14	0.78	0.73	0.82	1.00						
15	0.81	0.72	0.82	0.80	1.00					
16	0.84	0.76	0.88	0.82	0.85	1.00				
17	0.75	0.71	0.76	0.78	0.74	0.77	1.00			
18	0.73	0.75	0.74	0.74	0.72	0.80	0.80	1.00		
19	0.60	0.54	0.64	0.73	0.59	0.65	0.63	0.56	1.00	
20	0.71	0.64	0.77	0.83	0.70	0.73	0.78	0.72	0.68	1.00
21	0.57	0.62	0.63	0.57	0.61	0.59	0.51	0.57	0.51	0.52
22	0.64	0.63	0.65	0.56	0.58	0.61	0.51	0.59	0.40	0.56
23	0.50	0.55	0.56	0.53	0.54	0.57	0.60	0.57	0.44	0.54
24	0.71	0.62	0.74	0.73	0.63	0.66	0.71	0.64	0.61	0.70
25	0.67	0.69	0.65	0.71	0.68	0.71	0.71	0.73	0.54	0.66
26	0.62	0.59	0.68	0.60	0.64	0.66	0.61	0.67	0.48	0.61
27	0.68	0.69	0.70	0.72	0.68	0.72	0.63	0.71	0.57	0.67
28	0.63	0.70	0.72	0.67	0.63	0.65	0.71	0.71	0.54	0.71
29	0.63	0.65	0.59	0.58	0.61	0.64	0.58	0.62	0.54	0.50
30	0.55	0.56	0.60	0.54	0.51	0.54	0.59	0.61	0.42	0.63
31	0.25	0.25	0.23	0.24	0.23	0.25	0.26	0.27	0.19	0.24
32	0.29	0.31	0.28	0.25	0.22	0.27	0.28	0.22	0.19	0.26
33	0.09	0.18	0.16	0.13	0.16	0.15	0.16	0.11	0.16	0.19
34	0.23	0.27	0.21	0.18	0.16	0.23	0.20	0.13	0.00	0.14
35	0.37	0.33	0.41	0.40	0.36	0.38	0.31	0.32	0.33	0.39
36	0.23	0.21	0.15	0.22	0.11	0.20	0.11	0.11	0.19	0.16
37	0.08	0.10	0.09	0.08	0.09	0.09	0.09	0.09	-0.01	0.08
38	0.18	0.21	0.20	0.17	0.20	0.19	0.19	0.20	0.15	0.18
39	0.10	0.12	0.02	0.10	0.11	0.11	0.11	0.11	0.03	0.10
40	0.16	0.19	0.17	0.15	0.17	0.16	0.17	0.17	0.12	0.16
	11	12	13	14	15	16	17	18	19	20

(Table continued)

TABLE 6 (Cont.)

	21	22	23	24	25	26	27	28	29	30
21	1.00									
22	0.62	1.00								
23	0.52	0.54	1.00							
24	0.56	0.58	0.48	1.00						
25	0.57	0.49	0.52	0.66	1.00					
26	0.61	0.56	0.53	0.55	0.68	1.00				
27	0.61	0.62	0.53	0.60	0.73	0.72	1.00			
28	0.57	0.54	0.63	0.65	0.72	0.71	0.74	1.00		
29	0.64	0.51	0.44	0.54	0.61	0.62	0.60	0.60	1.00	
30	0.45	0.48	0.46	0.61	0.59	0.51	0.57	0.62	0.46	1.00
31	0.14	0.15	0.28	0.16	0.21	0.19	0.26	0.29	0.22	0.25
32	0.18	0.21	0.19	0.20	0.28	0.24	0.29	0.29	0.28	0.25
33	0.25	0.17	0.21	0.07	0.13	0.22	0.19	0.21	0.19	0.13
34	0.19	0.20	0.16	0.10	0.10	0.11	0.11	0.10	0.22	0.11
35	0.27	0.36	0.24	0.25	0.26	0.27	0.34	0.24	0.31	0.19
36	0.09	0.20	0.03	0.13	0.14	-0.06	0.19	0.11	0.05	0.07
37	0.13	0.12	0.03	0.10	0.10	0.12	0.10	0.11	0.13	0.10
38	0.23	0.21	0.29	0.16	0.21	0.25	0.22	0.24	0.17	0.16
39	0.07	0.15	0.08	0.03	0.12	0.06	0.13	0.05	0.16	0.12
40	0.25	0.22	0.14	0.18	0.19	0.11	0.08	0.10	0.19	0.13
	21	22	23	24	25	26	27	28	29	30

	31	32	33	34	35	36	37	38	39	40
31	1.00									
32	0.24	1.00								
33	0.18	0.21	1.00							
34	0.27	0.33	0.38	1.00						
35	0.15	0.33	0.12	0.09	1.00					
36	0.15	0.15	-0.08	0.04	0.15	1.00				
37	0.15	0.28	0.21	0.37	0.17	-0.04	1.00			
38	0.29	0.23	0.39	0.12	0.20	0.00	0.22	1.00		
39	0.26	0.35	0.16	0.29	0.11	0.24	0.40	0.37	1.00	
40	0.34	0.19	0.33	0.26	0.06	0.21	0.25	0.35	0.20	1.00
	31	32	33	34	35	36	37	38	39	40

TABLE 7

ROTATED FACTOR MATRICES : 2- AND 3- FACTOR SOLUTIONS (GROUP P - C)

2- factor solution

Item	FACTOR I	FACTOR II	h^2
1	0,56	-0,14	0,27
2	0,64	-0,09	0,37
3	0,75	-0,10	0,51
4	0,77	-0,16	0,51
5	0,68	-0,12	0,41
6	0,79	-0,05	0,59
7	0,62	0,02	0,40
8	0,71	0,10	0,56
9	0,77	0,08	0,65
10	0,79	0,17	0,75
11	0,89	0,01	0,79
12	0,72	0,24	0,72
13	0,90	0,06	0,85
14	0,91	-0,01	0,82
15	0,86	0,03	0,76
16	0,92	0,01	0,85
17	0,78	0,15	0,73
18	0,72	0,26	0,73
19	0,74	-0,05	0,52
20	0,79	0,11	0,71
21	0,53	0,31	0,50
22	0,53	0,30	0,51
23	0,44	0,37	0,46
24	0,72	0,13	0,61
25	0,63	0,33	0,67
26	0,53	0,41	0,63
27	0,65	0,31	0,69
28	0,57	0,43	0,71
29	0,56	0,29	0,52
30	0,50	0,31	0,47
31	0,17	0,23	0,11
32	0,20	0,23	0,13
33	0,01	0,34	0,12
34	0,14	0,15	0,06
35	0,41	0,01	0,17
36	0,29	-0,17	0,07
37	-0,03	0,27	0,07
38	0,04	0,37	0,15
39	-0,01	0,24	0,06
40	0,09	0,21	0,07

$r_{I \times II} = 0,41$

3- factor solution

Item	FACTOR I	FACTOR II	FACTOR III	h^2
1	0,40	-0,03	0,25	0,27
2	0,52	-0,01	0,22	0,37
3	0,54	0,11	0,33	0,55
4	0,50	0,12	0,39	0,57
5	0,44	0,15	0,35	0,47
6	0,63	0,08	0,27	0,61
7	0,56	0,04	0,14	0,40
8	0,76	-0,06	0,04	0,57
9	0,80	-0,06	0,07	0,65
10	0,86	0,01	0,02	0,75
11	0,83	-0,01	0,19	0,80
12	0,82	0,09	-0,02	0,72
13	0,90	-0,05	0,12	0,85
14	0,87	-0,09	0,18	0,82
15	0,82	-0,02	0,16	0,77
16	0,86	-0,02	0,19	0,85
17	0,87	-0,04	0,01	0,73
18	0,89	-0,02	-0,10	0,75
19	0,71	-0,13	0,15	0,53
20	0,87	-0,09	0,03	0,72
21	0,65	0,18	-0,09	0,51
22	0,68	0,13	-0,11	0,51
23	0,67	0,10	-0,20	0,47
24	0,83	-0,11	-0,02	0,63
25	0,85	0,05	-0,16	0,68
26	0,80	0,07	-0,24	0,64
27	0,82	0,08	-0,12	0,69
28	0,87	0,04	-0,27	0,73
29	0,66	0,18	-0,06	0,53
30	0,71	0,03	-0,17	0,48
31	0,15	0,36	-0,00	0,19
32	0,15	0,42	0,03	0,25
33	0,03	0,50	-0,07	0,25
34	-0,04	0,53	0,15	0,31
35	0,33	0,11	0,14	0,19
36	0,06	0,10	0,28	0,11
37	-0,06	0,49	-0,02	0,22
38	0,08	0,49	-0,10	0,28
39	-0,10	0,55	0,04	0,28
40	0,00	0,47	0,06	0,23

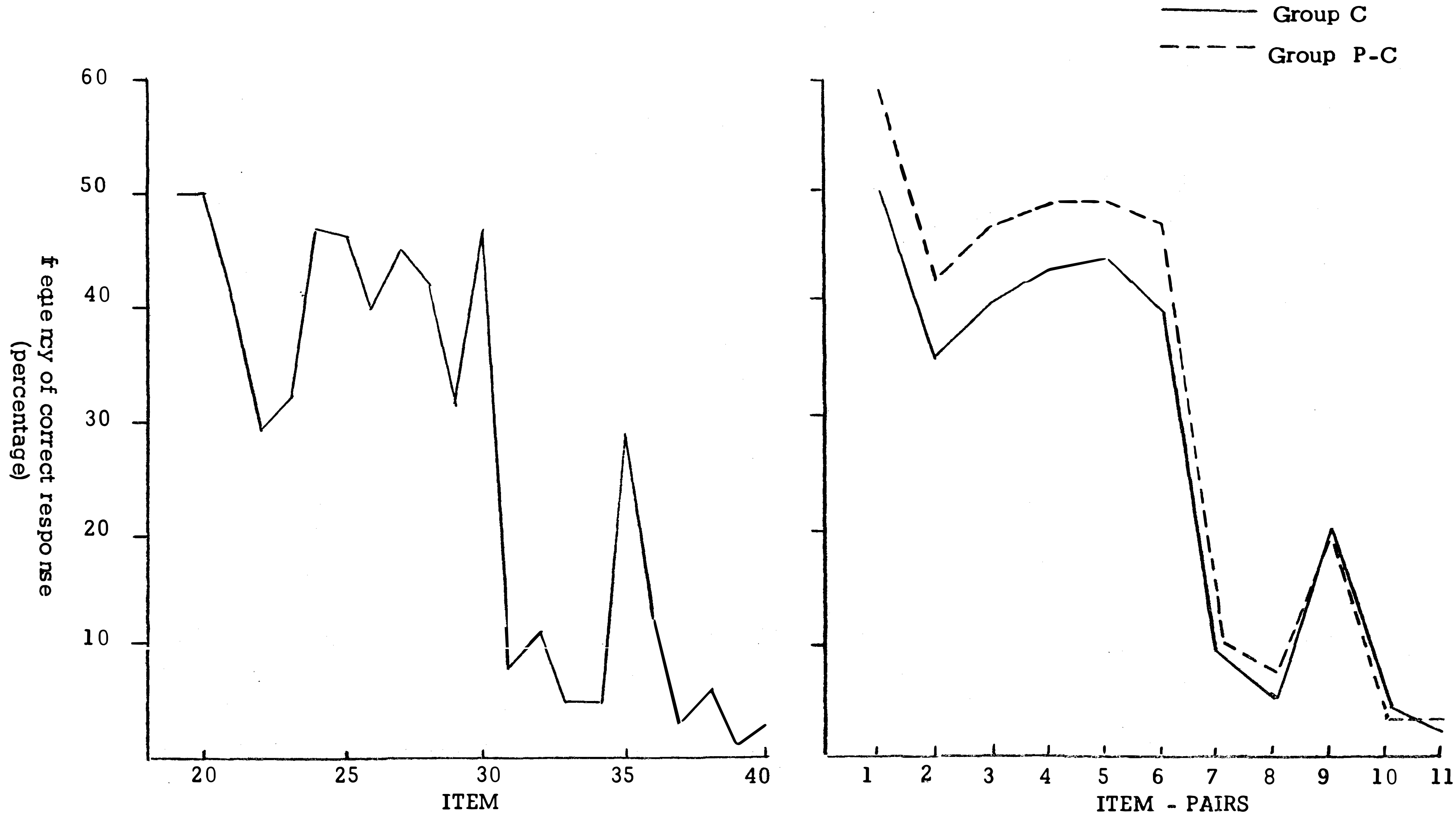
$r_{I \times II} = 0,37$

$r_{I \times III} = 0,27$

$r_{II \times III} = 0,10$

FIGURE 7

Item difficulty curves : group C



items 19 to 40 for group P-C.

Figure 7 also includes for comparison the difficulty curve for group P-C on the last 22 items. The main observation would seem to be that the trends in the two curves are identical for both groups. Again, three discernible levels of conceptual complexity are evident: the 'perceptual' level, evident in items 19 and 20, the 'easier' conceptual level and the 'more difficult' conceptual level.

(ii) Intercorrelations between F.S.T. score, age and education

The F.S.T. 22-item scale administered to group C correlated 0,52 with education and -0,25 with Age. The mean score was observed to be 5,81 with a standard deviation of 5,00 and coefficients of skewness and kurtosis to the order of 0,32 and -1,11 respectively. The maximum observed score was 18,00 and the minimum 0,00.

Figure 8 presents the distribution of F.S.T. scores across the conceptual items in graphic form. Apart from too many subjects scoring zero, the distribution is remarkably platykurtic. A comparison is offered with the performance of group P-C on the same 22 items.

(iii) Iterative item analysis

Table 8 summarises the results before iteration. The reliability of the test across all 22 items was observed to be 0,898 (Kuder-Richardson 20). The reliability increased to 0,927 after the third iteration in which the last 10 items had been eliminated in consideration of Gulliksen's index. The test after 3 iterations contained therefore 12 items, correlating on average to the extent of 0,74 with the total scale, with an average Gulliksen index of 0,36 and with a mean difficulty value of 0,42. Table 8 also offers comparative item analysis statistics for group P-C on the conceptual items.

(iv) Multiple factor analysis

The matrix of intercorrelations between the 22 items is presented in Table 9. The matrix was subjected to Jöreskog factor analysis, and it was observed that the Measure of Sampling Adequacy was again acceptable at 0,85. Two, three and four factors were extracted from the unrotated factor matrix. The factors were rotated to simple structure following the direct quartimin technique, which yields an oblique solution.

FIGURE 8

Comparative frequency distributions for groups P-C and C

(items 19 to 40 only)

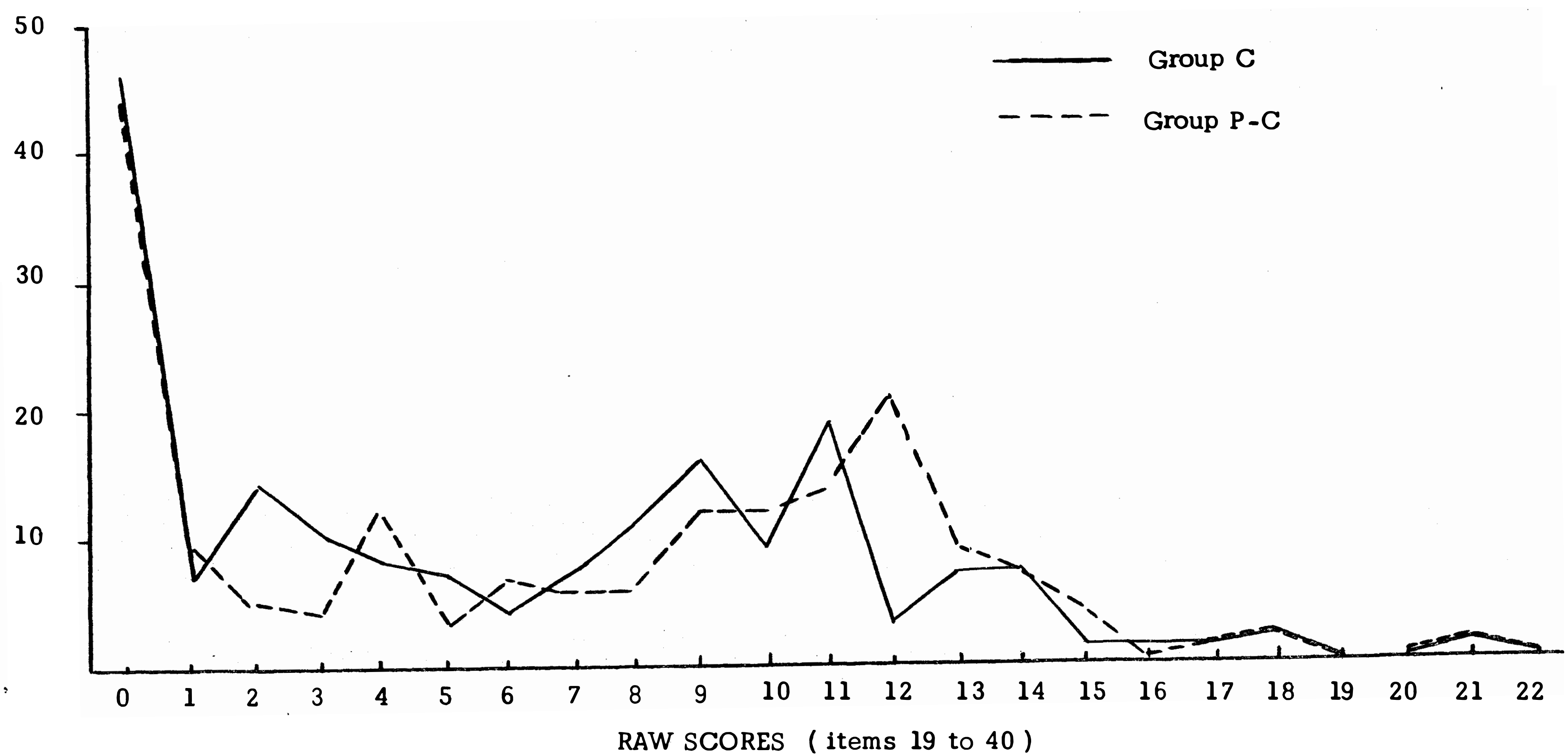


TABLE 8

ITEM ANALYSIS INFORMATION (BEFORE ITERATION) : GROUP C

ITEM	Pj	Sj	$r_{xj}s_j$	r_x
1	0,500	0,500	0,342	0,685
2	0,500	0,500	0,395	0,790
3	0,411	0,492	0,361	0,734
4	0,289	0,453	0,316	0,698
5	0,322	0,467	0,305	0,654
6	0,472	0,499	0,361	0,724
7	0,456	0,498	0,376	0,756
8	0,400	0,490	0,371	0,757
9	0,450	0,497	0,365	0,734
10	0,422	0,494	0,377	0,764
11	0,306	0,461	0,293	0,635
12	0,472	0,499	0,374	0,748
13	0,078	0,268	0,077	0,286
14	0,106	0,307	0,120	0,390
15	0,050	0,218	0,053	0,244
16	0,050	0,218	0,077	0,351
17	0,278	0,448	0,187	0,417
18	0,117	0,321	0,070	0,219
19	0,028	0,164	0,050	0,305
20	0,056	0,229	0,048	0,209
21	0,011	0,105	0,026	0,248
22	0,033	0,180	0,045	0,249

ITEM ANALYSIS INFORMATION (BEFORE ITERATION) : GROUP P - C

ITEM	Pj	Sj	$r_{xj}s_j$	r_x
19	0,567	0,496	0,344	0,694
20	0,622	0,485	0,396	0,817
21	0,400	0,490	0,366	0,747
22	0,444	0,497	0,366	0,736
23	0,383	0,486	0,337	0,693
24	0,550	0,497	0,381	0,767
25	0,539	0,498	0,400	0,803
26	0,450	0,497	0,385	0,773
27	0,517	0,500	0,416	0,832
28	0,472	0,499	0,414	0,829
29	0,406	0,491	0,366	0,745
30	0,533	0,499	0,349	0,699
31	0,089	0,285	0,109	0,382
32	0,122	0,328	0,140	0,428
33	0,056	0,229	0,073	0,319
34	0,078	0,268	0,075	0,280
35	0,283	0,451	0,208	0,462
36	0,106	0,307	0,066	0,215
37	0,011	0,105	0,022	0,212
38	0,050	0,218	0,079	0,362
39	0,017	0,128	0,030	0,232
40	0,039	0,193	0,059	0,304

TABLE 9

ITEM INTERCORRELATION MATRIX : GROUP C

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	0.64	1.00									
3	0.52	0.56	1.00								
4	0.42	0.51	0.44	1.00							
5	0.36	0.55	0.51	0.43	1.00						
6	0.39	0.57	0.48	0.45	0.42	1.00					
7	0.49	0.60	0.48	0.50	0.56	0.63	1.00				
8	0.50	0.59	0.49	0.46	0.53	0.57	0.64	1.00			
9	0.50	0.55	0.56	0.46	0.45	0.46	0.50	0.56	1.00		
10	0.52	0.63	0.59	0.52	0.47	0.57	0.60	0.63	0.61	1.00	
11	0.33	0.52	0.40	0.46	0.37	0.53	0.53	0.52	0.47	0.56	1.00
12	0.55	0.63	0.59	0.48	0.40	0.51	0.54	0.55	0.51	0.50	0.46
13	0.17	0.12	0.22	0.27	0.11	0.14	0.19	0.19	0.15	0.13	0.03
14	0.27	0.20	0.23	0.22	0.19	0.15	0.23	0.27	0.23	0.15	0.05
15	0.08	0.03	0.12	0.19	0.06	0.09	0.05	0.12	0.10	0.06	0.07
16	0.18	0.13	0.17	0.30	0.17	0.14	0.15	0.18	0.15	0.17	0.07
17	0.12	0.22	0.26	0.29	0.21	0.41	0.20	0.13	0.24	0.22	0.18
18	0.19	0.05	0.12	0.07	0.12	0.04	-0.02	0.02	0.19	0.00	0.02
19	0.10	0.17	0.20	0.19	0.17	0.11	0.05	0.21	0.19	0.13	0.11
20	0.05	0.15	0.04	0.11	0.09	0.11	0.12	0.0	0.12	0.09	0.10
21	0.11	0.11	0.13	0.17	0.15	0.11	0.01	0.13	0.12	0.12	0.04
22	0.19	0.12	0.10	0.22	-0.06	0.07	0.14	0.16	0.08	0.09	0.01
	1	2	3	4	5	6	7	8	9	10	11

	12	13	14	15	16	17	18	19	20	21	22
12	1.00										
13	0.18	1.00									
14	0.29	0.10	1.00								
15	0.14	0.12	0.25	1.00							
16	0.19	0.22	0.25	0.42	1.00						
17	0.26	0.05	0.11	0.14	0.26	1.00					
18	0.07	0.28	0.16	0.08	0.15	0.20	1.00				
19	0.18	0.08	0.27	0.27	0.27	0.20	0.15	1.00			
20	0.11	0.02	0.23	0.06	0.17	0.12	0.14	0.11	1.00		
21	0.11	-0.03	0.31	0.46	0.46	0.17	0.13	0.30	-0.03	1.00	
22	0.20	-0.05	0.34	0.38	0.24	0.09	0.03	0.35	0.23	0.28	1.00
	12	13	14	15	16	17	18	19	20	21	22

The results are presented in Table 10.

1.7.3. Comparison of group P-C and group C performances

A Student t-test was performed using the data pertaining to the F.S.T. performance of group C subjects, and group P-C subjects (last 22 items only). The mean score for group P-C ($\bar{X}$ = 6,73; S.D. 5,40) was found to be significantly higher than the mean score for group C ($\bar{X}$ = 5,81; S.D. 5,00) at the five percent level of confidence. The Kolmogorov-Smirnov (Siegel, 1956)[32)] test on the cumulative frequencies for the two groups again demonstrated a significant difference between the scores for the two groups. The F-ratio (1,17) was however within the limits for homogeneity of test variance.

Comparison of the item difficulty values for the two groups (Figure 7) indicates that group P-C subjects consistently scored higher on average than group C subjects up to item 30. After item 30, however, there were no appreciable differences between item difficulties for the two groups. Figure 9 presents a plot of the cumulative frequencies for groups C and P-C. Again, the superiority of group P-C's performance over that of group C is evident. The Kolmogorov-Smirnov test was used to test the significance of the maximum observed difference between the two graphs (viz. at point "D" which is indicated in Figure 9).

Inspection of Figure 7 suggests that both experimental groups found similar difficulties in adjusting to the different levels of item complexity. The same 'learning' or practice phenomenon across items 20 to 30 is evident for both groups, as well as uniform difficulty in coping with items beyond item 30. Item 35, somewhat of an anomaly in terms of its ranked position in the test, was relatively easier than its neighbouring items for both groups.

1.7.4. F.S.T. performance at different educational levels (group P-C only)

Subjects in group P-C were divided into four educational levels:

(i) illiterates and sub A to standard II (N : 54);

(ii) standards III and IV (N : 37);

(iii) standards V and VI (N : 70); and

(iv) form I to Matric (N : 19).

TABLE 10

DIRECT QUARTIMIN FACTOR SOLUTIONS : 2- AND 3-FACTORS (GROUP C)

Item	FACTORS		h^2
	1	2	
1(19)	0,64	0,07	0,45
2(20)	0,82	-0,05	0,65
3(21)	0,69	0,06	0,51
4(22)	0,58	0,18	0,45
5(23)	0,65	-0,02	0,42
6(24)	0,73	-0,04	0,52
7(25)	0,82	-0,10	0,61
8(26)	0,77	0,01	0,59
9(27)	0,69	0,04	0,50
10(28)	0,80	-0,06	0,61
11(29)	0,70	-0,13	0,43
12(30)	0,69	0,09	0,53
13(31)	0,18	0,12	0,06
14(32)	0,12	0,47	0,27
15(33)	-0,11	0,64	0,37
16(34)	0,01	0,60	0,37
17(35)	0,23	0,23	0,15
18(36)	0,01	0,25	0,07
19(37)	0,03	0,49	0,25
20(38)	0,06	0,19	0,05
21(39)	-0,08	0,64	0,37
22(40)	-0,05	0,56	0,30

$r_{I \times II} = 0,36$

Item	FACTORS			h^2
	1	2	3	
1	0,57	-0,03	0,34	0,52
2	0,79	-0,06	0,12	0,66
3	0,63	-0,00	0,24	0,54
4	0,57	0,20	0,03	0,45
5	0,63	-0,02	0,07	0,42
6	0,76	0,05	-0,17	0,56
7	0,83	-0,03	-0,11	0,64
8	0,77	0,06	-0,06	0,60
9	0,65	0,00	0,18	0,52
10	0,80	-0,02	-0,03	0,62
11	0,7[illegible]	-0,04	-0,20	0,48
12	0,65	0,07	0,15	0,54
13	0,11	0,01	0,34	0,15
14	0,09	0,41	0,17	0,28
15	-0,08	0,66	-0,06	0,40
16	0,01	0,59	0,07	0,38
17	0,24	0,25	-0,01	0,15
18	-0,08	0,09	0,45	0,22
19	0,03	0,47	0,06	0,25
20	0,06	0,18	0,05	0,05
21	-0,06	0,65	-0,04	0,39
22	-0,02	0,59	-0,07	0,32

$r_{I \times II} = 0,31$

$r_{I \times III} = 0,28$

$r_{II \times III} = 0,30$

The distribution of scores across the full 40-item version of the extended F.S.T. for each of the four educational groups is presented in Figure 10. There is a consistent increase in the mean test score across the four groups starting with 9,96 (SD 10,79) for illiterates-Std 11; proceeding to 17,13 (SD 11,32) for the next level; 21,96 (SD 9,88) for the third level; and finishing with 27,74 (SD 9,23) for high-school educated subjects. The best spread of scores was obtained for the Std 111 to Std 1V group. It is important to note that 47% of the high-school sample obtained scores of 31 and higher. High-school subjects appear therefore to be able to cope with the level of conceptual

FIGURE 9

Comparative graph of cumulative proportions across items 19 to 40 for experimental groups P - C and C

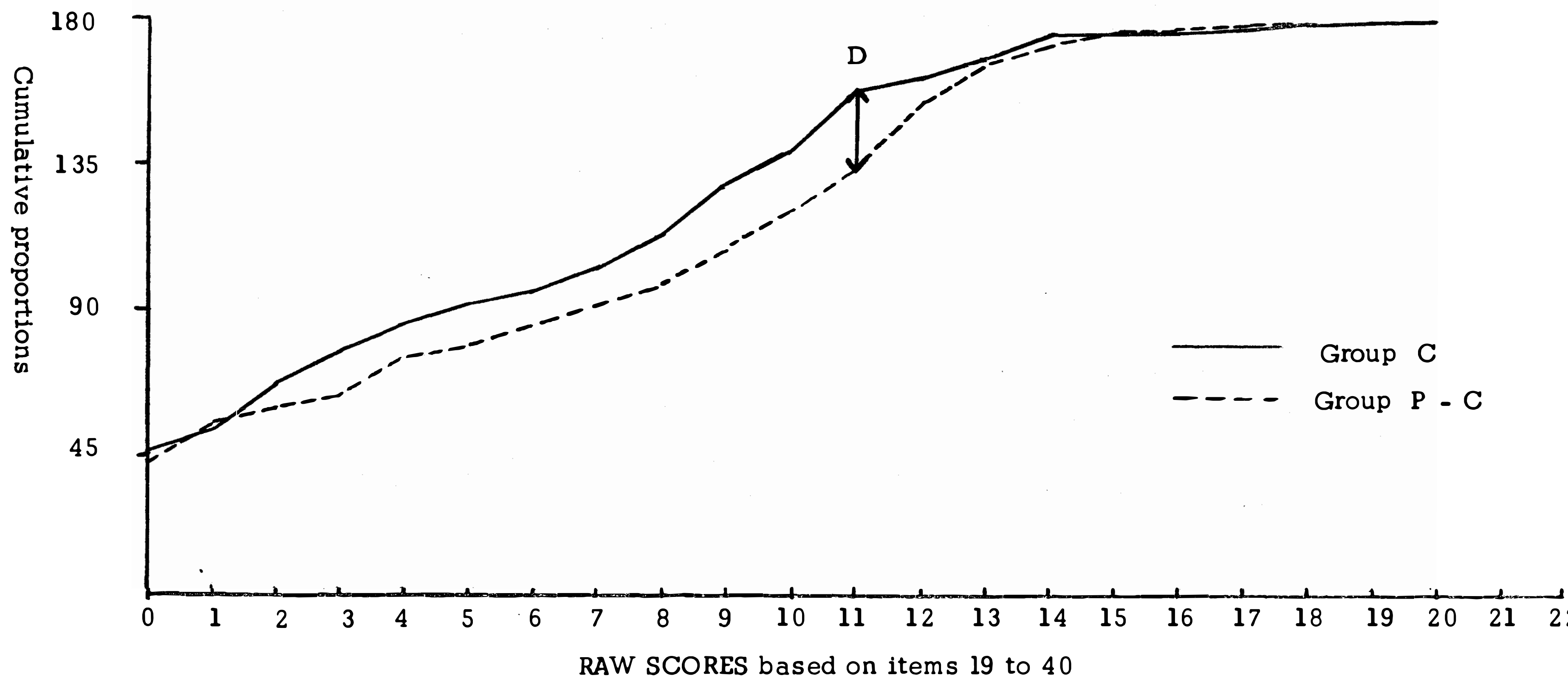
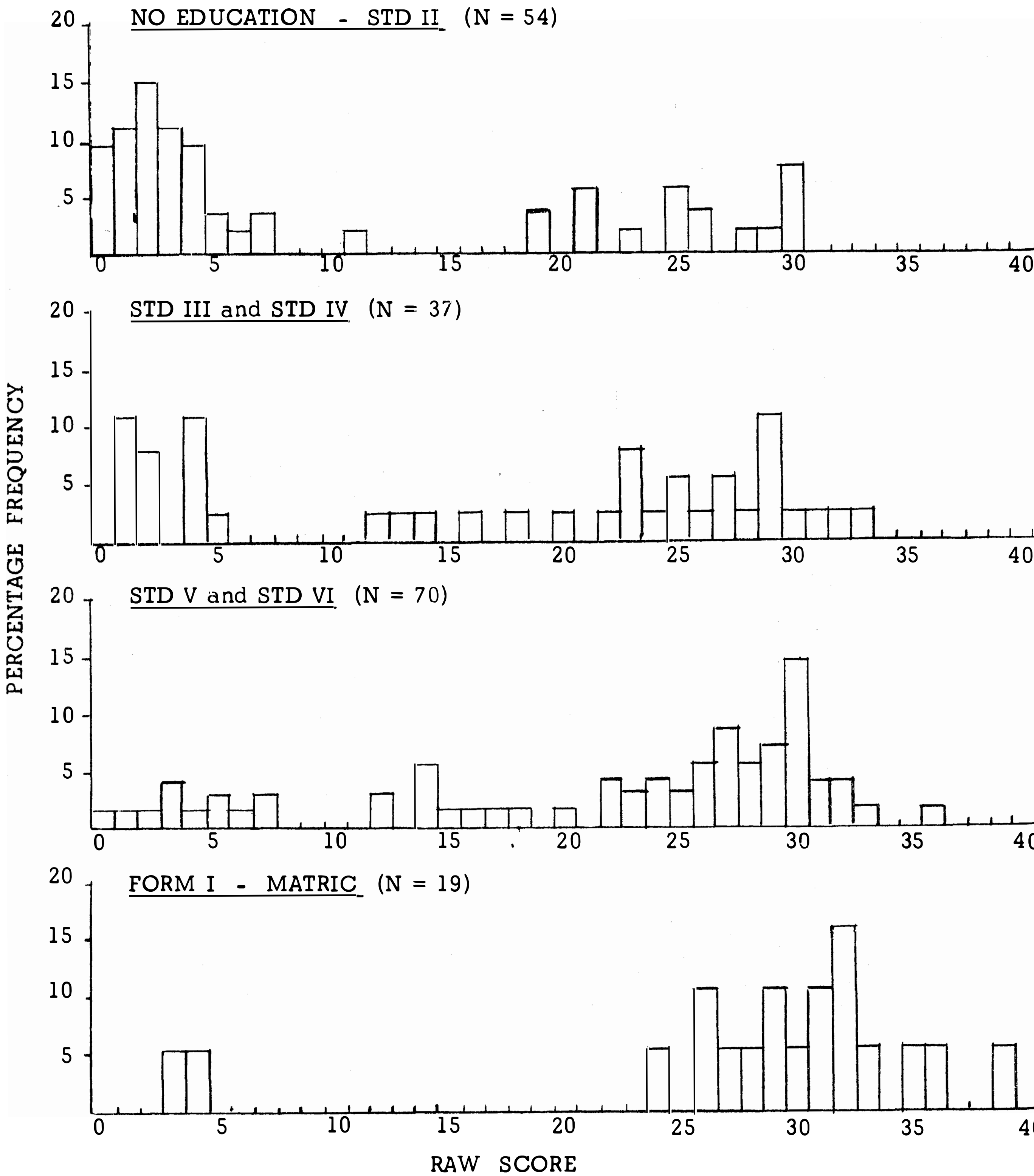


FIGURE 10

RAW SCORE FREQUENCY DISTRIBUTIONS AT FOUR EDUCATIONAL LEVELS



complexity expressed in items 31 to 40. The proportion of subjects achieving scores of 31 and higher drops quite considerably for Std 111 to V1 subjects (11% and 8% for the groups std V-V1 and 111-1V respectively) while not one single subject in the illiterate-std 11 group obtained a score of 31 and higher.

The overall distribution of raw scores becomes less pronouncedly bimodal when the 54 subjects in the educational range 0 to 4 years of schooling are omitted (see Figure 11). Item analysis parameters for the group with five years or more schooling do not differ appreciably from the parameters for all 180 subjects. The reliability of the 40-item test for the 126 subjects with five or more years of schooling is still exceptionally high at 0,962 (KR_{20}).

The 180 subjects in group P-C were also divided into 2 experimental groups on the basis of an illiteracy/literacy split. The "literate" group comprised 88 individuals who had been to school for at least 7 years. It included the educational range Std V to Senior Certificate (i.e. 7 to 12 years of schooling). The "illiterate" group embraced not only persons who had never been to school, but also semi-literates who had had between 1 and 6 years of schooling (i.e. Sub A to Std 1V). This group comprised 92 individuals.

The 40 items in the F.S.T. were intercorrelated for the two education groups. The intercorrelation matrix for the literate group is based on all 40 items, while the matrix for illiterates-semiliterates is based on 38 items only, as not a single subject was able to answer two of the items (no's 37 and 39) correctly.[1] Both intercorrelation matrices were subjected to a Jöreskog factor analysis. The 2- and 3-factor solutions after oblique rotation are reported in Table 11 for illiterates-semiliterates and in Table 12 for literates.

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[1] Intercorrelation matrices may be obtained from the author on request.

FIGURE 11

RAW SCORE FREQUENCY DISTRIBUTION:
STANDARD III TO MATRIC
(N = 126)

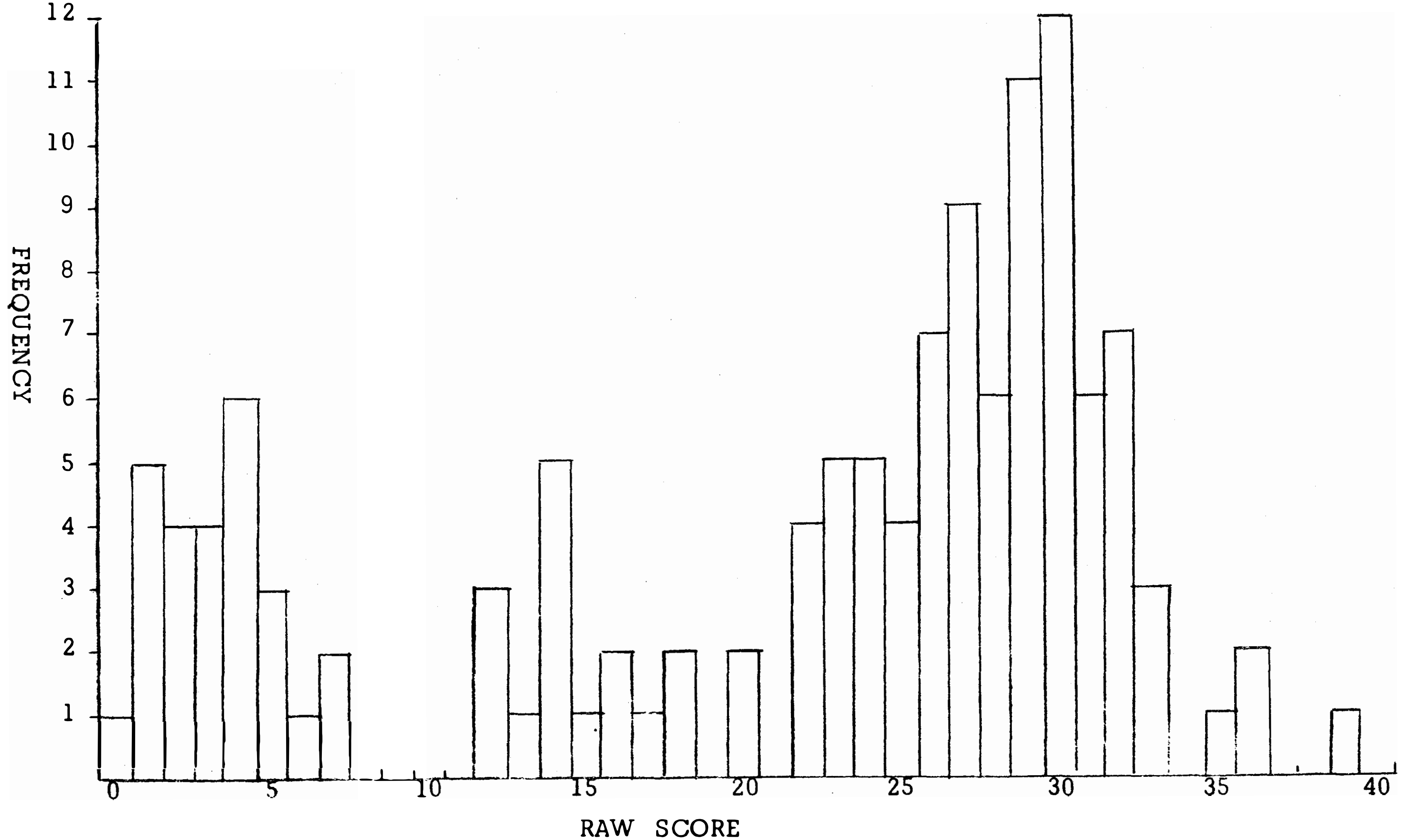


TABLE 11

DIRECT QUARTIMIN ROTATION : 2 AND 3 FACTORS (ILLITERATES)

Item	FACTOR 1	FACTOR 2	h^2	FACTOR I	FACTOR II	FACTOR III	h^2
1	0,08	0,47	0,27	0,48	-0,05	0,15	0,27
2	0,23	0,40	0,31	0,56	0,02	0,01	0,34
3	0,25	0,56	0,52	0,82	-0,06	-0,02	0,60
4	0,24	0,55	0,49	0,77	-0,05	0,01	0,55
5	0,25	0,49	0,44	0,55	0,08	0,13	0,44
6	0,32	0,54	0,58	0,50	0,21	0,24	0,58
7	0,41	0,32	0,41	0,47	0,24	0,01	0,42
8	0,49	0,32	0,50	0,56	0,25	-0,06	0,53
9	0,46	0,43	0,61	0,56	0,27	0,07	0,62
10	0,61	0,39	0,76	0,41	0,49	0,15	0,77
11	0,44	0,56	0,77	0,46	0,36	0,30	0,78
12	0,73	0,25	0,79	0,10	0,76	0,26	0,85
13	0,48	0,60	0,89	0,47	0,41	0,34	0,91
14	0,55	0,50	0,83	0,76	0,25	-0,02	0,87
15	0,40	0,56	0,69	0,48	0,30	0,28	0,70
16	0,43	0,65	0,89	0,53	0,33	0,35	0,91
17	0,67	0,24	0,68	0,55	0,42	-0,13	0,72
18	0,78	0,17	0,76	0,29	0,66	0,01	0,76
19	0,48	0,39	0,57	0,77	0,14	-0,17	0,68
20	0,61	0,36	0,72	0,75	0,26	-0,17	0,82
21	0,55	0,19	0,45	0,20	0,50	0,10	0,46
22	0,45	0,31	0,44	0,19	0,45	0,24	0,47
23	0,61	0,05	0,41	0,09	0,58	0,03	0,42
24	0,55	0,27	0,53	0,58	0,28	-0,13	0,58
25	0,80	0,09	0,73	0,27	0,67	-0,07	0,73
26	0,72	0,01	0,53	-0,01	0,73	0,07	0,55
27	0,79	0,07	0,69	0,14	0,74	0,02	0,70
28	0,98	-0,15	0,83	0,10	0,87	-0,19	0,84
29	0,72	0,04	0,55	0,09	0,69	0,02	0,56
30	0,63	0,07	0,44	0,20	0,53	-0,05	0,44
31	0,33	-0,05	0,10	0,04	0,29	-0,06	0,10
32	0,18	0,18	0,10	0,03	0,23	0,20	0,12
33	0,16	-0,04	0,02	-0,04	0,17	-0,01	0,02
34	-0,25	0,44	0,14	-0,05	-0,06	0,55	0,28
35	0,03	0,53	0,30	0,33	0,02	0,35	0,32
36	0,05	0,34	0,14	0,47	-0,12	0,01	0,16
37	This item has no variance			This item has no variance			
38	0,32	-0,06	0,09	-0,06	0,34	0,01	0,09
39	This item has no variance			This item has no variance			
40	0,09	0,25	0,09	0,21	0,04	0,12	0,09

$r_{I \times II} = 0,51$

$r_{I \times II} = 0,64$

$r_{I \times III} = 0,34$

$r_{II \times III} = 0,19$

TABLE 12

DIRECT QUARTIMIN ROTATION : 2 AND 3 FACTORS (LITERATES)

Item	FACTOR		h^2
	1	2	
1	0,44	-0,02	0,19
2	0,51	-0,04	0,24
3	0,50	0,10	0,29
4	0,53	0,10	0,33
5	0,43	0,11	0,23
6	0,68	0,01	0,47
7	0,49	0,06	0,26
8	0,76	-0,05	0,56
9	0,81	-0,03	0,65
10	0,82	-0,01	0,66
11	0,90	-0,10	0,75
12	0,77	0,02	0,61
13	0,93	-0,13	0,80
14	0,86	-0,08	0,70
15	0,92	-0,11	0,79
16	0,91	-0,10	0,78
17	0,86	-0,08	0,71
18	0,82	-0,06	0,65
19	0,57	-0,07	0,30
20	0,77	-0,06	0,57
21	0,60	0,09	0,41
22	0,62	0,12	0,44
23	0,53	0,10	0,33
24	0,81	-0,09	0,61
25	0,71	0,04	0,53
26	0,73	0,00	0,54
27	0,76	0,04	0,60
28	0,72	0,05	0,54
29	0,60	0,11	0,42
30	0,55	0,09	0,34
31	0,11	0,40	0,20
32	0,11	0,53	0,33
33	-0,04	0,59	0,33
34	0,05	0,46	0,23
35	0,29	0,17	0,15
36	0,08	0,12	0,03
37	-0,03	0,47	0,21
38	-0,01	0,70	0,49
39	-0,07	0,55	0,28
40	-0,08	0,75	0,52

$r_{I \times II} = 0,34$

FACTOR			h^2
1	2	3	
0,40	-0,03	0,18	0,21
0,52	-0,03	-0,05	0,25
0,52	0,11	-0,09	0,31
0,56	0,11	-0,12	0,35
0,45	0,12	-0,09	0,24
0,66	0,02	0,08	0,47
0,47	0,06	0,06	0,26
0,68	-0,07	0,37	0,66
0,79	-0,02	0,10	0,65
0,79	-0,01	0,13	0,67
0,91	-0,08	-0,10	0,77
0,78	0,03	-0,04	0,61
0,98	-0,11	-0,23	0,88
0,84	-0,07	0,07	0,71
0,90	-0,10	0,09	0,79
0,85	-0,10	0,27	0,83
0,85	-0,07	0,05	0,71
0,74	-0,07	0,33	0,73
0,59	-0,05	-0,11	0,32
0,78	-0,05	-0,06	0,58
0,64	0,11	-0,18	0,46
0,63	0,13	-0,03	0,45
0,52	0,11	0,02	0,33
0,86	-0,07	-0,22	0,68
0,63	0,02	0,35	0,62
0,70	0,00	0,13	0,54
0,70	0,03	0,27	0,65
0,74	0,07	-0,09	0,56
0,60	0,12	0,01	0,42
0,56	0,10	-0,06	0,35
0,10	0,39	0,08	0,21
0,10	0,52	0,10	0,34
0,00	0,60	-0,14	0,36
0,07	0,46	-0,03	0,23
0,28	0,17	0,07	0,15
0,02	0,10	0,31	0,11
-0,02	0,47	0,00	0,21
0,02	0,71	-0,03	0,50
-0,10	0,54	0,22	0,33
-0,05	0,75	-0,05	0,54

$r_{I \times II} = 0,30$

$r_{I \times III} = 0,19$

$r_{II \times III} = 0,10$

1.8. General Discussion

The aim of the study was to explore the possibility of extending the difficulty level of the Form Series Test in order to produce a single measuring device that could be administered to illiterates and literates alike. In attempting to assess the extent to which this aim has been fulfilled, the following broad areas will be discussed in turn:

(i) The performance of group P-C on all 40 items. This will include a consideration of actual item difficulty levels, the phenomenon of bi-modality in test score distribution, and a consideration of the significance of the factor analysis performed on the item intercorrelations for this group.

(ii) The performance of group C on the "conceptual" items, and a comparison of this group's performance with that of group P-C on the same items.

(iii) The influence of education on conceptual reasoning ability. This section will be concerned with questions of a more theoretical nature, and will deal with the development of conceptual reasoning ability from a global perceptual basis to a more differentiated abstract approach.

(iv) Finally, the practical implications of differentiating between literate and illiterate approaches to conceptual reasoning problems will be considered.

A series of recommendations will conclude the discussion.

1.8.1. The performance of group P-C

In the introduction, it was mentioned that the existing 18-item version of the F.S.T. did not measure differences in ability between individuals who had been to school for 8 years or more very reliably. Consequently, many more items of an "out-of-phase" nature were added to the test. It is apparent from the graphs in Figure 5 that items 1 to 20 (which are fundamentally "in-phase" in principle) are comparatively easy for the majority of the sample. Item difficulty values varied between 82% correct solution of item 1 and 62% correct solution of item 20. There was an abrupt increase in difficulty after item 20. This increase had been predicted under hypothesis I. Items 21 to 40 are out-of-phase in principle, which would account in part for the sudden increase in item difficulty values. What is puzzling, however, is the even greater jump in difficulty after item 30. This was entirely unforeseen.

Thus, on visual inspection of the results, three definite levels of item difficulty would appear to underlie performance on the extended F.S.T. Item analysis, and more particularly factor analysis, help provide valuable clues to the interrelationships among these three levels. Iterative item analysis established that there was a high degree of internal consistency among items 1 to 30 inclusive (i.e. across the first two difficulty levels). The 3-factor rotated matrix (see Table 7) confirmed the high measure of interrelatedness among these items by demonstrating that a broad factor emerged on which all items in the 1 to 30 range loaded in excess of 0,40. Items 31 to 40 on the other hand loaded on a second factor which correlated with Factor I to the extent of 0,37. This factor correlation suggests that the strategy adopted by the sample for the solution of items 31 to 40 had very little in common with the strategy that was followed for the first 30 items.

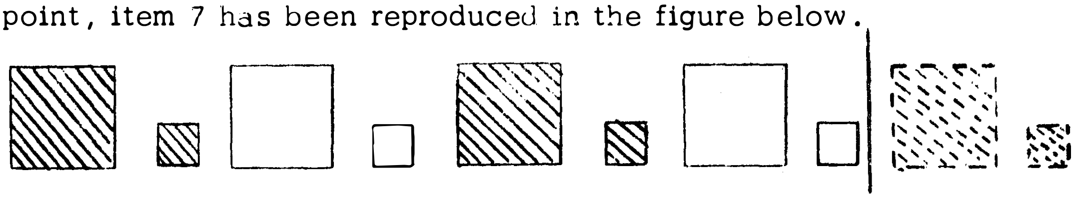
It would appear then that the psychological processes underlying performance on the F.S.T. are only partially explainable by reference to the hypothesized in-phase/out-of-phase dichotomy. Purely conceptual considerations are therefore not the only factors that account for differences in approach to conceptual reasoning tasks.

Performance on the conceptually out-of-phase series included in items 21 to 30 is very clearly more akin to performance on in-phase items than to performance on the last 10 out-of-phase items. The remainder of this discussion will attempt to justify the author's argument that the factor structure underlying item intercorrelations is attributable to the phenomenon of "perceptual set"; a phenomenon which, both by the nature of the test items, and by the particular cognitive style of the majority of subjects, overrides the strictly conceptual considerations that are built into the F.S.T. It is submitted that most subjects developed a "mental set" during their solution of the first 20 items (viz. those of the in-phase variety), and that they attempted to apply the same strategy to the solution of the remaining 20 out-of-phase conceptual problems.

Apparently, this strategy, which can be characterized as concretistic and perceptually-guided rather than 'conceptual' proved to be effective for performance on the easier type of out-of-phase item, but, for reasons which will become apparent, failed entirely when applied to the more difficult out-of-phase items.

The argument for an explanation of the observed factor structure in terms of perceptual set is best introduced by considering the raw-score distribution for group P-C presented in Figure 6. The bi-modality of the distribution is very evident. The first mode centres on raw scores 1 to 8, and corresponds almost exactly with the modes reported in other studies involving the Secondary Industry Version of the F.S.T. (notably Grant, 1965[33]; and Blake, 1972[34] - see Figure 1 of this report). Very few subjects scored within the range 11 to 19, while the second distribution extends across the 20 to 40 raw-score range. Considering the distribution around the first mode, it is informative to note that in the 3-factor rotated matrix (see Table 7), a highly specific factor emerged centred on items 3 to 7. This factor becomes more pronounced when 4 factors are extracted (the 4-factor solution has not been reported owing to the absence of high factor loadings on the fourth dimension). It is suggested that the strategy that was followed by most, if not all, of the subjects in the successful solution of items 3 to 7 is that of isolating a perceptually-obvious pattern; of verifying the pattern by matching its repetition with its appearance in the first cycle; and of continuing the pattern in the correct manner. <u>This can be done without the subject resorting to conceptual reasoning processes at all.</u> In order to demonstrate this point, item 7 has been reproduced in the figure below.

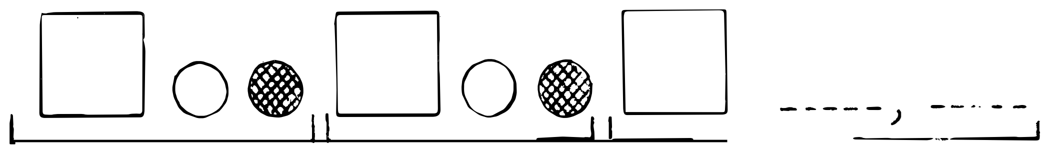
Item 7:



The perceptual pattern is immediately obvious. In this particular example, colour and size feature most prominently in enabling the subject to isolate a "perceptual pattern". It is therefore not necessary for him to decode the information in an abstract way (e.g. by telling himself that colour changes after every two forms, while size changes after every form and shape remains constant). Indeed, for some subjects, it could be speculated that such 'conceptual' principles do not even occur to him; he simply 'feels' that the correct solution should be one big and one small blue square. (i.e. the dotted forms in the item above.)

"Obvious" perceptual cues become less pronounced and a little more embedded in items 8 to 20, though they are still readily identifiable on close inspection. Consider item 14:

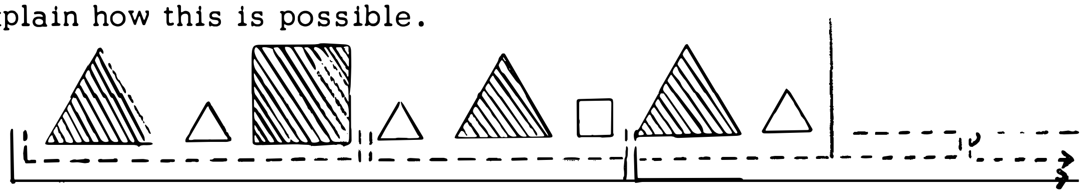
Item 14:



In this item there is a definite "perceptual" pattern which is twice repeated in the printed item, viz. big red square, small red circle, small blue circle. It so happens that the perceptual cycle coincides exactly with the conceptual cycle which was also the case in items 1 to 8. The subject simply has to identify the limits of the cycle; recognise that this cycle is twice repeated in the series (i.e. verify the cycle); and recognise too that the first form in the third repetition of the cycle is in fact the third big red square in the series, in order to be able to continue the series correctly. Again, the majority of subjects are more likely to copy the forms than to reason in terms of abstract categories. The memory load need not be great at all, for the subject can refer to the pattern before him. At this point it would be appropriate to recall Reuning's (1972)[35)] observation that the process of "following the culling rule" is a feasible and often successful approach in solving in-phase items. The subject simply has to follow a rule, with a minimum of conceptual insight, but at the same time has to be able to isolate the relevant perceptual cues relating the forms to one another. The perceptual cycle is identified most probably either by memorising the individual characteristic combinations (in our example, red and big square, red and little circle, blue and little circle) or by perceiving the pattern almost instantaneously. Therefore, all that would appear to be necessary for the correct solution of these items is a well-developed ability to pick out the relevant perceptual cues that define the beginning and the end of a pattern. It is not necessary to deal "in abstracto" with categories of big versus small, blue versus red and square versus circle; the perceptual pattern is sufficient. Perceptual cues may, of course, be quite different to the purely conceptual cues that objectively determine the complexity of a series. This becomes very apparent on consideration of the 'out-of-phase' items, some examples of which will be given below.

As already pointed out, both the item- and factor-analyses suggest that a similar (and hence "perceptual") approach was adopted by most subjects in solving the easier type of out-of-phase item. Examination of item 30 helps explain how this is possible.

Item 30:

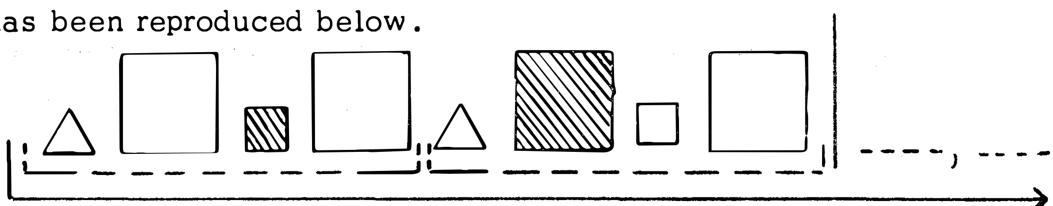


This item is fairly typical of items in the range 21 to 30. Conceptually, it is out-of-phase in nature in that the cycles for colour and size do not fit the cycle for shape within the longest conceptual cycle. The longest conceptually-defined phase is only 3 forms in length (viz. two triangles and a square, indicated above by a broken bracket). The longest complete perceptual phase is, however, now 6 forms long (indicated above by a solid bracket). It seems probable that while some subjects solved items 21 to 30 through a process of abstraction (viz. through reasoning that colour and size change with every form while shape varies on a 2-to-1 basis), others may have recognised that the beginning of the second perceptual cycle now comes later on in the item than it did in items 1 to 20 (of the in-phase variety). All the subject need do in order to obtain the correct solution is identify where the second cycle begins, and simply copy the forms that follow it in the first cycle. This is the only possible explanation for the fact that items became progressively easier for the sample from item 21 to 30, despite an increase in the conceptual complexity of the items. What seems to be occurring is a 'learning' or 'discovery' phase in which the subject gradually becomes aware of the fact that the old 'perceptual' rule which held for the in-phase items, was also valid (in somewhat modified form) for the out-of-phase items. The failure of some subjects to appreciate that a slight change in strategy was called for (and who started perseverating from item 21 onwards) might account for the difference in difficulty levels between items 1 to 20 and items 21 to 30. The difference is certainly not largely due to an abrupt change in the conceptual complexity of the items within this range, as was originally hypothesized.

The 2-factor solution to the factor analysis (see Table 7) nevertheless demonstrates that while items 21 to 30 load on dimension I together with all 20 in-phase items, they are involved at the same time in a factor specific to themselves. These two factors correlate to the extent of 0,41 and suggest 'difficulty' factors rather than 'concrete, perceptual' and 'abstract-conceptual' dimensions. Regardless of the label one assigns to the two factors, it would still appear that a definite, albeit minor, change in cognitive strategy seems called for in the solution of the easier type of out-of-phase item. It can be speculated that such a change is not from a 'concrete' to an 'abstract' way of thinking, but rather from one perceptually-guided approach to another fundamentally similar, but more flexible one.

"Perceptual" approaches to conceptual reasoning problems are entirely ill-suited to the solution of items 31 to 40. To demonstrate this point, item 40 has been reproduced below.

Item 40:



In this item, a complete perceptually-defined cycle would extend across 12 forms.' As there are only 8 forms in the printed series, it is impossible to identify the perceptual cycle. The conceptually-defined cycle on the other hand embraces 4 forms only (the longest phase being one triangle and three squares). It is therefore only after item 30 that the subject is compelled to change his cognitive strategy entirely. Theoretically, the only feasible approach to items 31 to 40 would appear to be one in which abstract thought processes are involved. It will be pointed out later on however, that perceptually-based approaches can, though with diminished success, still operate in solving some of these items. The fact that so few subjects were able to score correctly within this item range points to the extreme difficulty experienced by Africans, even at higher levels of education, to effect a realistic change in their manner of problem-solving. This difficulty is probably a function of struggling to overcome a 'mental set' which is damaging to their chances of obtaining further correct solutions to test items. It does not imply, however, that Africans experience difficulty with conceptual reasoning or that they cannot abstract. It is very likely that were the precise instructions explained to them before the test was begun, the difficulty in passage from a perceptually-guided to a conceptually-guided approach would be less apparent.

Of course, it is theoretically possible for a subject to adopt a completely conceptual approach to the F.S.T. right from the beginning. But such a person would have to overcome the extreme temptation of solving the items in a 'perceptual' way. He might well see the correct solution at a glance, and could use conceptual reasoning to 'verify' his choice of forms; for such subjects, there would be no shift in strategy after item 30; and items would appear more difficult only in terms of increased conceptual complexity, increased embeddedness of 'obvious' perceptual cues and attendant memory load. It is speculated however that few, if any, subjects approached the easier F.S.T. items in an abstract-conceptual way : there is simply no compelling reason for doing so. Perceptual cues in the first few items are so obvious that most candidates are induced, quite understandably, into following a perceptually-guided strategy right from the start. The phenomenon of 'a change in style' after item 30 therefore becomes a very significant aspect of psychological testing using the F.S.T. for it suggests a measure of flexibility in thinking.

At a practical level it is suggested that the inclusion of items requiring an abstract frame of mind for their solution in an extended F.S.T. will prove to be of immense value for purposes of worker selection and placement. <u>If it is accepted that by the very nature of the in-phase items, a perceptual set is encouraged, then it would appear that the more difficult out-of-phase items tap not only abstract reasoning ability as such, but also the capacity for reflective change from one mental approach to another.</u> The fact that relatively few African workers managed to effect such a change in test-strategy provides test-users in industry with a ready means of sorting out those candidates who not only obtain superior test scores in terms of reasoning ability, but who have demonstrated an additional capacity to be flexible in the testing situation. This ready-made criterion (which would be a raw-score of 31 or higher) has the advantage of being psychologically meaningful, and is therefore unlikely to be as arbitrary as most criteria that are adopted for purposes of worker selection and placement. The criterion should therefore have high predictive validity in the industrial situation.

As an aside, it will interest the reader to note that the author's conclusion that the new F.S.T. offers not only a measure of absolute performance in terms of conceptual reasoning ability, but in addition a measure of cognitive flexibility, was arrived at quite independently of a similar conclusion drawn by Laroche (1956)[36)] during his analysis of errors made by Africans on Raven's progressive matrix 38. Laroche administered the Ravens to 1900 boys aged 10 - 17 years who were being trained at a school run by the Upper Katanga Mining Union in the former Belgian Congo. His basis for a detailed analysis of the errors they committed on this test was a system elaborated by Bromley (1953)[37)], using a sample of patients from two mental observation wards in the United Kingdom. Laroche found that low scorers made mistakes through stereotyped duplication of a motif already contained in the matrix while the errors of high scorers were due to a process of <u>incomplete eduction.</u> In conclusion, Laroche (1956)[38)] wrote the following:

"........ the structure of matrix 38, characterized by the fact that 50% of the correct responses to items in series A and B call for a process of reproduction, is responsible for encouraging subjects to put into operation the same attitude when solving the last items, thereby encouraging them to <u>perseverate.</u> It therefore emerges that items B4 and B5, and more especially item B6 and those following it, are critical for succeeding in the test : (for) they require the subjects:

a) to accord a wider interpretation to the test requirements and to eventually restructure their perceptions; and

b) to abandon the work-method which proved feasible for the preceding items.

And in this sense, matrix 38 gives not so much a measure of the subjects' inability to reason by analogy as a <u>measure of their mental rigidity or agility."</u>

(Laroche, 1956, p. 170, author's translation from the French.)

Laroche also stated a little later on in his article that if his hunch was correct, viz. that low scorers perseverated through a process of stereotyped duplication, it would be inadmissible, indeed dangerous, to conclude that such subjects were incapable of reasoning by analogy if, in fact, their performance indicates a certain measure of "intellectual rigidity". Laroche queried whether this finding of his was specific to matrix 38, or whether it was a more general phenomenon. On the basis of the present findings, using an entirely different item format, and appealing possibly to very different mental processes, we are now more firmly able to conclude that stereotyped duplication and the attendant "perceptual set" it encourages is not a specific phenomenon, but is in fact a very real and general feature in the intellect of Africans in a state of cultural transition.

Werner (1957)[39], though with little empirical evidence for his assertions, also concluded that "primitive man" tends to rigidity in his thinking. Arguing that the world of the primitive is "dynamic and ever-changing", primitive man should be highly sensitive to change. "For the primitive man a trivial variation in the appearance of some object of daily use or of cult significance in his house or in his local world is interpreted not as a mere transposition or transformation of an unessential detail, but as a revision of the whole, a revolutionary change in the impression of the totality" (p. 141). The argument is developed by Werner that the slightest change can work most disturbingly on the primitive man, and that he must develop a tendency to resist, for self-preservative reasons, any change which might disrupt customary usage. Whether one accepts Werner's armchair anthropological observations on "primitive" behaviour or not, it is of interest to see that the whole issue of "rigidity" had already been raised well over 20 years ago. Perhaps non-verbal rigidity as a feature in the structure of intellect of non-westerners should be seen as a future research priority for cross-cultural research.

1.8.2. The performance of group C and a comparison with that of group P-C on items 19 to 40

Analysis of the performance of group C on the conceptual version of the extended F.S.T. suggests nothing to contradict the conclusions that were drawn in the preceding discussion. The graphs in figure 7 demonstrate that the same trend in difficulty values is observable for both groups C and P-C across items 19 to 40. Factor analysis of the 22-item intercorrelation matrix for group C further more suggests the presence of the same two factors that were observed for group P-C. Even the correlation between the two factors (r = 0,36) is of the same order as the correlation established for group P-C performance (r = 0,37). It can be argued therefore, that even in the absence of the opportunity to work through in-phase F.S.T. items, a "perceptual" approach to reasoning problems comes more readily at first than the conceptual approach.

Inspection of Figure 9 indicates that the distribution of raw scores across the item range 19 to 40 is very similar for both experimental groups. Skewness and kurtosis are of the same magnitude for both samples, with an indication that scores within the range 1 to 12 (i.e. 19 to 30 for group P-C) are negatively skewed. Estimates of reliability are also virtually identical for the two groups (KR_{20} being 0,898 and 0,915 for groups C and P-C respectively). Furthermore, both the 22-item "conceptual" scale for group P-C and the 22-item scale for group C correlated to the same extent with Education and Age. Finally, twenty-five percent of the sample in both groups scored zero on the conceptual items.

The results of the t-test and the Kolmogorov-Smirnov test indicate however, that the two distributions and their means differ significantly from one another at the 5% level of confidence. The superiority of group P-C's performance is limited to items 19 to 30 however, and does not extend into the item range that requires a conceptual strategy for its solution (see Figure 9). In other words, it would appear that exposure to the perceptually-loaded in-phase items (viz. the 18 items administered to group P-C, but not to group C) improves performance on items of a more conceptually-loaded nature but that transfer is limited to only those out-of-phase items which can be solved through using a perceptually-guided strategy.

It is interesting to note that the facilitative effect of practice instanced in this study is able to throw new light on Peiser's (1969)[40)] finding that practice effects using the 1965 version of the F.S.T. are more pronounced for groups who initially scored low than for groups who initially scored high. It is now apparent why this should be the case in that low scorers, after practice, will successfully transfer their perceptually-based strategies to the solution of a greater number of items in the test. In their case, there is much room for improvement in their absolute level of performance. High-scorers, on the other hand, have already reached a ceiling to their performance, and can improve their score only by appreciating that a fundamental change in cognitive strategy is necessary. The present study suggests that only a very small percentage of African factory workers are able to effect the necessary changes.

Peiser cites a study by Haygood and Bourne (1965)[41)] conducted in the United States of America which demonstrated that practice in utilizing conceptual rules produced strong learning effects, but that such transfer was limited to situations which had something in common. Interrule transfer reflects a common strategy, i.e. a common way of tackling the problems that are set in both the practice and in the subsequent testing session. In the present study, we have seen that transfer took place from practice at the in-phase to performance on the easier "concrete" out-of-phase items only, while the effects of practice on conceptual reasoning was negligible. This reinforces our conclusion that the particular cognitive style that was favoured in solving in-phase items could be used for solving the "concrete" out-of-phase problems, but was not transferable to situations calling for a strictly abstract approach, simply because the two sets of rules were so totally different.*

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* It could also be argued that the limited improvement in performance of group P-C over that of group C was in part attributable to a process of test familiarization, and might therefore have had little to do with positive transfer of cognitive strategy as such. In this connection, it is important to note that group C did not engage in any "substitute" activity during the time period in which group P-C were attempting the first 20 items. Both groups commenced their tasks at the same time : group P-C starting at item 1 and group C at item 19.

1.8.3. The influence of education on conceptual reasoning ability

Education correlates very highly with F.S.T. performance on both the 40-item and 22-item versions of the advanced test. (r being 0,52 in both cases.) This coefficient is a little higher in magnitude than the correlations that have been reported in the past using either the mines or the secondary industry versions of the F.S.T. (cf. Grant, 1965[42]; Grant, 1969[43]; Kendall, 1971[44]; Grant, 1972[45]) and is probably a comment on the greater heterogeneity of the present sample in terms of the wide education range of the subjects.

Of the various 'abilities' that have been uncovered in studies of the structure of pre-literate intellect, conceptual reasoning has perhaps emerged as the dimension most strongly influenced by formal education. This is probably because of the ability's peculiar relevance to technological culture. As Reuning (1972)[46] has pointed out, dealing with abstracted qualities per se, and with categories based on such abstractions, although not unknown in the traditional African context, is seldom applied to novel situations in technologically unsophisticated populations. It is therefore little practised, and as an ability remains undeveloped or dormant. Reasoning among pre-literate peoples, and Africans in particular, is therefore restricted to the cumbersome attempt to "search for the individual formula to fit the individual event". Reuning provides some lucid illustrations of what is meant by the application of individual formulae to novel events, for example:

"The herd-boy does not need to state: 'My three brown and four black cows and my five oxen are here; I can go home.' Rather he sees that his 'long-leg', his 'crooked horn' and 'white spotted one', and so on, are all right if he wants to be satisfied that his job is done. He does not have to categorize, because he gets along with regarding things, animals that interest him, etc., individually."

(Reuning, 1972, p. 187)

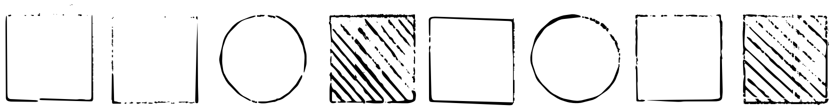
The ability to abstract conceptual information considerably eases the information load that is implied in the pre-literate's search for individual formulae, and is acquired in technological societies mainly in the early school years. For this reason, because abstract reasoning ability is directly fostered by formal educational institutions, the contribution of education to the growth of this ability assumes considerable importance.

The short history of empirical study of the African's ability to reason using concepts has been marked by a movement away from the traditional colonial assumption that Africans 'cannot abstract' towards a more cautious approach propounded by post-war researchers. Grant (1972)[47] has been instrumental in pointing out that the terms "abstraction" and "conceptual reasoning" should not be used synonymously. To insist that abstract reasoning ability is evident on a symbolic and conceptual plane only, leads to the erroneous conclusion that Africans are unable to attain concepts, and to reason in terms of abstractions. Recent studies by Jahoda (1956)[48], Price-Williams (1962)[49], Kellaghan (1968)[50], Poole (1968)[51], Evans and Segall (1969)[52], and Ciborowski and Cole (1971)[53] have all demonstrated that Africans, adult or children, are able to cope with a variety of conceptual problems, even though the manner in which such problems are handled need not necessarily be "abstract" in the western sense of the word. It is true that much research in the field of African conceptual reasoning ability has for long been dominated by Goldstein and Scheerer's (1941)[54] 'concrete-abstract' continuum which accounts for the conclusions that were reached by earlier investigators. Grant (1972)[55] however, suggests that the term 'conceptual' and its derivatives be used in place of 'abstractive' ability. If one must think in terms of a continuum, then Pikas' (1966)[56] primary-secondary or 'perceptual-conceptual' continuum might be more appropriate. The present author finds Pikas' perceptual-conceptual hierarchy of cognitive development to be of particular relevance to a discussion of F.S.T. performance in that it enables one to argue that reasoning ability can be reflected at both a predominantly perceptual and at a predominantly conceptual level. The remainder of this section of the discussion will attempt to comment on a variety of ways in which a 'perceptual' approach to conceptual reasoning problems can be used to advantage by African subjects. It will be seen that formal education plays a significant rôle in modifying the strategies that are adopted in the attempt to deal with reasoning problems.

It is clear from the separate factor analyses that were performed on the item-intercorrelation matrices for illiterates and semi-literates on the one hand and for literates on the other that a clearcut abstract-conceptual factor emerged only in the case of literates. It would appear then, that the approaches adopted by illiterates and semi-literates were of a fundamentally non-conceptual variety, or at least, were not related to the 'conceptual' demands of the test task. Let us now consider the possible bases for some of these perceptually-guided approaches.

The 2-factor structure for illiterates-semi-literates (Table 11) is interesting in that the items which have the highest loadings on the first factor are around items 25 to 30 (viz. the easier type of out-of-phase item). The magnitude of loading of the other items on this factor increases steadily from the first item right through to the thirtieth item, but is negligible after item 30. This manner of loading suggests a gradual learning or familiarisation phenomenon. To the illiterate, the array of concept variations with which he is required to work must surely be bewildering, while the task itself is of little relevance to his normal day-to-day thought processes. Many of the earlier errors made in the test might therefore be attributable to confusion between concept variations rather than to faulty reasoning processes. For example, even though the test administrator followed the manual instructions to the letter, which included a quick 'introduction' to the three shapes, sizes and colours featured in the test, the illiterate might not have thought the distinction between a medium-sized and a small-sized form to have been as important at the beginning of the test as towards the end. It is interesting to note that the difficulty curve for in-phase items is not as 'regular' as that for the easier out-of-phase items, while a quick perusal of errors suggests that 'carelessness' was more rife at the beginning of the test than towards the end. The 'familiarisation' factor that is postulated to underlie performance on the first 30 test items might also be attributable in part to increased insight as the test proceeds, a process wherein initial performance may have been more a function of trial-and-error than of proper understanding of the task requirements. What was probably learned, or became apparent to the subject, was that a definite perceptual pattern can account for the way in which the forms are arranged in the items.

Almost reciprocally, factor loadings on the second dimension tend to decrease from item 1 to 20, but re-appear in strength in the case of items 34, 35 and 36. Inspection of these last three items suggests that they are nevertheless a little more perceptually-loaded than their neighbours. Consider item 35.

Item 35:  ----, ----

In this item, all forms are of the same size. Although it has not been demonstrated convincingly, size (as a series concept) is probably a more difficult concept to deal with from the viewpoint of salience of perceptual cues, than are the concepts of shape and colour (particularly when small, medium and large forms appear in the relative sizes used in the F.S.T.). If this be accepted, then it follows that through holding size variations constant, a major source of error has been controlled, thereby making the item a little easier. The colour sequence in item 35 above is very obvious at a glance which leaves the individual who chooses to ignore, or who has not fully discovered the "conceptual" principles underlying this series, with a strong possibility of selecting the correct forms merely through guessing (or even through chance!) Thus, provided the testee limits his choice of forms to medium-sized red or blue squares or circles, there is a 1-in-4 likelihood that the correct forms will be chosen. In item 36, which is conceptually parallel (see Table 1) to item 35, perceptual cues are more embedded in that colour and not size has been held constant. To obtain a correct solution through educated guessing is now more difficult. Reuning (personal communication) has suggested that the factor producing the high loading of certain items in dimension II may be summarized as a process of "seeing the obvious and guessing the rest".

Factors I and II in the 2-factor structure for illiterates might therefore describe, respectively, the strategies of (i) learning to locate a perceptual pattern in the series of forms, and (ii) of seeing a perceptual pattern, but taking an educated guess as to the solution. The two factors are substantially intercorrelated (r = 0,51). It is important to note that neither factor suggests the presence of formal, conceptual thinking in solving the problems, which was also apparent when the 2-factor solution for the total sample was considered (see Table 7). Thus, it can be argued that illiterates and semi-literates tend to approach F.S.T. problems in a manner entirely at variance with the manner in which the test constructor believed the testees should approach the task. What emerged as 'conceptual reasoning' ability factors in the International Biological Programme studies (Grant, 1969[57]; Kendall, 1971[58]) may therefore have very little to do with abstract-conceptual thinking as such, and to have more in common with the more fundamental perceptual abilities that were uncovered in the same studies: hence the exceptionally high correlation between 'conceptual reasoning' and 'perceptual analysis' for both the Venda and the Pedi in these studies.

The 3-factor structure for illiterates and semi-literates is in many ways more informative than the 2-factor structure. Table 11 demonstrates that the first factor embraces items 1 to 20 inclusive as well as items 24 and 25. We know from our conceptual model that the first 20 items are basically in-phase in principle. It is suggested that this factor involves a certain degree of 'perceptual rhythm'. In this connection, it was interesting to watch the rhythmic manner in which some testees, particularly the elderly subjects, worked through the four practice items. The instructor would point to the beginning of a series on the demonstration poster, instruct his subjects to place their fingers at the beginning of the same item on their test board, and then "chant" the series, with the subjects joining in.

> "Big red triangle, little blue triangle, little blue triangle ...."
> (brief pause)
> "Big red triangle, little blue triangle, little blue triangle ...."
> (brief pause)
> "Big red triangle, little blue triangle, ...?"

The author observed that many of the subjects worked through the test items with their fingers. What was particularly interesting was that some subjects definitely used their fingers in a rhythmic stepping motion, going over and over the item from left to right. If the perceptual cycle was three forms long, it was often noticed that a subject would tap out a rhythm with his finger across the first three forms, sometimes as often as three or four times as if he were committing the cycle to memory. He would then move to the next three forms, verifying the pattern as it were (and in the case of in-phase items, forms in positions 4 to 6 are identical in respect of size, shape and colour to forms in positions 1 to 3), would see that the pattern had been repeated, and would then tap out the rhythm across positions 7 to 9, thereby identifying the correct forms for continuing the series.

This strategy would not prove as effective for items 21 to 40 (conceptually out-of-phase) as perceptual cycles are now very much longer. It is at this point that a simple 'rhythmic' strategy must be substituted by a more adaptable approach. To learn the combination of forms in a 6-form item would be demanding on one's memory and is therefore impractical in the case of out-of-phase items. The second dimension in the 3-factor solution embraces most of the easier type of out-of-phase item (i.e. items 21 to 30) as well as many items after item 10. It is definitely 'perceptual' in nature and probably differs from factor I (rhythmic identification and verification of a cperceptual pattern) in that it requires the subject to adopt a potentially more flexible strategy, a strategy which would allow for increases in the length of perceptual cycles. This factor involves the realisation that as cycles become lengthier, it is necessary to look at the forms nearer the end of the series in order to isolate a visually obvious pattern.

Factor III is too specific to interpret with any degree of confidence. What is apparent however, is that colour plays a major rôle in the ease of identification of a perceptual patterning of the forms.

Turning now to the factor analyses performed on literates, it is quite plain that factors I and II describe "perceptual" and "abstract-conceptual" approaches to problem-solving respectively (see Table 12). The two factors correlate to the extent of 0,34 which is substantially lower than the correlation of 0,51 between factors I and II for illiterates. It is difficult to interpret further specific factors that were extracted when three or more factors were called for.

It is interesting that a fairly clearcut "conceptual" factor emerged for literates, while this was not true of illiterates or of the combined illiterate-literate sample. It is a pity that the sample size was not large enough to permit a division of the total group into more than two educational groups for purposes of comparative factor analysis, as this would have enabled us to study developmental trends and to pinpoint more accurately the minimum standard of education associated with the emergence of a conceptual approach to problem solving. The present dichotomy into two groups termed "illiterate" and "literate" (arbitrarily split at the Standard V level) would suggest that it is perhaps only after seven years of formal schooling that a fundamental change in reasoning strategy becomes easier to effect among Africans. Inspection of the raw-score distributions for 4 educational levels (Figure 10) suggests, however, that the ability to handle conceptual problems at a more abstract-conceptual level and the ability to overcome a perceptual set in solving F.S.T. items is more generally characteristic of the working African who has completed his primary school education (i.e. who has passed as least Std VI).

Let us consider briefly the implications of the raw score distributions in Figure 10. Illiterates, and persons who have been to school for four years at most (i.e. whose qualifications are not higher than a Std II pass), adopt either a completely concrete approach to the test (evidenced by the high concentration of scores within the range 0 to 6), or a more successful perceptually-guided approach, which enables them to score as high as 30. However, not a single subject in the illiterate to Std II group scored 31 or higher, which suggests that the ability to discover a conceptually-based solution to out-of-phase problems did not manifest itself in any strength.

The Standard III to IV group (i.e. 5 to 6 years schooling) on the other hand, yielded a far more equitable spread of scores across the raw-score continuum with less pronounced clustering at the lower end of the scale. As many as 8% of this group scored a total of 31 or higher (though the highest observed score was only 33). This would indicate that at least 8% of this group answered at least one item within the 31 to 40 range correctly, though it is doubtful from the results of the factor analysis whether conceptual reasoning was used to obtain the correct solution.

A major change in the shape of the frequency distribution occurs for the standard V and VI group (i.e. 7 to 8 years of schooling), with a pronounced clustering of scores around the 28 mark, the modal score being 30. However, only 11% of this group attained total scores of 31 and higher. Finally, the high-school educated group (Form I through to Senior Certificate) yielded a platykurtic spread of scores across the raw score range 24 to 40, with 47% of the group scoring 31 and higher.

It would appear then that formal schooling at, or beyond the level of Form I equips the average African worker in secondary industry with the potential for solving conceptual reasoning problems in a more flexible and less concretistic manner.

1.9. Conclusions and Recommendations

The three hypotheses advanced in the introduction to this report have received a fair measure of substantiation in the present pilot study.

The first hypothesis stated that there should be two distinct difficulty levels underlying performance on the advanced F.S.T., corresponding respectively with the in-phase and the out-of-phase items. The data suggested rather that three distinct levels of item difficulty characterise performance on the new test. As already submitted, the three difficulty levels might well prove to be of considerable use to industrial test-users, particularly if it could be established that they bear strong empirical relationships with job-demands in the three traditional skill grades that are used to classify industrial jobs. It could be speculated, for instance that a raw score of at least 31 would be required before a recruit be assigned to skilled work, while a raw score of at least 21 might be necessary for semi-skilled work. On the basis of this speculation, then, it would be well worth our while to retain items from all three difficulty levels in the revised, final version of the advanced F.S.T.

The second hypothesis stated that practice at the in-phase items would facilitate performance at the out-of-phase items. This hypothesis was partially supported in that positive transfer occurred in the case of the easier half of the out-of-phase items, but not in the case of the more difficult half. This finding was interpreted in the light of current views on the nature of interrule transfer, and lent support to the author's speculation that the manner in which the subjects tackled the easier out-of-phase items was more related to the manner in which the in-phase items were solved than to the strategy for solving the last 10 out-of-phase items. This finding, together with the results of factor-, item- and difficulty-level analyses suggested that the first 30 items in the test could all be solved through following a perceptually-guided strategy. Evidence for positive transfer also suggests that it would be inadvisable to re-test subjects who have been given one of the two existing versions of the F.S.T. on the new advanced version, at least if the time lag between test and retest is very short. On the other hand, though, the gain in score on retest might be very small, while practice appears to have no effect on performance at the last few out-of-phase items.

From a more theoretical point of view, support for the third hypothesis, viz. that there should be a difference in the test's factor structure between literates and illiterates, would suggest that the same items do not measure the same psychological construct for different populations. This would mean that as a purely research tool, the new advanced F.S.T. should not be used to measure the same ability in two widely differing educational groups as it is quite clear that in the one case (viz. literates) both 'conceptual' and 'perceptual' styles are tapped, while in the other group (viz. illiterates), a wide variety of 'perceptually-guided' strategies are brought to the fore. Factor analytic study of the item intercorrelations for illiterates and literates indicates that even though it is extremely difficult to pinpoint different perceptual approaches by means of this technique of analysis, it may be concluded that education has the effect of narrowing the range of idiosyncratic perceptual styles that the subject may employ in the solution of F.S.T. problems. A greater homogeneity in strategy appears to emerge as a function of higher education. It was beyond the scope of the present investigation to analyse more closely the perceptual elements involved in conceptual reasoning ability; the execution of this task would necessitate the formulation of a 'perceptual code' to account for difficulty factors, as well as detailed error analyses and further testing in individual sessions wherein the subject could be asked to verbalise his choice of strategy to the best of his ability. Nevertheless, on the basis of the data at hand, it is possible to surmise, however tentatively, that conceptual reasoning processes among illiterates assume a loosely structured form. This may mistakenly be interpreted as a 'global' and possibly undifferentiated approach to handling conceptual problems, but in actual fact could refer to the subject's tendency to 'borrow', almost at random, from the abilities he has already developed (e.g. perceptual analysis, pattern recognition, perceptual rhythm, etc.). Through schooling, his approach to reasoning becomes more structured, more predictable and less erratic. It is evident from the factor structure for literates that education leads to the differentiation of two distinct styles (viz. the perceptual and the conceptual) which are moderately correlated with one another and which together account for the major portion of variance on tests of conceptual reasoning ability. The first style, termed 'perceptual' seems to be used for the solution of all in-phase and easier out-of-phase items, while the second style (conceptual) is used for the remaining items. The factor analytic results for literates furthermore suggest that most subjects were able to change from the one strategy to the other when this was required of them after item 30.

Education, then, significantly alters the manner of approach to tasks calling for the utilisation of conceptual reasoning ability.

While it has been concluded that it would be inadmissable to administer the new extended F.S.T. to both literates and literates in a strictly research context in that it is quite clear that the same basic ability is not being tapped for both groups, it need not necessarily follow that for practical purposes persons of differing educational achievement should be given different forms of the test. If the new F.S.T. is looked upon more as a developmental scale tapping the growth of qualitatively different forms of reasoning style or approach, then there would appear to be no harm in giving the new test to a wide range of workers. An illiterate is not going to perform any better, relative to literates, if he were given an 'easier' or 'fairer' version of the F.S.T., for all this would achieve is a better distribution of scores within the first modal distribution at the bottom end of the present scale. The hard fact would still remain that he cannot cope with items of greater complexity, which is a fact with which his employer is most likely to be concerned.

Therefore, for all practical purposes, the extended test could be administered to illiterates and literates alike. For purely research purposes, it would be more advisable to eliminate illiterates from samples that are given the extended version, and to administer to them the present 'mines' version rather.

An immediate practical drawback of the existing 40-item advanced F.S.T. is its length. It takes approximately one-and-a-half hours to test 25 candidates, compared with the estimated 35 to 40 minutes to test a similar number on the existing 18-item version. It is therefore strongly recommended that a shorter extended version be drawn up, and that in shortening the test, most of the items that would be dropped should come from the in-phase half of the test. It is recommended too, that in revising the advanced version, the present practice of writing items 'in parallel' should be abandoned in order to allow for as wide a range of conceptual complexity as possible within each of the three difficulty levels. Grant's original intention in writing parallel items was simply to show that the manipulation of colour, shape and size had a negligible effect on test performance from the one parallel version to the next. The need to demonstrate this point no longer exists. It is suggested therefore, that in drawing up the final version of the advanced F.S.T., the existing test should be shortened to 30 items at the most. Ten of these items should be 'in-phase', 10 'out-of-phase, level I' and 10 'out-of-phase, level II'.

Finally, it is also recommended that the transition from one item difficulty level to the next be eased. While it is not advocated that a practice item be inserted demonstrating the 'key' to the solution of the 'abstract'-loaded items, the author sees no harm in substituting for the fourth practice item the <u>easiest</u> type of out-of-phase item that can be generated.

The second half of this report will describe the analysis of data collected on 422 rural and urban factory workers, using a 30-item form of the advanced F.S.T.

PART TWO

PRELIMINARY STANDARDIZATION ON AN URBAN AND A RURAL GROUP

2.1. Description of the Revised 30-Item Test

Following recommendations made in the first part of this report, a shortened version of the advanced F.S.T. was drawn up for use during the second stage of investigation. The codes upon which each of the 30 items are based are reported in Table 13. It will be noticed that parallel items have not been written with the result that each item has been generated according to a unique permutation of the conceptual code. Thus, although the revised form of the test has fewer items than the preliminary form, the variation in conceptual complexity from the one item to the next is now considerably wider. The difficulty range for the two forms of the advanced F.S.T. is identical however.

Whilst drawing up the revised form of the extended F.S.T., the opportunity was taken to improve on the quality of some of the out-of-phase items. The first 10 items are no different to the first 20 items in the preliminary 40-item form (cf. Table 1). These items represent the first level of item difficulty and are all in-phase in principle. Items 11 to 15 are conceptually as complex as items 21 to 30 in the preliminary version. Items 16 to 20 are entirely new additions, though they should still fall under the second level of difficulty together with items 11 to 15. Being more complex than items 11 to 15, they were added in an attempt to ease the transition from a perceptually-orientated to a conceptually-orientated frame of mind. Similarly, items 21, 22, 24 and 25 were also added in order to ease transition. They are about the simplest kind of item at the third difficulty level that the author could devise, and unfortunately were all four absent from the preliminary version. Items 21 to 30 represent the level of difficulty expressed by items 31 to 40 in the 40-item version.

2.2 Method

2.2.1. Sample

A sample consisting of 422 male African workers was drawn from two industrial establishments in the Transvaal : 243 from a fertiliser-manufacturing plant in a rural region of the province, and 179 from an industrial packaging factory on the East Rand. Sampling at both firms was not strictly random for in both cases the author requested that as many high-school

TABLE 13

ITEM CODES FOR THE REVISED 30-ITEM ADVANCED F.S.T.

ITEM	CODE
1	I a^1b^1 0 II a^n III a^n
2	I a^2b^2 1 II a^2b^2 III a^n
3	I a^1b^2 1 II a^1b^2 III a^n
4	I a^2b^2 2 II a^1b^1 III a^n
5	I a^2b^1 1 II a^1b^2 III a^n
6	I $a^1b^1c^1$ 1 II $a^1b^1c^1$ III a^n
7	I a^2b^1 1 II a^1b^2 1 III a^1b^2 1
8	I a^1b^2 1 II $a^1b^1c^1$ 1 III a^1b^2
9	I a^1b^2 1 II $a^1b^1c^1$ 1 III a^2b^1 1
10	I a^1b^3 1 II a^1b^1 2 III a^1b^3 2
11	I a^1b^1 $1\frac{1}{2}$ II a^1b^2 III a^n
12	I a^1b^1 $1\frac{1}{2}$ II a^2b^1 III a^n
13	I a^1b^1 $1\frac{1}{2}$ II $a^1b^1c^1$ III a^n
14	I a^1b^1 1 II a^1b^2 $1\frac{1}{2}$ III a^1b^2 $1\frac{1}{2}$
15	I a^1b^1 1 II a^1b^1 $1\frac{1}{2}$ III a^2b^1 $1\frac{1}{2}$
16	I a^1b^1 1 II a^1b^2 $1\frac{1}{2}$ III a^2b^1 $1\frac{1}{2}$
17	I a^1b^1 1 II a^1b^1 $1\frac{1}{2}$ III $a^1b^1c^1$ $1\frac{1}{2}$
18	I a^1b^1 1 II a^1b^2 $1\frac{1}{2}$ III $a^1b^1c^1$ $1\frac{1}{2}$
19	I a^1b^1 1 II a^2b^1 $1\frac{1}{2}$ III $a^1b^1c^1$ $1\frac{1}{2}$
20	I a^1b^1 1 II $a^1b^1c^1$ $1\frac{1}{2}$ III $a^1b^1c^1$ $1\frac{1}{2}$
21	I a^1b^2 $1\frac{1}{3}$ II a^2b^2 III a^n
22	I a^2b^1 $1\frac{1}{3}$ II a^2b^2 III a^n
23	I a^2b^2 $1\frac{1}{3}$ II $a^1b^1c^1$ III a^n
24	I a^1b^2 $1\frac{1}{3}$ II a^1b^3 III a^n
25	I a^2b^1 $1\frac{1}{3}$ II a^1b^3 III a^n
26	I a^2b^1 $1\frac{1}{3}$ II a^3b^1 III a^n
27	I a^1b^2 $1\frac{2}{3}$ II $a^2b^1c^1$ III a^n
28	I a^1b^2 $1\frac{1}{3}$ II $a^1b^1c^2$ III a^n
29	I a^1b^1 2 II a^1b^2 $1\frac{1}{2}$ III a^2b^2 $1\frac{1}{3}$
30	I a^1b^1 2 II a^2b^1 $1\frac{1}{2}$ III a^1b^3 $1\frac{1}{3}$

educated workers as possible be drawn for the testing sessions. Subjects in the educational range 8 years and under were selected at random however. The sample is therefore not to be regarded as representative of the factory populations concerned.

The age range of the sample was 18 to 67 (mean age 29,90 years) while schooling extended from no education through to Matric (i.e. 0 to 13 years of formal schooling), with a mean of 6,26 years. Fifty-five percent of the sample had passed Standard IV (6 years of schooling) compared with 50% in the pilot study. The sample was ethnically heterogeneous, particularly in the case of urban subjects, though the rural sub-group was composed of Pedis and Shangaans for the most part, both of whom are indigenous to the area.

Tables 14, 15 and 16 present descriptions of the urban and rural subsamples in terms of the three principal biographical measures available (age, education and ethnic affiliation).

2.2.2. Procedure

Groups of 12 subjects were tested at a time. Instructions were delivered verbally by an African test administrator and were given in Sepedi to the rural sample and in either Zulu or Sepedi to the urban sample. The standard procedure for administering the test as described in the manual (Grant and Mauer, 1969)[59] was followed with one major exception : a new practice item 4 was devised corresponding in rank difficulty to item 11 of the revised 30-item FST (see Table 13 for code-identification). It was thought that the insertion of a fundamentally out-of-phase item in the practice series might assist in making the raw score distribution a little more platykurtic than at present. It was recommended by the African test administrator[1] that the 'new' practice item should feature three variations in one of the characteristics as this appears to be a major source of misunderstanding in solving some of the items.

Test performance was scored on the spot, use being made of a newly-devised fold-up scoring strip. As in the existing versions of the F.S.T.

[1] D.R. Mugudamane, personal communication.

credit was given only if both answer discs for an item were correct in respect of shape, colour and size. Errors were noted on the subject's score sheet.

2.3. Statistical Analysis and Results

Throughout the analysis the urban and the rural sub-samples will be treated as one sample despite the fact that rural subjects outnumbered their urban equivalents, proportion-wise, particularly at higher levels of education (see Table 15).

2.3.1. Item difficulty values

Figure 12 depicts the trend in the difficulty values across the 30 items. The graph describes the proportion of subjects achieving the correct solution for each test item. The correlation between the observed and the expected rankings of items in terms of difficulty, using Spearman's formula, was found to be 0,90 (cf. the coefficient of 0,95 that was obtained across the 40 items in the pilot study).

Figure 12 also compares the difficulty curves across the 30 items with the curve that was obtained across the 20 item-pairs in the pilot study. One immediate point of difference between the two curves is that the distinction between in-phase and the easier type of out-of-phase item is not as evident in the 30-item version as it was in the 40-item version.

2.3.2. Intercorrelations between F.S.T. score, age and education

Performance on the 30-item F.S.T. correlated 0,66 with education and -0,44 with age. Comparative coefficients for the 40-item extended version were 0,52 and -0,32 respectively (see Table 3 in the first part of this report).

Age and education correlated with each other to the extent of -0,50 (-0,26 for the pilot study sample).

Coefficients were established following Pearson's product-moment technique.

2.3.3. Descriptive statistics

Table 17 presents the means, standard deviations, coefficients of

TABLE 14

AGE DISTRIBUTIONS FOR RURAL AND URBAN SUB-SAMPLES

Age Group	RURAL		URBAN		COMBINED	
	N	%	N	%	N	%
16 20	10	4,12	30	16,76	40	9,48
21-25	78	32,10	69	38,55	147	34,83
26-30	52	21,40	25	13,97	77	18,25
31-35	43	17,70	13	7,26	56	13,27
36-40	25	10,29	14	7,82	39	9,24
41-45	18	7,41	4	2,23	22	5,21
46-50	7	2,88	16	8,94	23	5,45
51-55	9	3,70	6	3,35	15	3,55
56-60	0	-	2	1,12	2	0,47
61-65	0	-	0		0	
66-70	1	0,41	0	-	1	0,24
TOTAL	243	100,01	179	100,00	422	99,99

TABLE 15

EDUCATION DISTRIBUTIONS FOR RURAL AND URBAN SUB-SAMPLES

Education	RURAL		URBAN		COMBINED	
	N	%	N	%	N	%
0 years	54	22,22	26	14,53	80	18,96
Sub A	0	-	1	0,56	1	0,24
Sub B	1	0,41	0	-	1	0,24
Std. I	15	6,17	6	3,35	21	4,98
Std. II	15	6,17	9	5,03	24	5,69
Std. III	15	6,17	17	9,50	32	7,58
Std. IV	11	4,53	19	10,61	30	7,11
Std. V	13	5,35	22	12,29	35	8,29
Std. VI	26	10,70	36	20,11	62	14,69
Form I	22	9,05	5	2,79	27	6,40
Form II	47	19,34	20	11,17	67	15,88
J.C	15	6,17	14	7,82	29	6,87
Form IV	2	0,82	1	0,56	3	0,71
Matric	7	2,88	3	1,68	10	2,37
TOTAL	243	99,98	179	100,00	422	100,01

TABLE 16

ETHNIC AFFILIATION OF RURAL AND URBAN SUB-SAMPLES

Ethnic Group	RURAL		URBAN		COMBINED	
	N	%	N	%	N	%
Zulu	3	1,23	46	25,70	49	11,61
Swazi	2	0,82	25	13,97	27	6,40
Xhosa	0	-	22	12,97	22	5,21
Shangaan	86	35,39	4	2,23	90	21,33
Pedi	147	60,49	33	18,44	180	42,33
S. Sotho	0	-	15	8,38	15	3,55
Tswana	0	-	20	11,17	20	4,74
Venda	5	2,06	2	1,12	7	1,66
Ndebele	0	-	12	6,70	12	2,84
TOTAL	243	99,99	179	100,00	422	99,99

skewness and kurtosis and observed variable ranges for the F S.T., age and education.

TABLE 17

MEANS, STANDARD DEVIATIONS, SKEWNESS, KURTOSIS AND OBSERVED VARIABLE RANGES

Variable	Mean	S.D.	Sk.	Kt.	Observed range	
					Max.	Min.
1. F S.T. 30-item	13,56	8,24	-0,34	-1,23	30,00	0,00
2. Age	29,90	9,57	1,05	0,41	67,00	18,00
3. Education	6,26	3,82	-0,42	-0,97	13,00	0,00

The F.S.T. raw score frequency distribution is presented in Figure 13. The distribution of raw scores on the 30-item F S.T is once again bi-modal. The reliability of the new scale was calculated to be 0,95 (Kuder-Richardson 20), which is comparable to the reliability of 0,97 obtained for the 40-item version.

FIGURE 12

ITEM DIFFICULTY VALUES

(COMPARISON OF PILOT AND MAIN STUDIES)

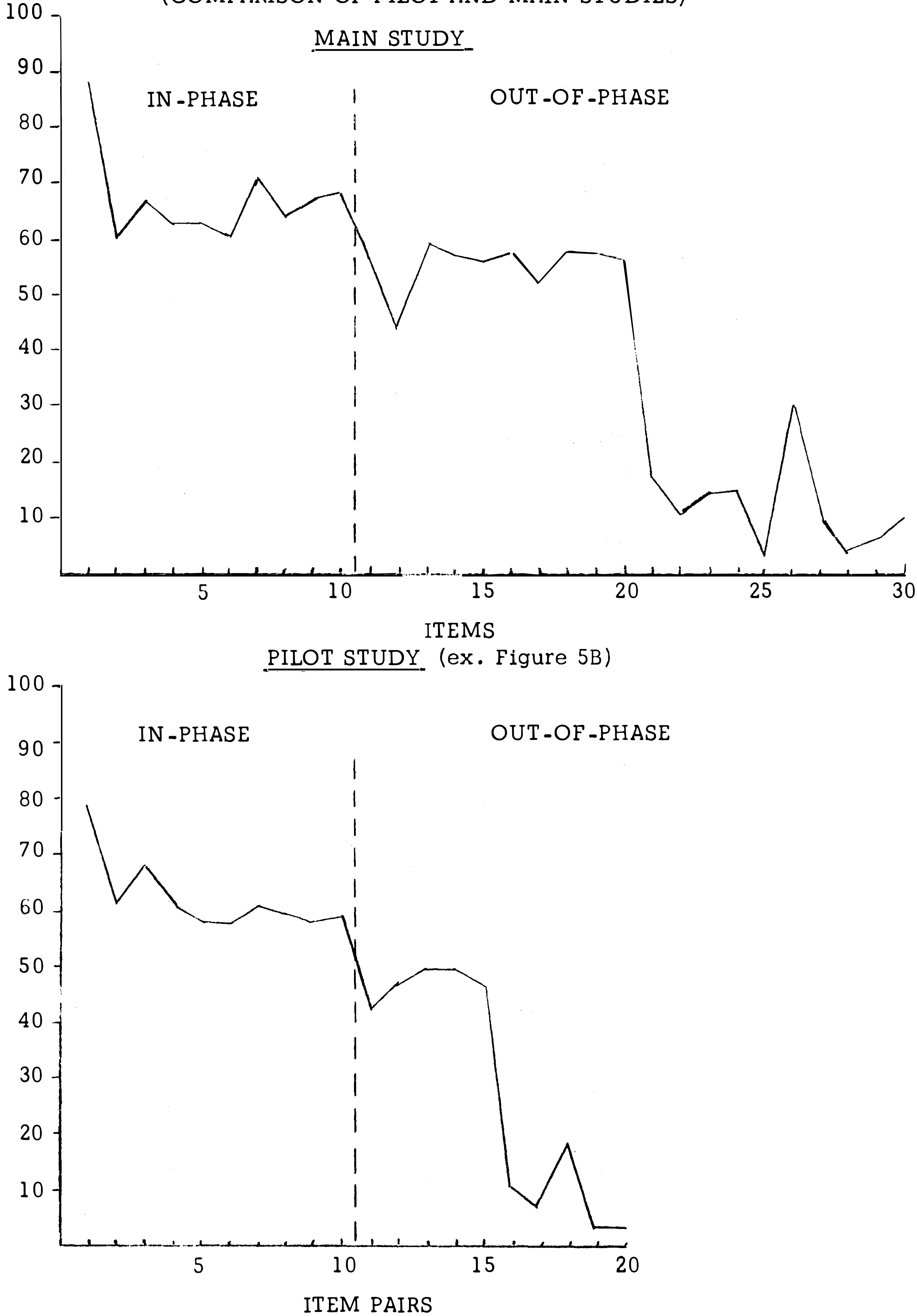
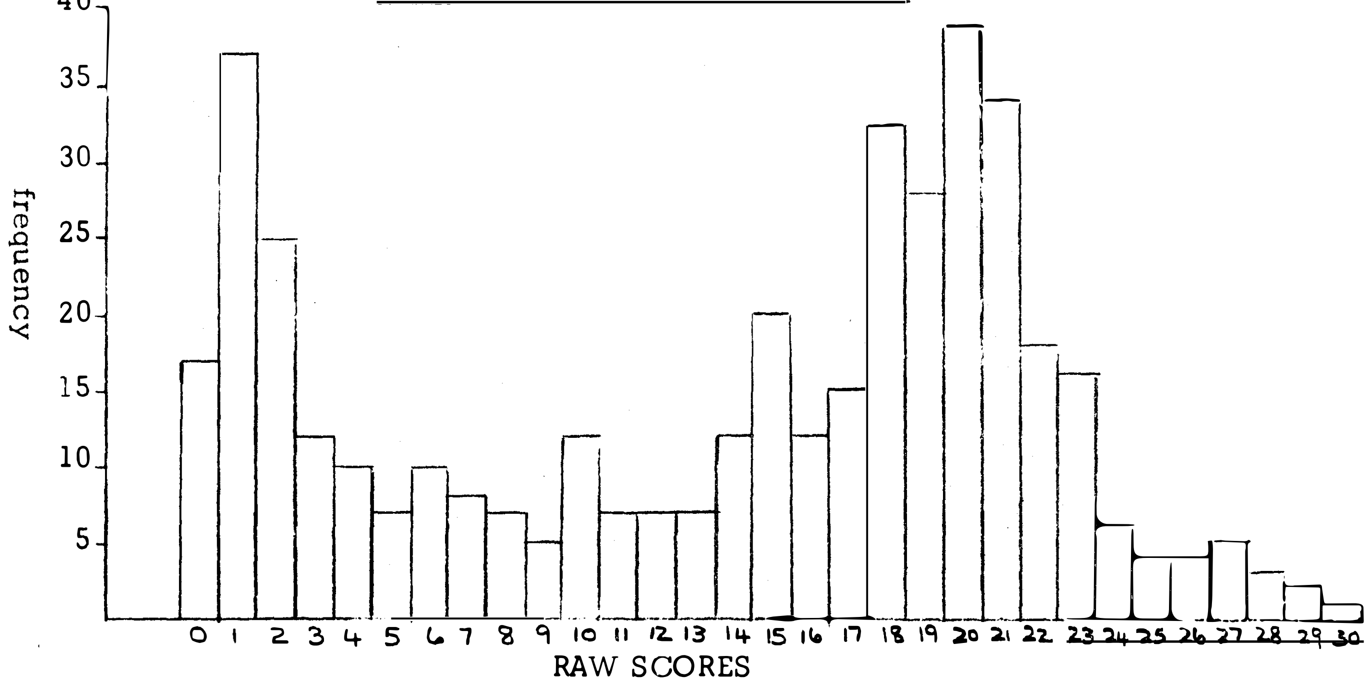


FIGURE 13

Distribution of F.S.T. raw scores



2.3.4. Item analysis

Table 18 presents the item parameters for each of the 30 items. Included in the table are the proportion of individuals responding to each item correctly (p_j), item standard deviations (s_j), point-biserial item-total correlations (r_x) and Gulliksen indices of item reliability ($r_{xj}s_j$).

No iteration was carried out owing to the observation that the items which yielded the poorest Gulliksen indices were all of the type that required the subject to adopt a conceptual approach.

2.3.5. Multiple factor analysis

Table 19 presents the intercorrelations among the 30 items. The intercorrelation matrix was subjected to a Jöreskog (1963)[60] factor analysis. Kaiser's (1970)[61] Measure of Sampling Adequacy was reported at 0,959 which indicates that the data are amenable to factor analysis. Kaiser's "Little Jiffy 2" criterion, which serves as a rule-of-thumb means of deciding upon the optimum number of factors to extract from the unrotated matrix, suggested the presence of three factors (four factors were suggested during analysis of the 40-item version). Accordingly, both 2- and 3-factor solutions were obtained. In both cases the factor matrices were rotated to simple structure following the direct quartimin technique. Table 20 presents the rotated factor matrices, together with

TABLE 18

ITEM ANALYSIS INFORMATION (BEFORE ITERATION)

ITEM	P_j	S_j	$r_{xj}s_j$	r_x
1	0,882	0,323	0,143	0,442
2	0,602	0,490	0,246	0,503
3	0,656	0,475	0,334	0,703
4	0,633	0,482	0,385	0,799
5	0,633	0,482	0,372	0,772
6	0,614	0,487	0,375	0,769
7	0,711	0,453	0,346	0,762
8	0,640	0,480	0,376	0,784
9	0,673	0,469	0,377	0,803
10	0,685	0,465	0,358	0,771
11	0,573	0,495	0,360	0,728
12	0,455	0,498	0,341	0,686
13	0,604	0,489	0,383	0,784
14	0,585	0,493	0,388	0,787
15	0,562	0,496	0,337	0,679
16	0,585	0,493	0,387	0,785
17	0,517	0,500	0,383	0,766
18	0,576	0,494	0,373	0,755
19	0,583	0,493	0,399	0,809
20	0,564	0,496	0,380	0,767
21	0,171	0,376	0,164	0,436
22	0,118	0,323	0,107	0,331
23	0,145	0,352	0,149	0,423
24	0,152	0,359	0,134	0,373
25	0,028	0,166	0,042	0,250
26	0,310	0,463	0,222	0,480
27	0,102	0,303	0,103	0,341
28	0,040	0,197	0,060	0,305
29	0,059	0,236	0,083	0,353
30	0,104	0,306	0,120	0,392

factor intercorrelations and estimates of item communalities.

2.3.6. F S.T. performance at different educational levels

In view of the exceptionally high correlation that was noted between performance on both the experimental 40-item version of the F.S.T. and the present, revised 30-item version, it was decided that the total sample should be divided into smaller groups on the basis of education for purposes of further statistical analysis.

TABLE 19

ITEM INTERCORRELATION MATRIX

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.00														
2	0.18	1.00													
3	0.40	0.43	1.00												
4	0.34	0.42	0.62	1.00											
5	0.39	0.37	0.59	0.63	1.00										
6	0.31	0.41	0.53	0.62	0.65	1.00									
7	0.40	0.30	0.56	0.62	0.65	0.62	1.00								
8	0.41	0.38	0.60	0.65	0.68	0.60	0.66	1.00							
9	0.40	0.36	0.55	0.66	0.69	0.70	0.67	0.69	1.00						
10	0.38	0.37	0.56	0.63	0.67	0.59	0.66	0.65	0.70	1.00					
11	0.25	0.32	0.48	0.58	0.54	0.54	0.52	0.58	0.57	0.61	1.00				
12	0.23	0.35	0.46	0.54	0.48	0.51	0.47	0.51	0.53	0.49	0.52	1.00			
13	0.33	0.37	0.54	0.64	0.61	0.57	0.56	0.60	0.65	0.65	0.61	0.61	1.00		
14	0.35	0.35	0.49	0.67	0.59	0.62	0.62	0.60	0.62	0.63	0.60	0.54	0.65	1.00	
15	0.25	0.31	0.43	0.52	0.56	0.53	0.51	0.52	0.52	0.48	0.44	0.50	0.52	0.52	1.00
16	0.32	0.37	0.57	0.63	0.57	0.59	0.63	0.61	0.64	0.58	0.60	0.53	0.64	0.60	0.58
17	0.26	0.35	0.50	0.65	0.55	0.57	0.57	0.54	0.60	0.55	0.60	0.48	0.60	0.64	0.52
18	0.28	0.32	0.48	0.62	0.57	0.56	0.53	0.61	0.60	0.54	0.56	0.54	0.63	0.61	0.56
19	0.30	0.38	0.52	0.66	0.57	0.62	0.63	0.58	0.63	0.58	0.59	0.56	0.62	0.64	0.55
20	0.30	0.29	0.51	0.60	0.56	0.59	0.56	0.58	0.59	0.58	0.56	0.49	0.64	0.61	0.55
21	0.13	0.12	0.28	0.25	0.24	0.23	0.23	0.27	0.25	0.25	0.21	0.23	0.26	0.29	0.27
22	0.11	0.15	0.19	0.19	0.20	0.20	0.20	0.17	0.21	0.20	0.20	0.15	0.15	0.22	0.16
23	0.11	0.11	0.18	0.20	0.24	0.28	0.25	0.21	0.26	0.25	0.30	0.26	0.25	0.25	0.24
24	0.13	0.11	0.19	0.21	0.19	0.24	0.21	0.19	0.18	0.17	0.20	0.21	0.21	0.22	0.20
25	0.06	0.08	0.09	0.10	0.07	0.14	0.11	0.13	0.12	0.09	0.12	0.13	0.08	0.12	0.12
26	0.18	0.23	0.24	0.32	0.31	0.30	0.30	0.32	0.30	0.32	0.31	0.27	0.30	0.36	0.23
27	0.12	0.16	0.19	0.21	0.18	0.19	0.16	0.22	0.18	0.16	0.21	0.20	0.19	0.19	0.14
28	0.08	0.14	0.15	0.13	0.13	0.16	0.13	0.13	0.14	0.14	0.13	0.18	0.12	0.15	0.11
29	0.09	0.16	0.14	0.17	0.15	0.20	0.16	0.17	0.15	0.15	0.18	0.17	0.16	0.21	0.16
30	0.10	0.17	0.20	0.23	0.20	0.19	0.22	0.22	0.22	0.18	0.15	0.22	0.23	0.21	0.18
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

(Table continued)

TABLE 19 (Cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
16	1.00														
17	0.64	1.00													
18	0.60	0.64	1.00												
19	0.70	0.70	0.66	1.00											
20	0.66	0.67	0.66	0.73	1.00										
21	0.31	0.31	0.29	0.29	0.31	1.00									
22	0.17	0.18	0.18	0.19	0.17	0.32	1.00								
23	0.28	0.25	0.23	0.32	0.29	0.24	0.14	1.00							
24	0.18	0.22	0.12	0.24	0.21	0.28	0.19	0.41	1.00						
25	0.14	0.14	0.12	0.12	0.12	0.26	0.29	0.29	0.21	1.00					
26	0.25	0.27	0.30	0.33	0.29	0.27	0.23	0.28	0.33	0.16	1.00				
27	0.16	0.20	0.16	0.19	0.12	0.28	0.19	0.28	0.34	0.23	0.30	1.00			
28	0.17	0.17	0.13	0.15	0.13	0.26	0.34	0.33	0.28	0.62	0.28	0.25	1.00		
29	0.17	0.20	0.17	0.17	0.18	0.39	0.28	0.35	0.34	0.38	0.27	0.41	0.46	1.00	
30	0.22	0.17	0.21	0.26	0.17	0.30	0.28	0.41	0.37	0.36	0.34	0.30	0.48	0.57	1.00
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

TABLE 20

ROTATED FACTOR MATRICES : 2- AND 3- FACTOR SOLUTIONS

2-factor solution

Item	FACTOR		h^2
	I	II	
1	0,44	-0,02	0,19
2	0,44	0,06	0,22
3	0,69	0,00	0,48
4	0,82	-0,02	0,65
5	0,80	-0,04	0,61
6	0,76	0,02	0,59
7	0,78	-0,02	0,60
8	0,80	-0,02	0,63
9	0,84	-0,03	0,68
10	0,80	-0,04	0,62
11	0,72	0,01	0,53
12	0,64	0,07	0,44
13	0,80	-0,03	0,63
14	0,78	0,02	0,62
15	0,66	0,01	0,45
16	0,79	0,01	0,63
17	0,76	0,03	0,59
18	0,77	-0,01	0,58
19	0,80	0,03	0,67
20	0,78	-0,00	0,61
21	0,17	0,42	0,26
22	0,07	0,40	0,19
23	0,12	0,49	0,30
24	0,06	0,49	0,27
25	-0,13	0,65	0,37
26	0,24	0,35	0,25
27	0,05	0,46	0,23
28	-0,13	0,74	0,49
29	-0,08	0,73	0,49
30	-0,02	0,70	0,48

$r_{I \times II} = 0,42$

3-factor solution

Item	FACTOR			h^2
	I	II	III	
1	0,40	0,01	0,26	0,25
2	0,43	0,07	0,09	0,23
3	0,67	0,03	0,18	0,51
4	0,81	-0,00	0,03	0,66
5	0,77	-0,01	0,24	0,67
6	0,74	0,04	0,09	0,60
7	0,76	0,01	0,17	0,63
8	0,77	0,01	0,20	0,67
9	0,81	-0,00	0,18	0,71
10	0,77	-0,01	0,20	0,66
11	0,72	0,02	-0,07	0,53
12	0,64	0,07	-0,08	0,45
13	0,80	-0,02	-0,04	0,63
14	0,78	0,03	-0,04	0,62
15	0,67	0,02	-0,09	0,46
16	0,80	0,01	-0,13	0,65
17	0,78	0,02	-0,24	0,65
18	0,78	-0,01	-0,18	0,62
19	0,83	0,02	-0,24	0,73
20	0,81	-0,01	-0,25	0,67
21	0,18	0,42	-0,09	0,27
22	0,07	0,41	0,06	0,20
23	0,13	0,49	-0,09	0,31
24	0,06	0,49	-0,01	0,27
25	-0,13	0,65	-0,02	0,38
26	0,23	0,36	0,05	0,26
27	0,04	0,47	0,05	0,24
28	-0,13	0,75	0,01	0,50
29	-0,08	0,73	-0,02	0,49
30	-0,03	0,71	0,02	0,49

$r_{I \times II} = 0,40$

$r_{I \times III} = 0,09$

$r_{II \times III} = 0,00$

A two-tier system of dividing the total group (N : 422) into smaller sub-groups was adopted. On the first level, the sample was divided into three more-or-less equally sized groups termed 'illiterates', 'semi-literates' and 'literates'. At the second level, each of these groups was in turn divided into two further sub-groups. The table below describes the N's in each sub-group.

Group	N	Sub-Group	N	%N
A Illiterates	127	A1 No schooling	80	19
		A2 Sub A, Sub B, Std I, Std II	47	11
B Semi-literates	159	B1 Std III and Std IV	62	15
		B2 Std V and Std VI	97	23
C Literates	136	C1 Form I and Form II	94	22
		C2 J.C., Form IV and Matric	42	10
	422		422	100

The distribution of raw scores on the 30-item F.S.T. for each of the six sub-groups A1 through to C2 is presented in Figure 14. The frequencies have been reported as percentages in order to facilitate comparison between the different groups. The mean score consistently increases from Group A1 (no education) through to C2 (J.C. to Matric). The standard deviation for each group similarly increases up to Group B1 (Standards III and IV) but then starts to decrease; the best spread of scores is obtained across the Standard III and IV group, but it is encouraging to note that the distribution for the best educated group (J.C. to Matric) is psychometrically satisfactory. In none of the sub-group distributions is bi-modality a pronounced feature. It is quite obvious that bi-modality occurs only when the sample is considered as a whole. One is here reminded of Biesheuvel's (1958)[62)] argument that bi-modality is indicative of a heterogeneous sample.

Figure 15 offers a comparative picture of the extent to which each of the three major educational groups, A, B and C (i.e. illiterates, semi-literates

FIGURE 14

PERCENTAGE FREQUENCY HISTOGRAMS SHOWING F.S.T. RAW-SCORE DISTRIBUTIONS AT DIFFERENT EDUCATIONAL LEVELS

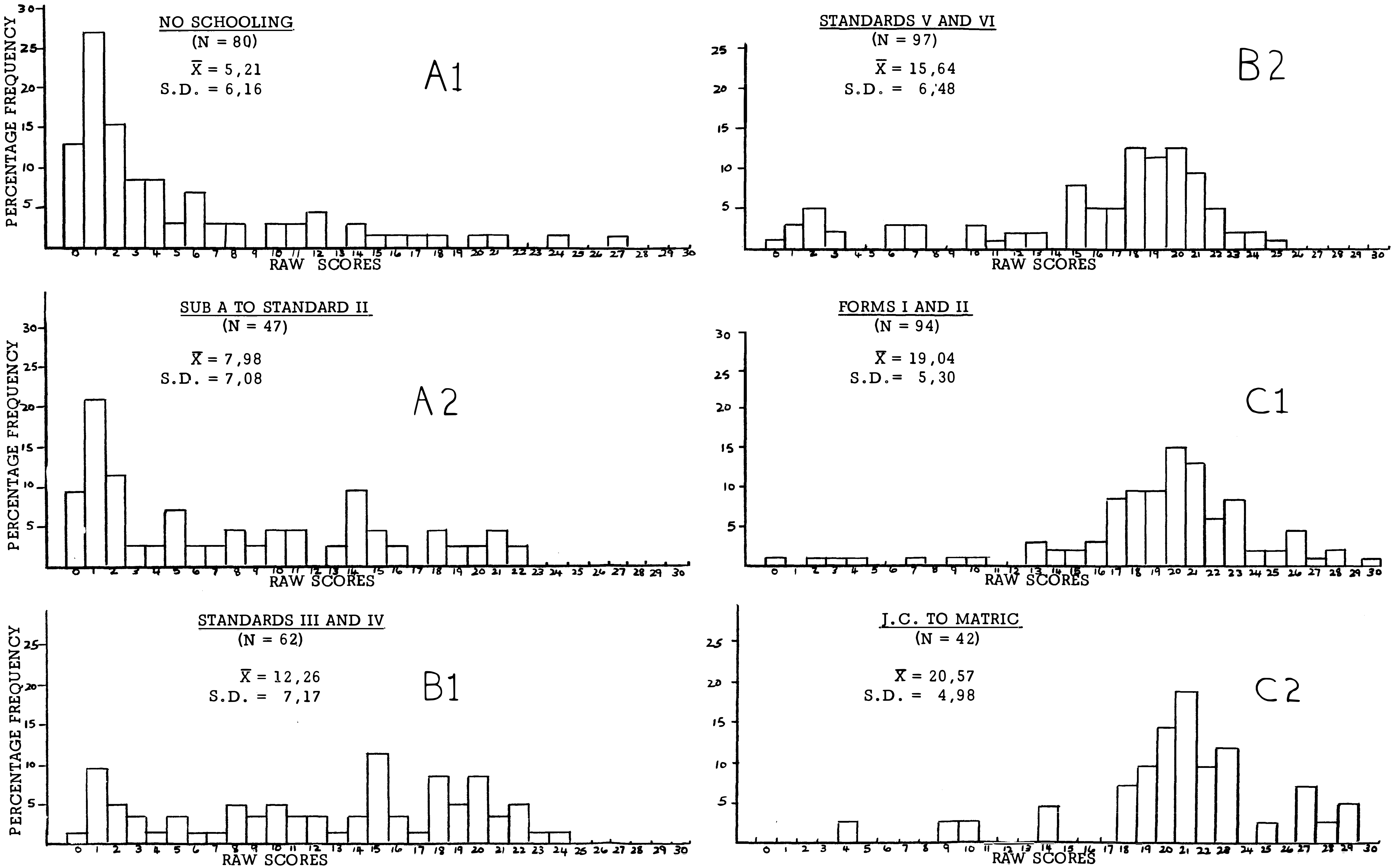
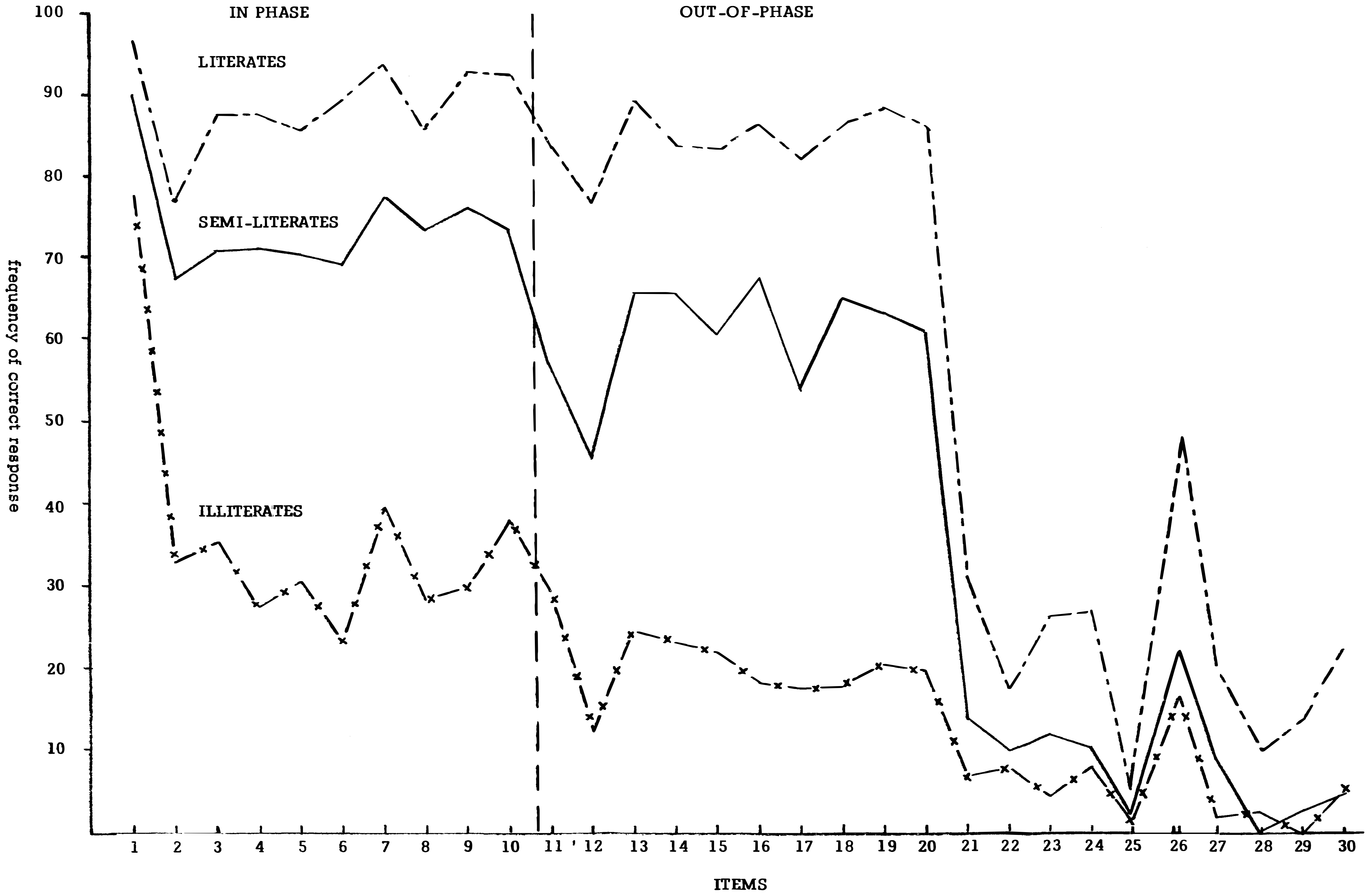


FIGURE 15

ITEM DIFFICULTY LEVELS :

COMPARISON OF CURVES FOR LITERATES, SEMILITERATES AND ILLITERATES



and literates) found difficulty in answering each item correctly. Two features of interest become apparent on inspection of this graph:

(i) the shape of the difficulty curve for all three groups is very similar, with two major difficulty levels being apparent in the case of semi-literates and literates,

(ii) differences in performance between the three groups are more marked at the first level of item difficulty than at the second.

These differences and similarities will be commented upon at length in the discussion.

One-run item-analyses were also performed for each of the three groups separately. The items parameters are to be found in Tables 21, 22 and 23. Estimates of reliability are high for all three groups : illiterates (0,93), semi-literates (0,92) and literates (0,89)

Finally, for each of the three educational groups illiterates, semi-literates and literates, factor analyses were performed. The items were intercorrelated for each group (Tables 24, 25 and 26) following Pearson's technique, and the resultant matrices were subjected to a Jöreskog factor analysis. Kaiser's (1970)[63)] Measure of Sampling Adequacy suggested that the data for illiterates and semi-literates were amenable to factor analysis, but that the data for literates was not acceptable. Nevertheless, factor analyses were performed on all three groups. Kaiser's "Little Jiffy 2" criterion suggested the presence of 5 factors underlying the performance of both illiterates and semi-literates, and 7 factors underlying literate performance As there was no seemingly logical reason why the above number of factors should be regarded as 'significant', the author proceeded to study a 3-factor solution for each group. These are reported in Table 27 together with factor intercorrelations and communalities.

TABLE 21

ITEM ANALYSIS INFORMATION ILLITERATES

ITEM	P_j	S_j	$r_{xj}s_j$	r_x
1	0,772	0,420	0,143	0,341
2	0,331	0,470	0,168	0,358
3	0,354	0,478	0,348	0,727
4	0,276	0,447	0,346	0,773
5	0,307	0,461	0,340	0,736
6	0,236	0,425	0,322	0,758
7	0,394	0,489	0,335	0,[illegible]
8	0,283	0,451	0,355	0,787
9	0,299	0,458	0,332	0,724
10	0,378	0,485	0,342	0,705
11	0,291	0,454	0,301	0,662
12	0,126	0,332	0,213	0,641
13	0,244	0,430	0,305	0,710
14	0,228	0,420	0,315	0,751
15	0,220	0,415	0,246	0,594
16	0,181	0,385	0,261	0,677
17	0,173	0,378	0,272	0,718
18	0,181	0,385	0,251	0,652
19	0,205	0,404	0,285	0,70[illegible]
20	0,197	0,398	0,290	0,729
21	0,071	0,257	0,102	0,399
22	0,079	0,269	0,136	0,503
23	0,047	0,212	0,094	0,442
24	0,079	0,269	0,103	0,384
25	0,016	0,124	0,042	0,340
26	0,165	0,371	0,153	0,411
27	0,016	0,124	0,023	0,187
28	0,024	0,152	0,064	0,419
29	0,008	0,088	0,018	0,199
30	0,055	0,228	0,099	0,436

RELIABILITY (KR_{20}) = 0,934

TABLE 22

ITEM ANALYSIS INFORMATION SEMI-LITERATES

ITEM	P_j	S_j	$r_{xj}s_j$	r_x
1	0,899	0,301	0,155	0,515
2	0,673	0,469	0,164	0.349
3	0,711	0.453	0,273	0.602
4	0,711	0,453	0,340	0,750
5	0,704	0,456	0.332	0,728
6	0 679	0,467	0,307	0,658
7	0,774	0,419	0,304	0,725
8	0,730	0,444	0,323	0.727
9	0,755	0,430	0,329	0.765
10	0,730	0,444	0,327	0,735
11	0,572	0 495	0,336	0,678
12	0,453	0,498	0,292	0,587
13	0,654	0,476	0,360	0,757
14	0,654	0,476	0 352	0,740
15	0,604	0,489	0,288	0,588
16	0,673	0,469	0.326	0,694
17	0,535	0,499	0,337	0,675
18	0,648	0,478	0,321	0,673
19	0,629	0,483	0,369	0,763
20	0,610	0,488	0,340	0,698
21	0.138	0,345	0,126	0,364
22	0,101	0.301	0,075	0,248
23	0,119	0,324	0,102	0,314
24	0,107	0,309	0,084	0,273
25	0,019	0,136	0,020	0,147
26	0 277	0,447	0.186	0,417
27	0,088	0,283	0,058	0,204
28	This item has no variance			
29	0,031	0,175	0,038	0,216
30	0,044	0,205	0,050	0,243

RELIABILITY (KR_{20}) = 0,925

TABLE 23

ITEM ANALYSIS INFORMATION
LITERATES

ITEM	P_j	S_j	$r_{xj}s_j$	r_x
1	0,963	0,188	0,050	0,266
2	0,772	0,420	0,192	0,457
3	0,875	0,331	0,145	0,438
4	0,875	0,331	0,191	0,579
5	0,853	0,354	0,213	0,602
6	0,890	0,313	0,156	0,498
7	0,934	0,249	0,143	0,576
8	0,868	0,339	0,179	0,529
9	0,926	0,261	0,148	0,568
10	0,919	0,273	0,164	0,603
11	0,838	0,368	0,213	0,579
12	0,765	0,424	0,183	0,430
13	0,882	0,322	0,160	0,495
14	0,838	0,368	0,211	0,572
15	0,831	0,375	0,151	0,402
16	0,860	0,347	0,222	0,642
17	0,816	0,387	0,235	0,607
18	0,860	0,347	0,177	0,511
19	0,882	0,322	0,198	0,614
20	0,853	0,354	0,172	0,487
21	0,301	0,459	0,213	0,464
22	0,176	0,381	0,132	0,346
23	0,265	0,441	0,198	0,449
24	0,272	0,445	0,176	0,396
25	0,051	0,221	0,081	0,366
26	0,485	0,500	0,234	0,468
27	0,199	0,399	0,166	0,417
28	0,103	0,304	0,132	0,435
29	0,140	0,347	0,174	0,501
30	0,221	0,415	0,205	0,495

RELIABILITY (KR_{20}) = 0,887

TABLE 24

ITEM INTERCORRELATION MATRIX (ILLITERATES)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	0.06	1.00																
3	0.32	0.39	1.00															
4	0.21	0.35	0.65	1.00														
5	0.24	0.22	0.51	0.54	1.00													
6	0.21	0.36	0.56	0.57	0.59	1.00												
7	0.28	0.15	0.45	0.51	0.51	0.50	1.00											
8	0.26	0.15	0.56	0.63	0.60	0.47	0.53	1.00										
9	0.23	0.16	0.41	0.52	0.68	0.61	0.49	0.58	1.00									
10	0.31	0.14	0.44	0.50	0.61	0.48	0.54	0.63	0.55	1.00								
11	0.14	0.14	0.50	0.42	0.47	0.46	0.44	0.60	0.49	0.57	1.00							
12	0.04	0.19	0.41	0.46	0.36	0.40	0.37	0.55	0.43	0.29	0.49	1.00						
13	0.18	0.15	0.46	0.51	0.58	0.46	0.41	0.58	0.55	0.54	0.44	0.50	1.00					
14	0.21	0.26	0.46	0.59	0.49	0.67	0.52	0.53	0.50	0.62	0.52	0.47	0.56	1.00				
15	0.15	0.23	0.32	0.44	0.51	0.42	0.35	0.47	0.48	0.41	0.29	0.43	0.41	0.30	1.00			
16	0.16	0.19	0.51	0.49	0.44	0.56	0.50	0.52	0.45	0.35	0.46	0.44	0.49	0.43	0.34	1.00		
17	0.15	0.25	0.57	0.65	0.51	0.53	0.48	0.45	0.47	0.37	0.48	0.45	0.47	0.49	0.46	0.54	1.00	
18	0.16	0.10	0.46	0.49	0.53	0.41	0.33	0.61	0.45	0.35	0.46	0.62	0.49	0.43	0.49	0.36	0.49	1.00
19	0.14	0.39	0.48	0.60	0.42	0.54	0.51	0.50	0.39	0.33	0.45	0.57	0.44	0.51	0.48	0.52	0.64	0.52
20	0.22	0.20	0.46	0.54	0.53	0.52	0.45	0.57	0.45	0.47	0.42	0.47	0.59	0.53	0.50	0.54	0.56	0.54
21	[illegible]	0.07	0.31	0.24	0.22	0.28	0.28	0.30	0.15	0.29	0.09	0.17	0.20	0.29	0.22	0.27	0.28	0.11
22	0.16	0.17	0.33	0.28	0.31	0.46	0.36	0.27	0.38	0.31	0.26	0.33	0.24	0.40	0.13	0.32	0.25	0.32
23	0.12	0.08	0.22	0.28	0.17	0.23	0.20	0.35	0.18	0.29	0.27	0.25	0.22	0.32	0.24	0.18	0.29	0.28
24	0.09	0.04	0.27	0.28	0.12	0.25	0.24	0.21	0.19	0.19	0.26	0.33	0.24	0.26	0.20	0.24	0.41	0.17
25	0.07	0.05	0.17	0.21	0.05	0.23	0.16	0.20	0.19	0.16	0.06	0.14	0.22	0.23	0.09	0.27	0.11	0.10
26	0.14	0.05	0.20	0.20	0.16	0.25	0.21	0.28	0.31	0.31	0.32	0.21	0.24	0.36	0.17	0.18	0.13	0.12
27	0.07	-0.09	0.17	0.21	0.19	0.08	0.03	0.20	0.06	0.16	0.06	-0.05	0.08	0.08	-0.07	0.10	0.11	0.10
28	0.08	0.11	0.21	0.25	0.12	0.28	0.19	0.25	0.24	0.20	0.13	0.25	0.27	0.29	0.17	0.33	0.20	0.20
29	0.05	-0.06	0.12	0.14	0.13	0.16	0.11	0.14	0.14	0.11	-0.06	-0.03	0.16	0.16	-0.05	0.19	-0.04	-0.04
30	0.13	0.12	0.25	0.31	0.21	0.27	0.30	0.31	0.29	0.17	0.07	0.32	0.34	0.28	0.12	0.33	0.25	0.24
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

(Continued on Page 91)

TABLE 25

ITEM CORRELATION MATRIX (SEMI-LITERATES)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	0.17	1.00																
3	0.39	0.26	1.00															
4	0.34	0.24	0.51	1.00														
5	0.47	0.22	0.50	0.53	1.00													
6	0.26	0.21	0.36	0.48	0.50	1.00												
7	0.47	0.14	0.52	0.48	0.64	0.53	1.00											
8	0.50	0.24	0.49	0.49	0.63	0.49	0.65	1.00										
9	0.49	0.26	0.47	0.60	0.62	0.64	0.63	0.64	1.00									
10	0.36	0.21	0.52	0.55	0.60	0.49	0.62	0.55	0.67	1.00								
11	0.22	0.18	0.29	0.51	0.44	0.39	0.35	0.42	0.48	0.53	1.00							
12	0.26	0.26	0.36	0.39	0.31	0.35	0.34	0.35	0.40	0.35	0.48	1.00						
13	0.37	0.28	0.38	0.61	0.51	0.44	0.52	0.48	0.57	0.57	0.57	0.56	1.00					
14	0.37	0.11	0.35	0.53	0.51	0.41	0.49	0.51	0.51	0.48	0.52	0.42	0.58	1.00				
15	0.24	0.18	0.31	0.39	0.46	0.38	0.42	0.43	0.32	0.32	0.34	0.38	0.38	0.44	1.00			
16	0.35	0.26	0.41	0.53	0.43	0.41	0.49	0.48	0.51	0.51	0.48	0.42	0.54	0.45	0.48	1.00		
17	0.27	0.18	0.29	0.57	0.45	0.33	0.43	0.43	0.46	0.48	0.54	0.29	0.54	0.59	0.33	0.48	1.00	
18	0.28	0.16	0.26	0.55	0.47	0.37	0.42	0.47	0.44	0.44	0.45	0.35	0.49	0.57	0.34	0.47	0.53	1.00
19	0.35	0.16	0.37	0.57	0.50	0.53	0.52	0.44	0.56	0.56	0.49	0.41	0.56	0.59	0.34	0.55	0.56	0.58
20	0.29	0.07	0.37	0.51	0.47	0.42	0.46	0.44	0.44	0.50	0.48	0.29	0.48	0.53	0.43	0.51	0.55	0.57
21	0.13	0.01	0.22	0.22	0.18	0.16	0.13	0.20	0.19	0.16	0.20	0.15	0.21	0.25	0.25	0.28	0.23	0.30
22	0.11	0.10	0.17	0.12	0.13	0.14	0.13	0.11	0.19	0.16	0.16	0.07	0.11	0.20	0.19	0.10	0.10	0.16
23	0.06	0.01	0.11	0.11	0.21	0.25	0.20	0.09	0.21	0.18	0.28	0.13	0.19	0.15	0.10	0.17	0.15	0.11
24	0.12	0.02	0.13	0.13	0.15	0.19	0.19	0.16	0.10	0.07	0.13	0.09	0.21	0.21	0.16	0.07	0.08	0.06
25	0.05	-0.00	-0.01	-0.01	-0.01	0.10	0.08	0.08	0.08	-0.02	0.12	0.06	0.00	0.10	0.11	0.10	0.13	0.10
26	0.16	0.16	0.15	0.27	0.31	0.24	0.27	0.25	0.22	0.25	0.19	0.26	0.21	0.30	0.21	0.13	0.18	0.22
27	0.10	0.12	0.10	0.15	0.01	0.02	0.12	0.19	0.13	0.04	0.09	0.16	0.13	0.18	0.07	-0.02	0.07	0.04
29	0.06	0.13	0.04	0.11	0.04	0.12	0.10	0.11	0.02	0.11	0.08	0.05	0.06	0.13	0.15	0.05	0.10	0.13
30	0.07	0.15	0.14	0.14	0.07	0.15	0.12	0.13	0.12	0.13	0.06	0.11	0.16	0.09	0.11	0.08	0.08	0.16
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

(Continued on Page 91)

TABLE 26

ITEM CORRELATION MATRIX (LITERATES)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	0.08	1.00																
3	0.28	0.32	1.00															
4	0.28	0.32	0.26	1.00														
5	0.25	0.32	0.41	0.47	1.00													
6	0.18	0.26	0.15	0.29	0.52	1.00												
7	0.11	0.21	0.26	0.53	0.47	0.38	1.00											
8	0.27	0.36	0.38	0.44	0.45	0.35	0.42	1.00										
9	0.24	0.18	0.23	0.40	0.36	0.35	0.49	0.39	1.00									
10	0.23	0.48	0.30	0.46	0.49	0.33	0.46	0.36	0.54	1.00								
11	0.13	0.28	0.26	0.44	0.33	0.36	0.45	0.42	0.34	0.38	1.00							
12	0.08	0.19	0.16	0.37	0.36	0.25	0.20	0.19	0.24	0.41	0.13	1.00						
13	0.17	0.24	0.35	0.28	0.30	0.24	0.18	0.26	0.33	0.48	0.40	0.34	1.00					
14	0.23	0.28	0.20	0.56	0.33	0.36	0.53	0.30	0.41	0.46	0.40	0.27	0.34	1.00				
15	0.02	0.04	0.13	0.19	0.26	0.22	0.27	0.11	0.25	0.23	0.17	0.21	0.20	0.28	1.00			
16	0.15	0.13	0.36	0.36	0.37	0.2[illegible]	0.58	0.34	0.54	0.42	0.51	0.18	0.38	0.46	0.44	1.00		
17	0.01	0.19	0.22	0.34	0.29	0.44	0.41	0.26	0.45	0.35	0.41	0.23	0.30	0.41	0.34	0.52	1.00	
18	0.03	0.19	0.23	0.30	0.19	0.33	0.32	0.28	0.37	0.35	0.34	0.23	0.45	0.28	0.38	0.39	0.47	1.00
19	0.05	0.18	0.21	0.35	0.30	0.24	0.45	0.26	0.42	0.39	0.46	0.23	0.29	0.34	0.38	0.71	0.59	0.38
20	0.03	0.12	0.22	0.22	0.18	0.32	0.22	0.27	0.36	0.26	0.33	0.21	0.43	0.27	0.20	0.49	0.55	0.37
21	0.13	0.09	0.15	0.10	0.14	0.03	0.11	0.16	0.19	0.14	0.07	0.10	0.14	0.16	0.13	0.17	0.23	0.17
22	-0.01	0.11	0.0	0.12	0.14	-0.02	0.05	0.07	-0.02	0.07	0.10	0.03	-0.01	0.05	0.05	0.08	0.12	0.02
23	0.03	0.05	0.03	0.03	0.16	0.16	0.16	0.04	0.17	0.12	0.17	0.18	0.12	0.13	0.18	0.24	0.11	0.10
24	0.12	0.10	0.03	0.08	0.21	0.11	0.03	0.04	0.05	0.06	0.04	0.07	-0.03	0.04	0.06	0.06	0.08	-0.09
25	0.05	0.13	0.09	0.09	0.10	0.08	0.06	0.09	0.07	0.07	0.10	0.13	-0.02	0.01	0.11	0.09	0.11	0.09
26	0.11	0.25	0.10	0.23	0.20	0.11	0.20	0.21	0.10	0.18	0.19	0.02	0.17	0.19	-0.03	0.14	0.16	0.22
27	0.10	0.14	0.13	0.08	0.15	0.18	0.06	0.09	0.07	0.08	0.22	0.06	0.07	0.02	0.03	0.09	0.14	0.04
28	0.07	0.18	0.13	0.05	0.14	0.12	0.09	0.06	0.10	0.10	0.08	0.13	-0.03	0.08	0.02	0.14	0.16	0.07
29	0.08	0.17	0.09	0.09	0.11	0.14	0.11	0.09	0.11	0.04	0.18	0.12	0.08	0.18	0.07	0.10	0.19	0.10
30	0.01	0.12	0.09	0.15	0.17	0.02	0.14	0.16	0.15	0.09	0.09	0.09	0.08	0.14	0.10	0.16	0.02	0.11
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

(Continued on Page 91)

TABLE 24 (Cont.)

ILLITERATES

	19	20	21	22	23	24	25	26	27	28	29	30
19	1.00											
20	0.58	1.00										
21	0.16	0.33	1.00									
22	0.21	0.30	0.37	1.00								
23	0.25	0.26	0.23	0.35	1.00							
24	0.21	0.37	0.26	0.13	0.21	1.00						
25	0.09	0.10	0.46	0.43	0.57	0.20	1.00					
26	0.19	0.26	0.21	0.26	0.40	0.34	0.28	1.00				
27	-0.06	-0.06	0.21	0.20	0.57	-0.04	0.49	0.11	1.00			
28	0.18	0.18	0.36	0.53	0.70	0.15	0.81	0.35	0.40	1.00		
29	-0.05	-0.04	0.32	0.30	0.40	-0.03	0.70	0.20	0.70	0.57	1.00	
30	0.39	0.23	0.34	0.31	0.27	0.06	0.52	0.26	0.25	0.42	0.37	1.00

TABLE 25 (Cont.)

SEMI-LITERATES

	19	20	21	22	23	24	25	26	27	29	30
19	1.00										
20	0.67	1.00									
21	0.27	0.28	1.00								
22	0.13	0.10	0.29	1.00							
23	0.28	0.25	0.08	-0.06	1.00						
24	0.18	0.11	0.16	0.09	0.25	1.00					
25	0.11	0.11	0.21	0.11	0.23	0.10	1.00				
26	0.30	0.24	0.12	0.07	0.25	0.20	0.02	1.00			
27	0.10	0.02	0.07	-0.03	0.16	0.32	0.12	0.16	1.00		
29	0.14	0.14	0.24	0.18	0.04	0.29	0.24	0.21	0.07	1.00	
30	0.16	0.11	0.00	0.03	0.30	0.22	-0.03	0.28	0.15	0.31	1.00

TABLE 26 (Cont.)

LITERATES

	19	20	21	22	23	24	25	26	27	28	29	30
19	1.00											
20	0.56	1.00										
21	0.19	0.14	1.00									
22	0.17	0.08	0.28	1.00								
23	0.22	0.16	0.26	0.16	1.00							
24	0.12	0.02	0.28	0.24	0.49	1.00						
25	0.09	0.10	0.21	0.33	0.24	0.23	1.00					
26	0.17	0.07	0.29	0.28	0.15	0.33	0.17	1.00				
27	0.12	-0.00	0.36	0.30	0.24	0.36	0.22	0.37	1.00			
28	0.12	0.07	0.25	0.35	0.29	0.34	0.69	0.30	0.26	1.00		
29	0.08	0.11	0.43	0.31	0.43	0.37	0.39	0.25	0.49	0.49	1.00	
30	0.14	0.02	0.35	0.36	0.44	0.47	0.44	0.33	0.31	0.52	0.66	1.00

TABLE 27

ROTATED FACTOR MATRICES
(ILLITERATES, SEMI-LITERATES AND LITERATES)

ITEM	ILLITERATES				SEMI-LITERATES				LITERATES				ITEM
	FACTORS			h^2	FACTORS			h^2	FACTORS			h^2	
	I	II	III		I	II	III		I	II	III		
1	0,33	-0,02	-0,10	0,10	0,00	0,57	0,02	0,33	0,43	0,01	-0,14	0,15	1
2	0,24	0,03	0,21	0,13	0,02	0,27	0,07	0,10	0,54	0,09	-0,11	0,28	2
3	0,69	0,04	-0,01	0,49	0,03	0,62	0,02	0,42	0,40	0,02	0,10	0,22	3
4	0,74	0,07	0,00	0,59	0,54	0,31	-0,05	0,58	0,65	-0,03	0,10	0,48	4
5	0,89	-0,15	-0,23	0,65	0,20	0,66	-0,06	0,61	0,68	0,05	0,01	0,50	5
6	0,67	0,11	0,07	0,55	0,15	0,52	0,13	0,45	0,50	0,00	0,11	0,32	6
7	0,63	0,04	0,04	0,44	0,08	0,72	0,07	0,63	0,45	-0,02	0,35	0,47	7
8	0,80	0,04	-0,09	0,64	0,10	0,69	0,07	0,60	0,57	0,00	0,07	0,37	8
9	0,73	0,01	-0,05	0,52	0,18	0,71	-0,02	0,68	0,36	-0,01	0,40	0,43	9
10	0,77	-0,03	-0,20	0,54	0,31	0,56	-0,07	0,60	0,62	-0,06	0,18	0,51	10
11	0,70	-0,08	0,02	0,46	0,67	0,06	-0,02	0,49	0,33	0,03	0,38	0,40	11
12	0,47	0,13	0,34	0,49	0,28	0,19	0,07	0,30	0,38	0,04	0,08	0,19	12
13	0,66	0,08	0,03	0,50	0,56	0,27	-0,01	0,58	0,33	-0,07	0,31	0,30	13
14	0,66	0,13	0,06	0,54	0,62	0,15	0,06	0,56	0,47	-0,01	0,26	0,41	14
15	0,53	-0,01	0,19	0,37	0,33	0,22	0,12	0,30	0,00	0,03	0,47	0,23	15
16	0,53	0,18	0,12	0,45	0,55	0,24	-0,09	0,49	0,08	0,04	0,77	0,68	16
17	0,65	0,04	0,19	0,55	0,75	0,02	-0,09	0,54	0,08	0,06	0,67	0,52	17
18	0,63	0,01	0,12	0,46	0,71	0,03	-0,04	0,52	0,17	0,00	0,47	0,32	18
19	0,57	0,05	0,36	0,59	0,66	0,14	0,07	0,62	-0,03	0,07	0,79	0,63	19
20	0,64	0,02	0,25	0,57	0,71	0,05	0,01	0,55	-0,05	0,01	0,68	0,43	20
21	0,14	0,42	0,01	0,24	0,36	-0,09	0,17	0,16	0,01	0,45	0,12	0,24	21
22	0,20	0,47	0,06	0,35	0,11	0,08	0,10	0,05	-0,04	0,48	0,03	0,22	22
23	0,06	0,71	-0,07	0,55	0,10	0,03	0,39	0,20	-0,08	0,51	0,18	0,30	23
24	0,18	0,17	0,27	0,19	-0,06	0,06	0,55	0,30	0,03	0,58	-0,09	0,33	24
25	-0,19	0,95	-0,06	0,79	0,14	-0,14	0,28	0,10	-0,04	0,61	0,00	0,36	25
26	0,16	0,34	0,07	0,20	0,07	0,17	0,36	0,22	0,22	0,38	-0,03	0,23	26
27	0,11	0,50	-0,65	0,69	-0,09	0,09	0,39	0,15	0,08	0,51	-0,05	0,27	27
28	-0,14	0,94	0,08	0,79	....	....	....	....	-0,02	0,71	-0,01	0,49	28
29	-0,05	0,70	-0,48	0,71	0,06	-0,09	0,48	0,24	-0,01	0,76	-0,01	0,57	29
30	0,12	0,49	0,07	0,32	-0,07	0,08	0,46	0,22	0,01	0,77	-0,04	0,59	30

Illiterates	Semi-literates	Literates
Factor I x II: r = 0,42	Factor I x II: r = 0,63	Factor I x II: r = 0,25
Factor I x III: r = 0,27	Factor I x III: r = 0,36	Factor I x III: r = 0,49
Factor II x III: r = 0,00	Factor II x III: r = 0,23	Factor II x III: r = 0,18

2.4. Discussion

2.4.1. Item difficulty values

A comparison of the item difficulty values for the revised 30-item and the preliminary 40-item versions of the advanced F.S.T. is offered in Figure 12 (Page 75). The similarities between the shapes of the two curves far outweigh the differences, the most striking point of concurrence being the obvious and very abrupt increase in item difficulty value once the testee starts to attempt solutions to items demanding a conceptually-guided approach.

The reader may well be puzzled by the noticeable increase in easiness of one of the items in both versions about half-way through the conceptual-loaded range. This item was not 'misplaced' in terms of conceptual complexity, as might be suspected. Rather, in both versions, the patterning for colour for this particular item was such that testees who found difficulty in adopting a conceptual approach were able to isolate a recognizable perceptual patterning of the forms more readily than in the case of neighbouring items. It will be recalled that this particular item was singled out for consideration during discussion of the pilot study findings, wherein it was cited as a good example of the process of 'seeing the obvious and guessing the rest'. The role of colour in influencing the difficulty values of items seems to be paramount in accounting for other anomalies in the ranking of items. Where colour is held constant from the one form to the next, that item is noticeably more difficult than its neighbour, despite the underlying level of conceptual complexity prescribed by the code. In the 30-item revised version there were six items in which colour was held constant, viz. no's 2, 5, 12, 22, 25 and 28. Significantly, items 22, 25 and 28 account for most of the anomalies in the rank difficulty of items at the end of the test. Even at the easy end on the scale, item 2 proved to be considerably more difficult than either items 1 or 3. On the other hand, where size or shape were held constant from the one form to the next, the item proved to be easier than its neighbour, the most dramatic example of this being the above-cited item 26.

Turning now to the in-phase items, it can be seen that items in both the

30- and 40-item versions are of much the same difficulty, with the curve for the revised version being somewhat less regular and smooth than that for the preliminary version. A disturbing situation arises however in the case of the middle range of items (easier out-of-phase). In part I of this report, it was concluded that the in-phase and easier out-of-phase items were distinguishable from one another in terms of difficulty values. Inspection of the comparative graph would suggest however, that in the case of the 30-item version, this can no longer be claimed, for if a line of 'best fit' were to be drawn through the points on the graph for items 1 to 10, it is more than likely that this line, if extended, would deviate very little from the line of best fit drawn through the points for items 11 to 20. This would probably not have been the case in the pilot study. Item 12 is certainly the most difficult item in the 1 to 20 range, but this could be due mainly to colour constancy. Unlike in the pilot study graph, there appears to be no evidence of a gradual improvement in performance across the middle range of items, and hence, there can be no justification for supposing that the testees 'gradually discovered' a higher-order perceptually-guided rule as was concluded in the pilot study discussion. The conclusion that is to be drawn therefore, is that difficulty levels I and II which were claimed for the 40-item version have now merged into one level of difficulty only, cutting across the conceptually-defined in-phase/out-of-phase distinction.

It is felt that the disappearance of a distinction between in-phase and perceptually-loaded out-of-phase items in terms of difficulty values can be ascribed to (i) the higher mean educational achievement of the present sample over that of the pilot sample ($t = 1,81$; $p < 0,05$) and (ii) the insertion of the new practice item which was patterned on item 11 in conceptual complexity, and was thus out-of-phase in principle. If this be the case, then it would appear that the new practice item, which was designed mainly to encourage a more conceptual approach to reasoning, in fact facilitated performance on the wrong range of items, eliminating in the process the useful distinction between performance at in-phase and out-of-phase items.

Interestingly enough, however, the new practice item appears to have had no effect whatsoever on <u>illiterate</u> performance (see Figure 15, Page 83).

Item difficulty values for the illiterate group arrange themselves very neatly into the three difficulty levels that were observed in the pilot study analysis. In fact, for illiterates, the difference in difficulty values between items 10 and 11 is just as great as the difference between items 20 and 21. For literates on the other hand, there is little change in difficulty value between items 1 to 10 and 11 to 20, while semi-literate performance would appear to be more akin to that of literates than of illiterates.

Semi-literate performance approximates that of illiterates, when the conceptually-loaded items are considered, however. This is perhaps not easy to deduce from Figure 15 (Page 83) until the differences in performance between the three educational groups are expressed in terms of averages. Through averaging out the 'percentage correct' values for each group across all ten conceptually-loaded items, it becomes apparent that mean semi-literate performance (8,5% success rate) is closer to that of the mean illiterate success rate (5,5%) than that of the literate rate (22%). The comparatively low success rate for literates, across the abstract-conceptual range of items, relative to the high success rate for literates across the perceptually-loaded range of items (85%) is perhaps one of the most interesting features in the graph, and has profound implications for the utilisation of literate Africans in skilled jobs in industry. It would appear that the excellent performance of literates when the perceptually-loaded items are considered is suggestive of a well-developed ability to isolate relevant perceptual cues, to apply the same basic rule to situations in which this is feasible and successful, and to do so accurately. In other words, given the precise instructions (which the four practice items do), the average literate African worker can apply a rule with clerical efficiency. However, when a fundamental change in thinking and problem solving strategy is called for (which implies a certain measure of cognitive flexibility and intellectual initiative), only a small percentage of the literate African population can adapt to the new demands. This 'creaming off' process which the F.S.T. achieves even at the literate level, will possibly be the most significant contribution that the advanced F.S.T. will make to worker selection and placement in industry.

In summary, what the comparative graph of item difficulty values across three educational groups suggests is that:

(i) literates and semi-literates tackle the perceptually-loaded items with a good measure of 'clerical accuracy' (i.e. they are not as confused as illiterates between variations in colour, shape and size, and seem to work more consistently and accurately on a reasoning task in which application of the same basic (perceptual) rule leads to success.

(ii) illiterates perform at a below average level throughout the test, their performance being highly dependent on the gradual increases in item difficulty that, conceptually, are built into the F.S.T. Illiterates would appear to find difficulty in copying not only with abstract-conceptual out-of-phase items, but also with the perceptually-loaded out-of-phase ones.

(iii) semi-literates share to a certain extent the literate group's postulated 'clerical accuracy' skills, but they do not appear to be as 'intellectually flexible' as literates when changes in cognitive strategy are called for, being in this respect more like the illiterate group.

2.4.2. Item analysis and multiple factor analysis

As with the 40-item preliminary version, both the item-total correlations and the Gulliksen indices for the 20 perceptually-loaded items differed appreciably from the same item parameters for the conceptually-loaded items (see Table 18 Page 77). In the 40-item version, the average item-total correlation for items 1-20 (in-phase) was 0,795, while for items 21-30 (easier out-of-phase) it was 0,745, and for items 31-40 (more difficulty out-of-phase) 0,275. In the 30-item version the picture is somewhat different, largely due to the reduction in the number of in-phase items. Items 1-10 (in-phase) correlated 0,725 on average with the total test score, while items 11-20 (easier out-of-phase) correlated 0,760, and items 21-30 (more difficulty out-of-phase) to the extent of 0,385. It would seem therefore that there is a greater measure of internal consistency among all items in the revised 30-item version than there was in the preliminary 40-item one, attributable, as already said, to the removal of many in-phase items. It would seem too that it is now the middle range of items in the test (11-20) which correlate highest with the total test score, rather than the first range (items 1-20) in the preliminary version, which is more desirable from a psychometric point of view.

Iterations on the basis of Gulliksen indices were not carried out owing to the observation that it would be the conceptually-loaded items which would be rejected on successive runs.

Table 20 (Page 80) presents the rotated 2- and 3-factor matrices for the total sample These should be compared with the matrices in Table 7 (Page 32) for the pilot sample. Very little information over and above what was provided by item analysis and inspection of item difficulty levels is given in the factor matrices. In both the 2- and 3-factor solutions it is quite clear that items in the revised version load on either of two dimensions, viz. a perceptual or abstract-conceptual dimension. The two factors correlate to the extent of 0,42 in the 2-factor solution and 0,40 in the three factor solution. Factor III in the 3-factor solution defies interpretation, there being not a single substantial loading. It is interesting however, that the matrices are <u>not</u> strictly comparable to those obtained in the pilot study. In the pilot study, the 2-factor solution yielded in the case of the first factor a dimension much the same as factor I in the present study, viz. comprising all the in-phase and easier out-of-phase items. In the case of the second factor however, this comprised the easier out-of-phase items only. The last range of items did not load on either factor. The 3-factor solution in the pilot study corresponded more closely with the 3-factor solution in the present study, factor intercorrelations for dimensions I and II being 0,37 and 0,40 respectively. Even the third factor which proved difficult to interpret in the present study displayed the same manner of loading in the two studies with small, but negative, loadings around the easier out-of-phase level.

All that can be concluded from the factor analysis for the combined sample is that the easier out-of-phase items now form a less distinctive entity than they did in the first study. A certain measure of stability for the factor referenced by the last group of items is suggested however.

The relative factorial stability of F.S.T. performance suggests that it is now possible to conclude more firmly that two differing styles of approach appear to underlie performance at different stages in the test : one is probably perceptually-based relying heavily on skills of pattern-isolating, copying and verification as explained in Part One of this report while the other is probably conceptually-based, depending on skills of conceptual inference. It might be speculated that the two strategies share strong affinities with the two processes that Laroche (1956)[64)] isolated in accounting for African performance on the Raven's progressive matrices test; viz. "repetition" (which is obviously perceptually-based) and "eduction" (which implies conceptual processes).

2.4.3. Factor analyses at different educational levels

A comparison of the rotated factor matrices for illiterates, semi-literates and literates is offered in Table 27 (Page 92). Three factors were extracted in all three cases. It should be borne in mind that according to Kaiser's (1970)[65)] 'Measure of Sampling Adequacy' statistic, the literate data was not optimal for purposes of factor analysis. This is probably because too many factors were suggested by Kaiser's little Jiffy 2 criterion, the number of potential factors being of importance in determining the MSA. At this point, one might enquire why an intergroup factor analysis, which assumes the equality of the factor matrix across all groups, was not carried out. Use of the inter-group procedure was rejected simply because it was felt that any differences which would emerge on comparison of literates and illiterates would be more qualitative than quantitative, thereby rendering inter-group comparison rather meaningless.

The highest single interfactor correlation is that between factors 1 and 2 for semi-literates (r = 0,63). Together, these factors are referenced by the same items that load on dimension 1 for illiterates. Thus, for both illiterates and semi-literates, adoption of a fundamentally perceptually-guided style would account for performance on the in-phase and the easier out-of-phase items. In the case of illiterates, precisely the same strategy appears to be followed in solving all 20 items, while in the case of semi-literates, there appear to be two substantially intercorrelated styles operating, one for in-phase and the other for out-of-phase items. Illiterates possibly failed to perceive that once items became more complex and out-of-phase in nature it was still possibly to copy the correct solution. It is also likely that illiterates approached the first 20 items on an entirely different yet still fundamentally perceptual basis to that adopted by semi-literates. For instance, recalling the prior reference that was made to Reuning's (1972)[66)] suggestion that the pre-literate tends to memorise the individual quality combinations of each form in a series, plus their sequential patterning, it could be that illiterates turned very little to copying as was postulated by the author, and consequently found the test items becoming more and more difficult as the amount of information increased. In conclusion, then, the author would suggest that illiterates chose to "follow the culling rule" in coping with the first 20 items, whereas semi-literates probably looked for obvious patterns, and copied the relevant forms.

Literates approached items 1 to 20 on an entirely different basis. As in the case of semi-literates, two factors appear to account for performance on the in-phase and the easier out-of-phase items, yet these factors are not identical in terms of factor loadings to those for semi-literates. Factor 1 accounts for all the in-phase items, plus the first four out-of-phase items, while factor 3 is referenced by the remaining 6 out-of-phase items as well as 4 of the earlier ones (2 in-phase and 2 out-of-phase). This factor patterning is difficult to interpret, though it is informative to note that items 7, 9, 11 and 13 (which all load on factor 3) differ from their neighbours in one important respect, viz. that they are written with seven forms only, as opposed to eight or nine in the other items. Now given that the conceptual cycles for these four items are all three forms long, by the time the two answer forms are added by the testee there will be a completely closed series consisting of a cycle that is three times repeated. Any error the literate testee may have made in solving these items might be more readily identifiable in a closed series (and hence easier for him to rectify) than it would be in an incomplete series. A series cannot be closed if 8 or 9 forms have already been given, for after having added the two answer forms, the total number of forms in the series is not a multiple of three.

It is not suggested that factor 3 for literates is therefore a "closure" factor as such, for this would not account for the substantial loading of items 15 to 20 on this dimension. Possibly, literates may have approached the F.S.T. from the beginning in a more analytic and abstract-conceptual way than did either illiterates or semi-literates, but the closed series convinced then that it was not really necessary to carry on with such a plodding approach. This is mere speculation on the author's part, backed up by observations made during actual testing which suggested that the speed and accuracy with which literates worked through the easier out-of-phase items after item 15 could effectively rule out conceptual reasoning as the underlying process.

Turning now to the last 10 items (in which copying does not present a convenient shortcut to the correct solution), an interesting picture emerges. At all three levels of literacy items 21 to 30 tend to form their own factor as distinct from the factor(s) defined by the first 20 items. The factors for illiterates and literates in particular bear certain very strong similarities on the surface. Indeed, the only noticeable difference in factor patterning between these two groups is the loading for item 26 (reference to Figure 15, Page 83 shows that this item is substantially easier than its neighbours, the reason being perceptual and not conceptual in that colour evidently plays a powerful rôle in isolating an obvious pattern, enabling many non-abstract reasoners to achieve the correct solution simply through "seeing the obvious and guessing the rest"). Are we to conclude therefore, that the marked similarities between the factors formed by items 21 to 30 for the three groups suggests that at all levels of literacy individuals are capable of adopting a conceptually-guided style when this is required? The author hesitates to draw such a conclusion for two main reasons:

(i) The loading of these items on factor 3 for semi-literates is less clear-cut than in the case of illiterates and literates. Why would a conceptual factor be clearly evident for illiterates, become less evident for semi-literates, and then reappear for literates? This seems illogical.

(ii) If one were to order the factor loadings for the last ten items from lowest to highest, it would be found that the correlation between the ranked magnitude of an item's loading and its ranked difficulty is somewhat higher for illiterates (r = 0,83) than for literates (r = 0,63). Could this mean that factor 2 is little more than a difficulty factor for illiterates (the more difficult an item, the higher its loading on the "conceptual" factor) while for literates, it is less of a difficulty factor than an indication of a conceptual style of reasoning? It is difficult to answer this question, but the author feels that the interpretation that would be closest to the truth is one which considers that a conceptual style becomes progressively more apparent as the degree of literacy increases.

Assuming that most testees adopted a perceptually-guided approach to their solution of the first 20 items (which seems reasonable in the light of conclusions drawn elsewhere in this report), then it is interesting to note that the magnitude of the intercorrelation between the factor(s) on which items 1-20 load on the one hand, and items 21-30 on the other hand, decreases as a function of literacy. Thus: for illiterates, factor 1 (items 1-20) correlates 0,420 with factor 2 (items 21-30); for semi-literates, the averaged correlation of factors 1 and 2 (items 10-21 and 1-10) with factor 3 (items 23-30) is substantially lower at 0,295; while for literates, the averaged correlation of factors 1 and 3 (items 1-14 and 15-20) with factor 2 (items 21-30) is even lower, at 0,215.

This decrease in the intercorrelation between perceptual and non-perceptual (or reduced-perceptual) styles of reasoning as a function of literacy is in line with expectations in terms of the Burt-Garrett hypothesis concerning intellectual differentiation. Using their hypothesis, one could argue that with higher education, the perceptual and "conceptual" modes of conceptual reasoning share less and less in common. Also, among illiterates a certain amount of transfer from the perceptual style to that defined by the "abstract-loaded" items seems evident, which might suggest that the factor described by items 21-30 for this group is not really conceptually-based at all, bearing in mind our earlier assumptions that interrule transfer presupposes a common strategy (see Page 56). Because of the absolute difficulty values of items 21-30 for illiterates, it is highly likely that these items were tackled with a copying strategy that resulted either in erroneous stereotyped duplication solutions, or in solutions obtained through educated guessing which sometimes proved correct.

Transfer from the perceptual- to the conceptual-loaded range of items for semi-literates appears from the factor intercorrelations to be a lot less evident. This conclusion, together with the rather erratic manner of factor loadings for items 21-30 for semi-literates suggests possibly the beginnings of the emergence of the capacity to be flexible in the test situation. Finally, transfer from the perceptual approach to the hypothesized conceptual is even less evident for literates, while the factor loadings for this group are a lot neater, suggesting perhaps a more crystallised capacity to effect the necessary change in mental approach to the test problems which is less influenced by perceptual approaches than in the case of the other two groups. Of course, the lowered intercorrelations between the two styles of approach to the test items as a function of literacy might also be attributed to a purely statistical consideration, viz. truncation in the factor(s) referenced by items 1 to 20 through increasing easiness of these items as one moves away from illiteracy.

In conclusion, it appears likely that the capacity for reflective change from one mental approach to reasoning to another is more a feature of literate black performance than of illiterate performance, with semi-literates occupying an intermediate position. <u>It is still not possible to argue conclusively from the data at hand that this change in approach is from a perceptually-guided to a more conceptual one.</u> An attempt was made to answer this question by studying the specific errors made by testees on each item, but this had to be abandoned at an early stage as it proved to be extremely difficult to determine whether an error was classifiable as one of the copying variety or of incomplete or faulty eduction. Short of intercorrelating F.S.T. performance with that on other tests known to measure deductive/inductive reasoning and the broad perceptual abilities, the <u>only</u> approach to the problem that the author can suggest is to ask the testee to <u>verbalise</u> his thoughts during the testing session. Only then will it become clear whether copying or eductive strategies are being followed.

Future research using the advanced Form Series Test should therefore attempt to go beyond the analyses performed in the present study. It is urged that three avenues of exploration deserve immediate attention:

(i) the intercorrelation of F.S.T. performance with other suitable "marker" tests for the conceptual and perceptual array of abilities;

(ii) the conducting of individual testing sessions in an endeavour to observe more closely the individual's (as opposed to his group's) manner of solving F.S.T. items; and

(iii) cross-cultural testing programmes featuring African and non-African comparisons.

2.4.4. Some concluding comments and observations on conceptual reasoning ability among Africans

It would appear from the foregoing discussions concerning African performance on the advanced F.S.T. that several issues have emerged which were not anticipated before analysis. The most important of these relates to the qualitatively different styles that seem to operate in tackling different ranges of items. It would now seem that the previously clearcut conceptual distinction between in-phase and out-of-phase items is far more complex than it appeared in Grant's (1965[67), 1966[68)]) pioneering analyses using the original versions of the F.S.T. Evidence for Grant's speculation that Africans function at one of three levels of "abstraction" is no longer as simplistic as it seemed 10 years ago. It will be recalled that Grant concluded that subjects who scored within the first mode in the raw score distribution were operating at a "concrete" level of reasoning. However, the reduction in the number of in-phase items in the 30-item advanced F.S.T., together with the modification of those items that could be solved through "stereotype duplication" (a weakness in the original F.S.T. that was overcome in the present study by adding or subtracting a form from such series), has all but eliminated the first mode in the distribution of scores. The first mode is now suggestive of complete inability to do the test. Are we to conclude, therefore, that Grant's "concrete" level of abstraction has become little more than simple inability to obtain a single correct solution? The evidence for this conclusion now seems compelling. The performance of testees who score between 4 and 20 (Grant's "adaptable" level?) seems, very convincingly, to be dependent on perceptually-guided strategies : in the case of those who managed to score fairly well this was because of a process of copying and verification, while in the case of low-scorers, copying might have assumed the form of stereotype duplication. It is suggested that all testees who scored 20 and lower displayed a strong manifestation of the "concrete" approach to reasoning. "Conceptual" reasoning, though unconvincingly demonstrated, appears to be a feature of testees who score 21 or higher, with the added consideration that such testees are more likely to be literate.

We are left with two primary classes of thinkers: the "concrete" and the "conceptual", the distinction between the two being the ability to modify one's manner of reasoning when this is required. It would seem that the point in the test at which such a change in strategy becomes imperative is not necessarily immediately after items become out-of-phase, but rather at that point when copying and verification prove unwieldy. It is obvious therefore, that given the presence of only 2 items in the old F.S.T. (viz. items 17 and 18) where perceptual strategies could not work effectively, Grant's conclusion that an individual who tackled any out-of-phase item must be an "abstract" thinker is no longer tenable.

Bearing in mind that previous NIPR findings using the old F.S.T. were used as evidence for the separate existence of a "conceptual" reasoning factor in the structure of intellect of (largely illiterate and semi-literate) Africans (e.g. Grant, 1969[69]; Grant, 1972[70]; Kendall, 1971[71]) it now seems that the factor which emerged in these studies cannot continue to bear that label. "Perceptual" reasoning might be more appropriate as a psychological description for this factor, and would explain the high measure of interrelationship between the factors termed "conceptual reasoning" and "perceptual analysis". The old label "conceptual reasoning" betrays Grant's original expectation that the F.S.T. should measure an ability that is defined more in terms of how a Western test constructor would like the testee to solve the items, rather than in terms of how he actually solves them, and serves to underline the tremendous caution that needs to be adopted when interpreting African test performance in the light of factor analytic evidence. One begins to wonder whether the other factors that have been isolated by Grant and his associates and also by other cross-cultural workers throughout the world are little more than artefacts of what the Western investigator expects them to be rather than what they actually are!

In order to avoid conceptual ambiguity and imprecision, the F.S.T. should simply be termed a measure of "Reasoning Ability", which would recognise that reasoning and the processes of abstraction in general can operate at both a perceptual and at a conceptual level. In addition to reasoning ability, the F.S.T. appears to offer the test user some indication of an African worker's apparent inflexibility/rigidity in abandoning the perceptual approach to reasoning when this is necessary. Whether the reasons for such non-verbal rigidity are culture-specific, test-specific or due to temperatmental factors, this added feature of the test should prove to have profound implications for the selection and placement of Africans in jobs that demand the ability to discover and apply conceptual principles.

The author believes that there is a story parallel between the difficulty in effecting a change in reasoning strategy that was observed in this study and the difficulty experienced by African pupils in learning to master western scientific concepts. In order to illustrate this speculation, the major points that were raised by contributors to an international symposium on Science Education in Africa, convened in Malawi in 1968, will be summarized : The proceedings of the symposium are published in a book edited by Gilbert and Lovegrove (1972)[72)], wherein it is stated that the object of the conference was to "clarify the fundamental problems encountered by emerging countries in the construction and evaluation of new science curricula for primary and secondary schools". (p. 5).

The first section of the book deals with the pupils themselves, viewed from a psychosocial point of view, and it is from this section that several important observations have emerged which may have some bearing on the perceptual-conceptual issues which have come to the fore during analysis of data from the advanced F.S.T. Lovell, discussing the attainments and abilities of African children outlines very breifly the Piagetian framework for the development of operational thought. He begins by deducing that concrete operational thought should emerge in the African child in much the same way as it emerges among European children but that cultural factors (e.g. level of agricultural sophistication of the society in which he lives, or degree of contact with a western society) will facilitate its emergence. Once concrete operational thought is in evidence, children's thinking should be ready for the elaboration of basic mathematical and scientific concepts and "by the end of primary school or at the beginning of the secondary school period concrete operational thought should be much more flexible". (p. 21).

Lovell goes on to say that " it is in the growth of thinking skills that culture plays a great part, in the sense that it controls the extent to which open ended questions are posed, anticipatory thinking is encouraged and the individual is able to represent to himself a range of possibilities". (p. 23). Lovell seems very much to be describing a "conceptual" frame of mind, and his observation that concrete operational thought should be much more flexible by the end of primary school education tallies very neatly with our own findings relating to the F.S.T. (viz. the flexibility that enables a testee to discover what is believed to be a conceptually-guided principle for the solution of the more difficult test items). From this we should be able to deduce that many of our literate African subjects have passed through the stage of concrete operational thought, and are standing on the threshold of formal operational thinking. Why, then, the pronounced difficulty in effecting a basic change in reasoning process? Odhiambo suggests that a primary stumbling block to the elaboration of "abstract-type" thinking is the African's traditional conception of causality, which may be termed monistic (i.e. viewing nature as a whole) and which offers the possibilities of a synthetic as opposed to an analytic approach to science. Ideas of cause and effect are foreign to the traditional African's cosmology. It is not possible to observe nature by way of a series of hypotheses because such a problem does not arise in his conceptual framework. Odhiambo suggests that the manner in which science is taught in African schools, being so alien to the pupils' ordinary circumstances, is at the root of the frequently remarked upon tendency for Africans to learn abstract subjects by rote. As one pupil put it, he would not like to study science because it mean memorising what the teacher wrote on the black-board! This attitude towards learning suggests that the secret of thinking "in abstracto" has not been discovered. It is understandable that when problems cannot be solved in familiar ways (e.g. through perception and memory) the pupil should resort to rote learning. In the case of the F.S.T., the inability to appreciate that items can be solved through synthesising and then re-integrating the various conceptual components of a series may mean one of two things:

(i) that the testee is blinded by his previously successful (and perceptually-based) approach, implying insufficient flexibility in his style of thinking; or

(ii) conceptual ways of looking at problems are totally meaningless to him.

In much the same way that Odhiambo warns that it is catastrophic to teach science in a manner which is not linked to what the African already believes (in a monistic sense), it is similarly unreasonable to expect that the average literate African will respond to a change in intelligence test demands when the solution to the problem is not linked to what he believes to be the correct approach, again implying a certain degree of cognitive rigidity.

Hendrikz takes up the theme of "magic formulae" which is suggested by Odhiambo's observations relating to a monistic view of nature and speculates that failure to progress in science is the result of teaching that is grafted onto children whose early development of habits of enquiry and general cognitive skills have been stunted by restricted environmental opportunity.

"Only when what is termed the capacity for formal operational thought has developed can the abstractions of mathematics and science be really understood and used as the basis for prognosis, hypothesis formation and testing. It is fairly certain that many otherwise intelligent people do not attain complete mastery for thinking in abstractions; a major element, apart from the possession of a sufficiently good quality intellect, seems to be the sort of educational and environmental opportunity one has to learn to use such formal reasoning." (pp. 31-32).

In summary, what Lovell, Odhiambo and Hendrikz seem to be suggesting is that most Africans are unable to progress much beyond Piaget's stage of concrete operational thinking. Odhiambo blames this largely on the manner in which abstract topics are taught at school, where concepts that are not linked to what the child already believes are presented to him in a manner that is totally meaningless, and this by a teacher who in all probability does not himself fully understand his subject matter. Hendrikz sees inadequate environmental opportunity as the basis for the

Africans' difficulty in grasping and mastering scientific and hence abstract topics, though it is far from clear what she means by "inadequate environmental opportunity". Presumably, these could relate to the general African cultural milieu which still does not foster "habits of inquiry" and which still encourages a monistic view of cause and effect. Then again, she could be referring to the impoverishment of vernacular African languages in getting across basic abstract concepts to the African child, as well as the rational thought processes that go with them. Biesheuvel sees these problems as playing but a partial role in explaining the mediocre performance of the African Child in Science. He writes:

"Over-riding all else in importance, however, is the arousing of interest. Generally speaking, this is likely to be at a lower level of intensity and more restricted in range in African culture than elsewhere. The relative simplicity of the material environment, the particular relations that obtain between children and their elders, the frequent lack of education on the part of the latter, and the tradition-bound, authoritarian quality of most cultures, all these give little scope for and repress natural curiosity and spontaneity." (p. 54).

Thus, if one is justified in treating success in science-learning with ability to change one's way of thinking in a psychological test situation, it can be appreciated that the root cause of the inability on the part of many of the literates to effect a meaningful change in test strategy towards the end of the F.S.T., might well relate to such factors as lack of natural curiosity and inquisitiveness, and to the meaninglessness of alternative non-perceptual approaches to reasoning. This, despite the probability that most literate Africans are standing on the threshold of formal operational thinking.

It seems possible therefore, that th literates could effect a realistic (and presumably conceptually-based) change in their approach to F.S.T. items is largely sociocultural. The present study appears to have re-opened the whole issue of "concrete" versus "abstract" reasoning. It has also posed the question as to why so many literate Africans, let alone illiterates and semi-literates, appear to experience difficulty in adopting a basically conceptual as opposed to perceptual approach to reasoning problems. The author views these issues as of fundamental importance in an understanding of the processes involved in African reasoning ability. The hope is expressed that future research will lead to greater clarification of the complicated picture that has begun to unfold in this study.

CONCLUSION

Many exciting fields of interest have been opened up through findings which emerged quite unintentionally after analysis of the performance of African factory workers on the advanced F.S.T. The issues of concrete versus abstract thinking and of non-verbal rigidity have come to the fore; while the need to explore the reasoning processes that underlie performance on the new test through means other than factor analysis of item intercorrelations has become evident.

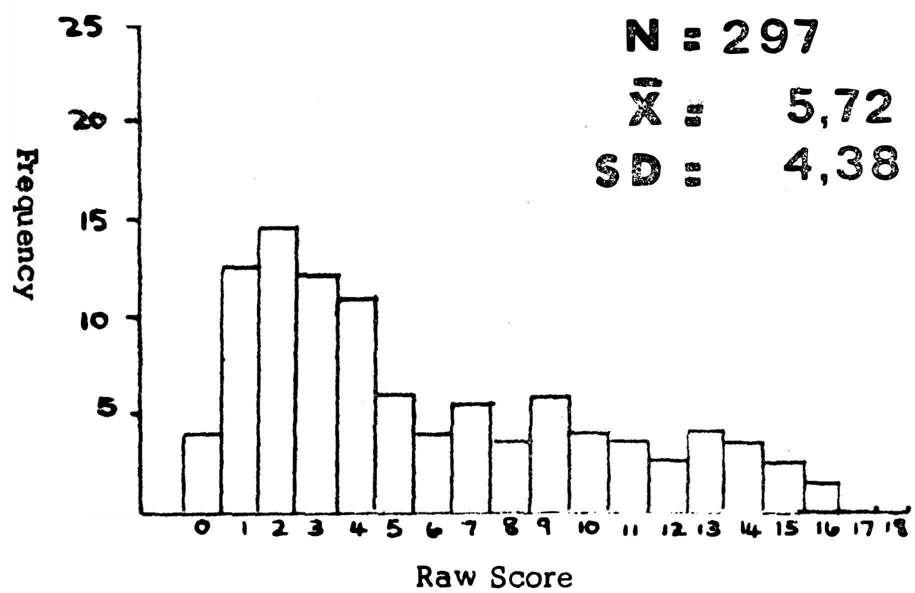
Nevertheless, the largely academic issues which formed the bulk of the discussion in both parts of this report should not be permitted to overshadow the basic conclusions which should be drawn in a report on the construction of a test. Thus, regardless of whether the testee tackles items in a fundamentally perceptual or fundamentally conceptual manner, the fact seems to stand that the principle aim of this study has been realised, viz. to re-develop the F.S.T. by means of increasing the difficulty range of the items in an endeavour to improve its reliability and discriminability when administered to literates.

Figures 17 to 21 offer a comparison of the raw score distributions at 5 educational levels. The graph at the top of each figure is taken from Blake's findings, reported in Figure 1 of this report, while the graph below it describes the distribution of scores that can be expected for the same educational population given the new 30-item test.

Largely because of the elimination of many in-phase items, F.S.T. variance for illiterates (see Figure 17) is slightly less favourable in terms of the new test than it was in terms of the existing 18-item version. Both versions are too difficult for illiterates, however. It is recommended that illiterate factory workers continue to be tested by means of either the

ILLITERATES

EXISTING VERSION



ADVANCED VERSION

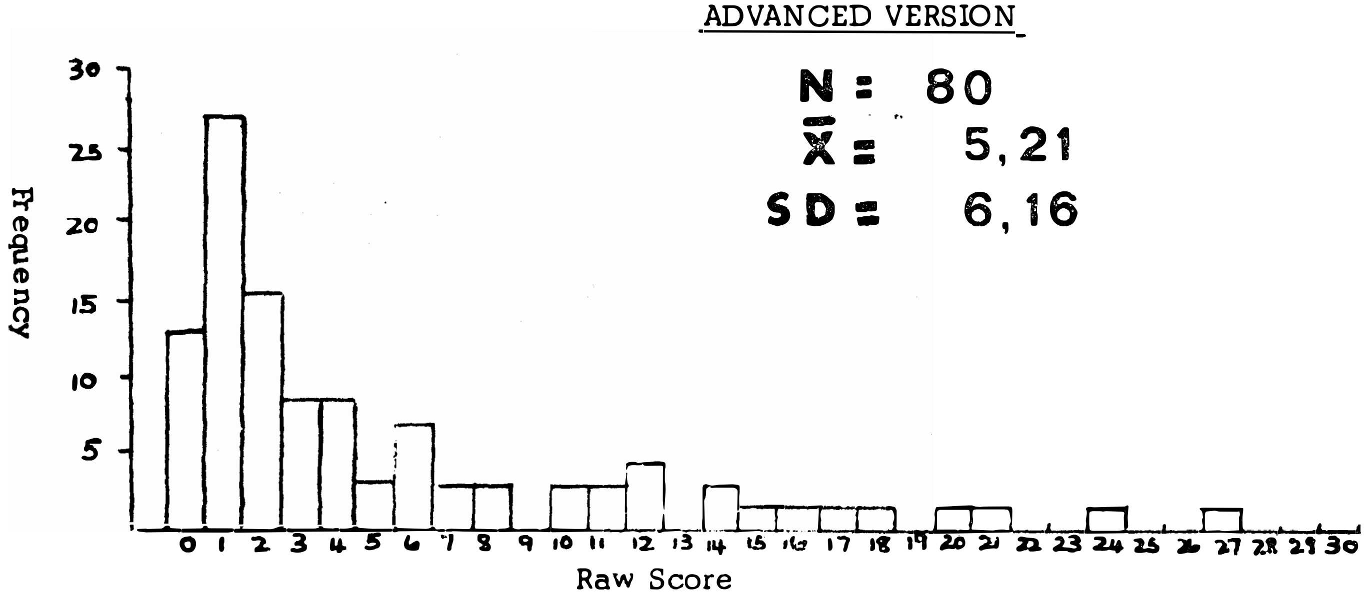


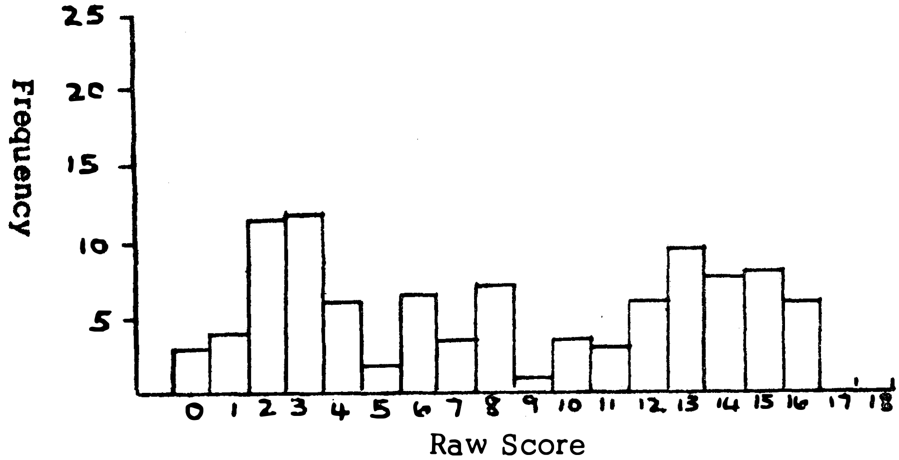
Figure 17

COMPARISON OF RAW-SCORE FREQUENCY DISTRIBUTIONS OBTAINED ON THE EXISTING AND ADVANCED VERSIONS

STANDARDS I & II

EXISTING VERSION

N = 172
$\bar{X}$ = 8,06
SD = 5,16



ADVANCED VERSION

N = 47
$\bar{X}$ = 7,98
SD = 7,01

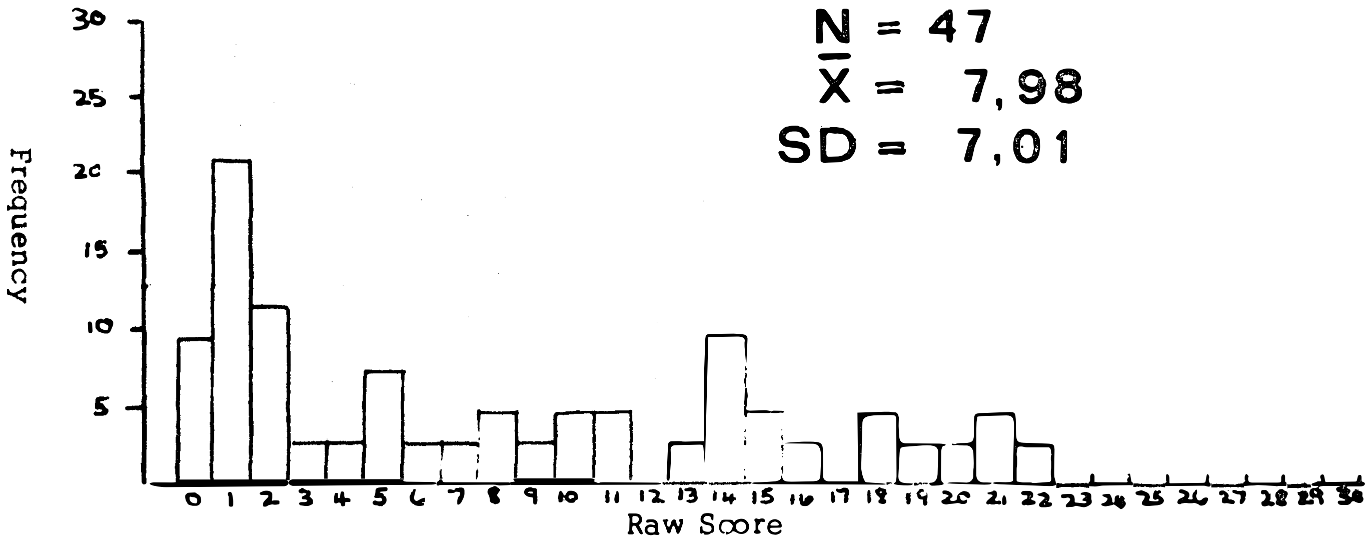
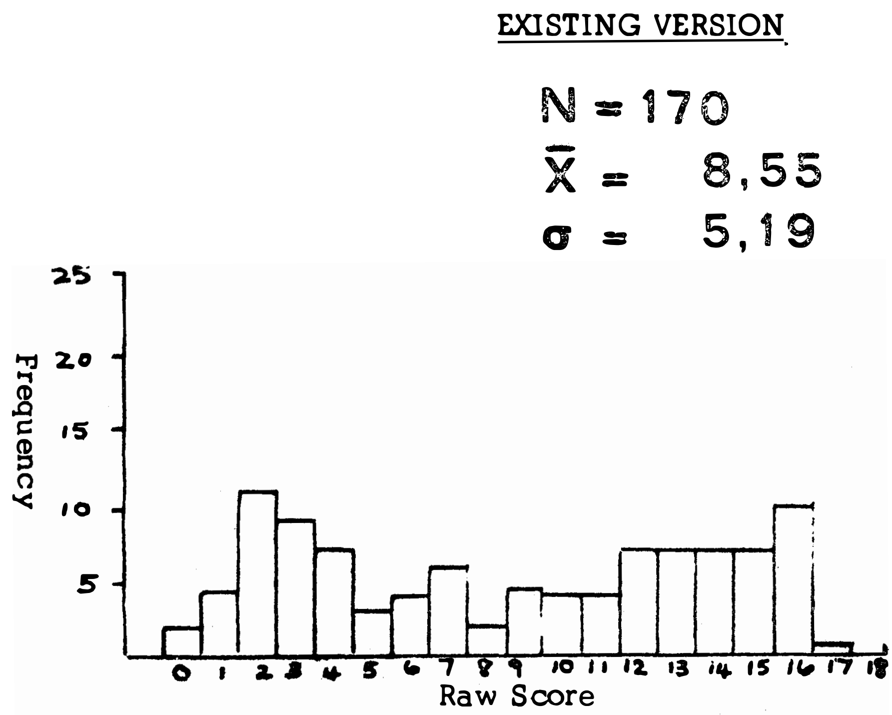


Figure 18

COMPARISON OF RAW-SCORE FREQUENCY DISTRIBUTIONS OBTAINED ON THE EXISTING AND ADVANCED VERSIONS

STANDARDS III & IV



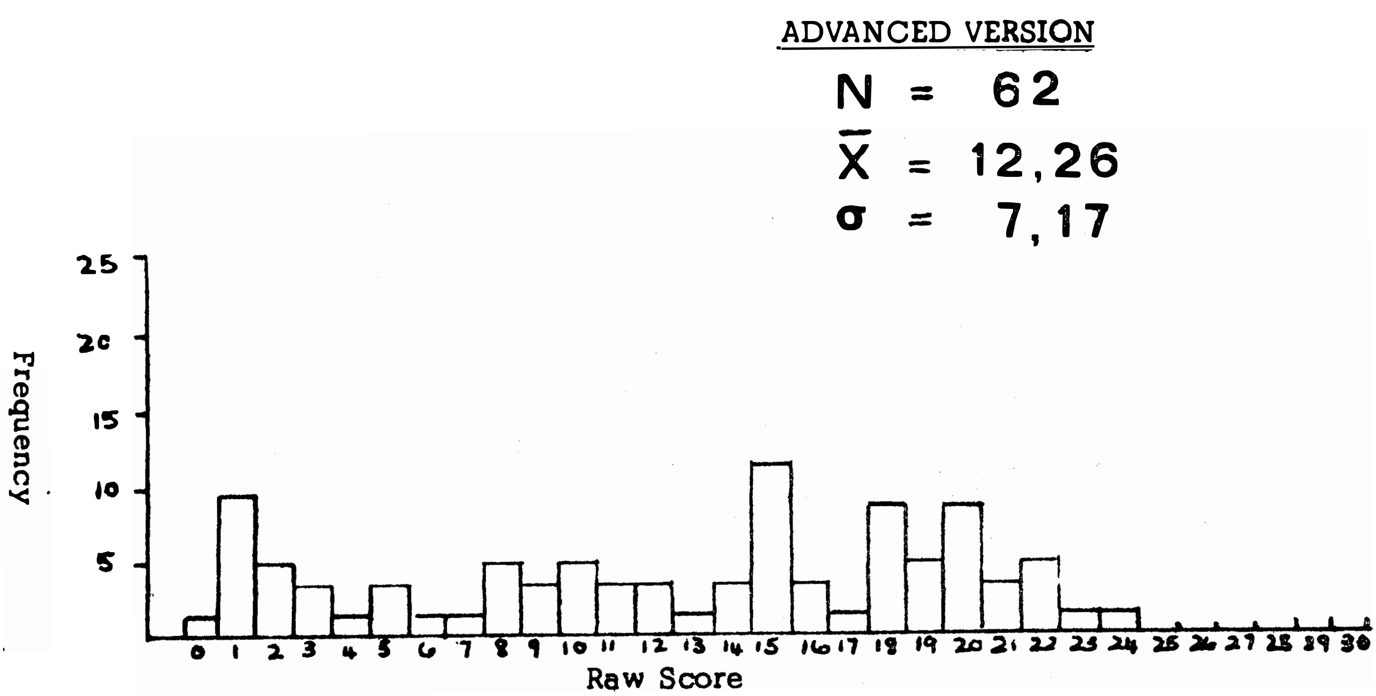


Figure 19

COMPARISON OF RAW-SCORE FREQUENCY DISTRIBUTIONS OBTAINED ON THE EXISTING AND ADVANCED VERSIONS

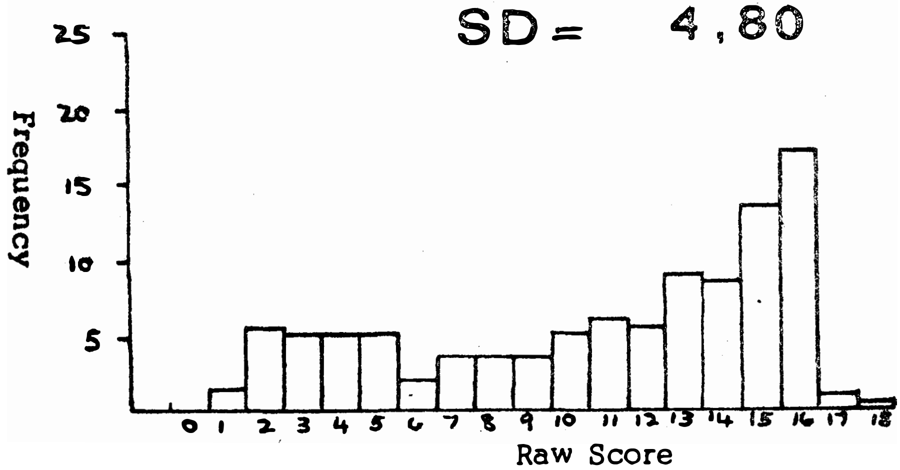
STANDARDS V & VI

EXISTING VERSION

$N = 272$

$\bar{X} = 10{,}82$

$SD = 4{,}80$



ADVANCED VERSION

$N = 97$

$\bar{X} = 15{,}64$

$SD = 6{,}48$

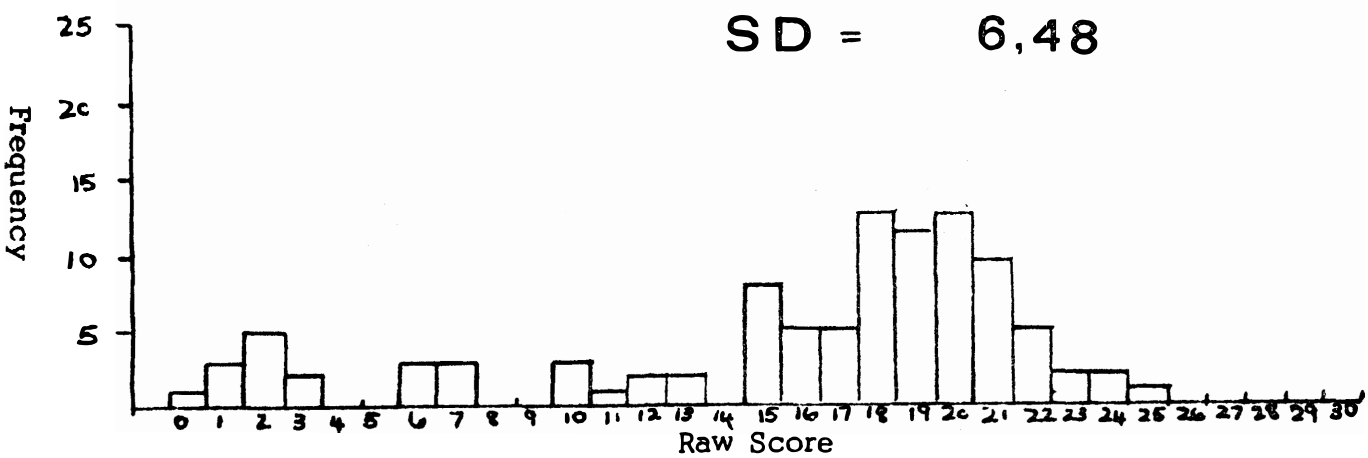
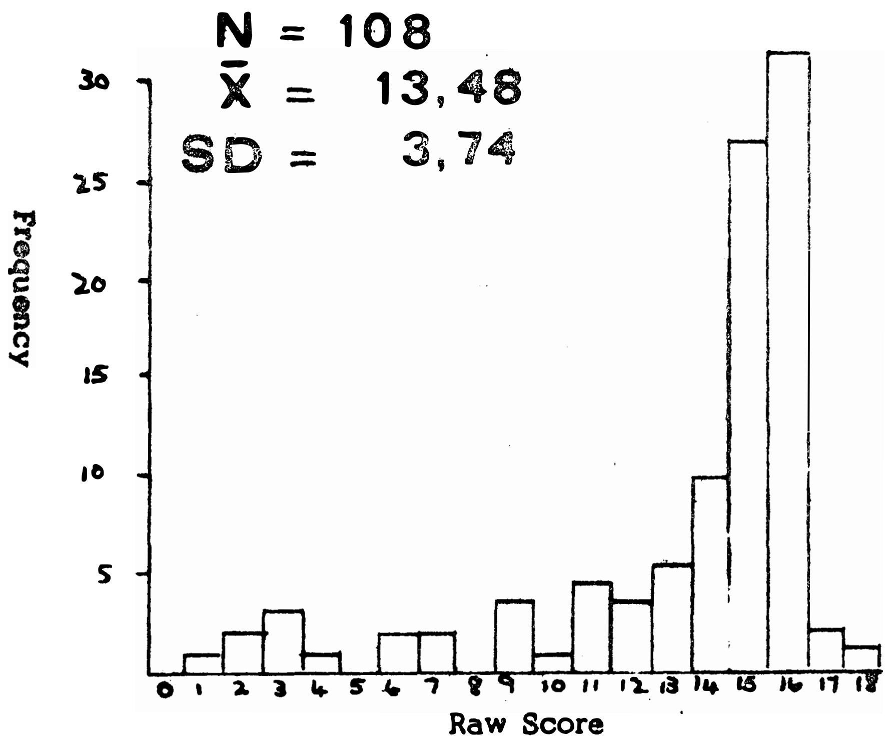


Figure 20

COMPARISON OF RAW-SCORE FREQUENCY DISTRIBUTIONS OBTAINED ON THE EXISTING AND ADVANCED VERSIONS

FORM I TO MATRIC

EXISTING VERSION



ADVANCED VERSION

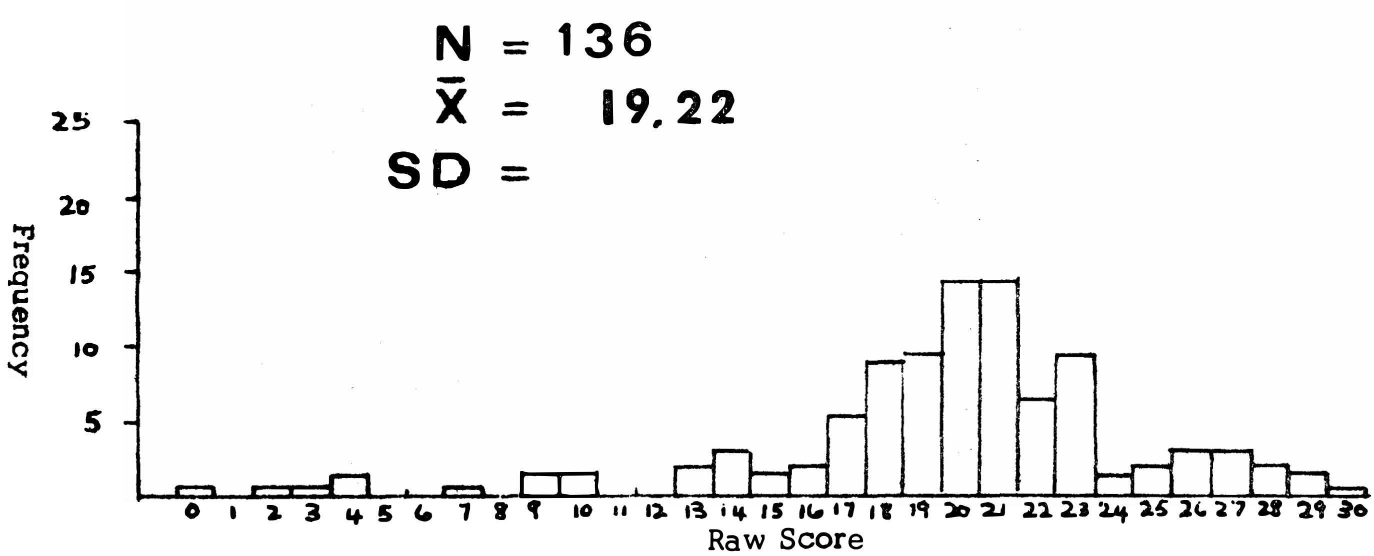


Figure 21

COMPARISON OF RAW-SCORE FREQUENCY DISTRIBUTIONS OBTAINED ON THE EXISTING AND ADVANCED VERSIONS

existing secondary industry version of the F.S.T., or by means of the "Mines" version which yields a less pronouncedly skewed distribution of scores.

Variances for the educational group Standards I and II (see Figure 18) are broadly comparable for both the old 18-item and the new 30-item versions. Again, there would be no harm in administering the existing versions of the F.S.T. to this group in preference to the advanced version.

For the remaining three educational groups (see Figures 19, 20 and 21), variance in terms of the new F.S.T. is far greater than variance in terms of the old F.S.T., thereby allowing the test user to make finer inferences concerning individual differences in cognitive performance, through using the new version. The distribution of scores is remarkably flat for the Standard III and IV group, but starts to become normal at the Standard V and VI level, and retains normality in the case of literates (Form I to Matric).

By far the best and most useful feature of the new F.S.T. is its ability to overcome the tendency in the old version for scores to cluster at the upper end of the scale.

In conclusion, the new F.S.T. should prove to be a worthy successor to the existing version, particularly when used as a means of selecting and placing African industrial workers who have had 8 or more years of formal schooling.

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